Spotlight on: Science and Technology Cooperation Between Southeast Asia and Europe

Analyses and Recommendations from the SEA-EU-NET Project

Alexander Degelsegger, Cosima Blasy (Eds.)

SEA-EU-NET
partners in science

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Preface

The ten member countries of the Association of Southeast Asian Nations (ASEAN) are home to around 600 million inhabitants. Both the ASEAN member countries, as well as the organisation, which was founded in 1967, are currently undergoing rapid and wide-reaching development. A key component of this development is investment in, and the implementation of measures to strengthen research and education, both nationally and regionally.

Individual ASEAN countries are partly developing very rapidly in terms of education, research, technology development and innovation. Patent applications and scientific publications are on the rise, competitiveness is increasing and a regional education area is developing. ASEAN countries' higher education systems are increasingly attractive to students from neighbouring countries.

Whilst the EU is working towards maximising the capacity and impact of research and innovation around the 2020 horizon through the "Innovation Union" initiative, the ASEAN nations are striving to increase their integration measures and to establish a union by 2015, which will share similarities with the EU model. Research and education will be an important part of this integration process and cooperation in research and education is gaining importance. The ASEAN Committee on Science and Technology (ASEAN COST) has a long standing history in ASEAN and is a platform for continuous dialogue and coordination. In twice yearly meetings, anually at ministerial level, common priorities are agreed and project proposals discussed. These meetings are increasingly used to discuss research and development cooperation between the ASEAN countries and partner regions or countries, and China, Japan, Korea and the EU are now involved in a structural and continuous exchange with ASEAN COST.

ASEAN countries are characterized by large differences in economic and S&T- indicators, for instance: GDP and per capita income, average education levels, level of investment in research and research capacity, development of innovation systems. Balancing the drive to rapidly develop scientific excellence, whilst smoothing inequalities in the standard of living within the countries of ASEAN and across the region as a whole, is a challenge for governments, businesses and academia across Southeast Asia. An additional challenge is posed by the threat to the the countries and especially the large cities of the region by the effects of climate change. Climate change is also affecting Southeast Asia's biodiversity: on about 3 % of the earth's surface, the region is home to 20 % of the world's species – many of these are endangered.

We are convinced that Southeast Asia and Europe are unique and exciting partners for each other. Combining their respective strengths in the areas of science and technology is a promising endeavour for both sides. S&T cooperation can, not only generate economic and social benefits for both regions, but is likely to contribute to addressing bi-regional and global challenges as well.

In order to maximise the potential for S&T cooperation and harness the opportunities, in depth dialogue and active cooperation are key. The SEA-EU-NET project, funded under the EU's 7th Research Framework Programme, is born from this conviction. It aims to suport both the S&T policy dialogue (such as between ASEAN COST and the European Union) as well as stimulate concrete cooperation between researchers and research institutions.

This book represents a compilation of SEA-EU-NET's analysis work to inform the policy dialogue between the two regions and to develop a greater understanding of ASEAN strengths and priorities in research, as well as of current patterns of cooperation between Europe and Southeast Asia.

We hope you find it useful and informative.

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INTRODUCTION

Introduction

Southeast Asia

Southeast Asia is a highly populated, demographically young region with a mostly tropical climate, spanning 5 million km² and including over 20,000 islands. It is rich in natural resources and biodiversity, comprising three of the world's seventeen 'megadiverse' countries and seven of the world's twenty five biodiversity hotspots. The region consists of 10 countries, namely Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam and is inhabited by circa 600 million people[1].

Southeast Asia is one of the most economically dynamic regions of the world, showing rapid development, stable growth performance and high potential for innovation. Levels of incoming, but also outgoing investment are growing. Industrial production, for instance in the automotive and electronics sector, is significant and enterprises are increasingly performing research and technological development (R&D) in the region. Exports from Southeast Asia have doubled in the last decade. While ASEAN is the EU's third largest trading partner (after the US and China), for ASEAN, the EU is its second largest partner after China.[2]

Southeast Asia has a highly diverse research landscape ranging from affluent city-state Singapore through to emerging economies with pockets of scientific excellence. Scientific output from Southeast Asia, as registered by international citation databases, has quadrupled over the last decade: Elsevier's Scopus database lists around 10,000 publications for the year 2000. For the year 2010, 40,000 Southeast Asian publications have been registered. Research strengths are recorded in engineering, biological sciences, food and medicine. The EU is ASEAN's most important partner in international scientific co-publications.

The geo-political and economic region of Southeast Asia is institutionalized as the Association of Southeast Asian Nations (ASEAN). ASEAN was founded in 1967 and has been moving towards tighter regional integration since its formation, with the goal of forming an ASEAN Community by 2015. Built upon the principles of mutual respect for the independence, sovereignty, equality, territorial integrity and national identity of all nations, the Association's aims include the acceleration of economic growth, social progress, the protection of regional peace and stability, cultural development among its members, and the provision of opportunities for member countries to discuss differences peacefully.[3]

Aside from the many differences in terms of natural resources, societal conditions, historical legacy and economic development, ASEAN shares similar political values and ambitions and is faced by similar challenges as the European Union. The diversity of the societies of Southeast Asia is a social and cultural capital, but at the same time poses an additional challenge to the regional integration not least of national S&T systems. Exchange on respective policy approaches is advantageous to both ASEAN, as well as the European Union. Cooperation between the two regions has mutual benefits on many levels.

ASEAN and the EU

As early as 2004, the European Commission published a Communication on the importance of its relationship with the Southeast Asian region, in which it outlined „a new partnership with Southeast Asia"[4]. The paper mentions not only mutual strong economic interests as a reason for the enhancement of bi-regional ties, but also the global scope of societal challenges in the intertwined world of today. Whilst these are both drivers for fostering science and technology cooperation between Europe and Southeast Asia, the Communication also identifies S&T as one of the sectors where cooperation and dialogue could, and should, be extended.

There is mutual interest in ASEAN in expanding the bi-regional S&T cooperation and dialogue. The ASEAN Committee on Science and Technology (COST), and its subcommittees, provide a forum for discussing regional S&T cooperation in ASEAN, and have implemented a Plan of Action in S&T (APAST), which identifies thematic priorities for regional S&T cooperation, as well as defines guidelines for stronger international collaboration. Along these guidelines, ASEAN COST and the European Commission launched an S&T policy dialogue in 2008 with regular senior officials meetings. This dialogue was formalised in 2010, becoming the annual EU-ASEAN S&T Dialogue.

ASEAN-EU cooperation in the field of science, technology and innovation

Drivers and motivations for international cooperation in science, technology and innovation are manifold as reported by literature[5]. At the policy-making level, these can include (depending among other things on the current S&T output): tackling societal and global challenges through research, S&T capacity-building, maintaining and developing competitiveness, achieving research excellence and facilitating the free exchange of ideas, as well as the will to guide researchers' mobility in a global competition for scarce human resources and research talent, and the growing importance of science as a means in international diplomacy.

All of these drivers are relevant for the European Union's process of implementing a European Research Area and for other regions' cooperation with Europe, for instance through participation of researchers in the 'Cooperation' programme of the current EU Research Framework Programme (FP7, running 2007–2013). Within its 'Capacities' programme, FP7 also supports a series of projects facilitating the bi-regional S&T policy dialogue with Southeast Asia and other regions with the aim of increasing international S&T cooperation levels and output.

International S&T cooperation, which will continue to be vital to deliver world class science and encourage innovation, is highlighted in the Innovation Union flagship initiative of the Europe 2020 Strategy. It will also be a strong element of the next Framework Programme, 'Horizon 2020', which will be the first framework programme to bring together research and innovation.

SEA-EU-NET

The FP7-supported project SEA-EU-NET, "Facilitating the Bi-regional S&T Policy Dialogue between Southeast Asia and Europe", has been running since the beginning of 2008 and brings together 9 Southeast Asian and 13 European institutions. Its mandate is to increase the quality, quantity, profile and impact of bi-regional S&T cooperation between the ASEAN states and the EU Member States and Associated Countries.

Following this mandate, the project supports the networking of both research areas through policy dialogue, thematic workshops as well as networking events. It increased the information flow to scientists on the ground and explored opportunities for scientists to make collaborations happen. Since the launch of SEA-EU-NET, there has been a notable increase in Southeast Asian participation in FP7. Inspired by SEA-EU-NET, 2012 will be the ASEAN-EU Year of Science, Technology and Innovation. This Year will highlight, promote and extend the reach of scientific cooperation between the regions and its benefits to society. It will further increase the networking on the policy level and the services and opportunities for scientists.

SEA-EU-NET also provides quantitative and qualitative analytical evidence for S&T policy making and identifying strategic areas for S&T collaboration. The project has developed a profound knowledge base of both the current and future cooperation, of the mutual relevance of both research areas for each other as well as of the strategies of both regions in terms of international S&T cooperation.

The following compilation brings together some of the most significant components of this knowledge base. It presents outcomes of a set of SEA-EU-NET analysis activities aiming at deepening cooperation and supporting shared science policy in and between Southeast Asia and Europe. In these analyses, quantitative studies have been conducted as well as a set of qualitative methods used.

The book is set out as follows: In three chapters, the first part presents the results of the quantitative studies on research strengths of Southeast Asian countries (chapter 1), co-publication activity between Southeast Asia and Europe (chapter 2) and participation of Southeast Asian partners in FP7 (chapter 3).

The second part of the book focuses on the results of a series of qualitative studies conducted by SEA-EU-NET. Chapter 4 sets the stage by introducing some of the priorities outlined in selected ASEAN countries' S&T policies and by pointing out areas of possible mutual interest between Europe and Southeast Asia. Chapter 5 identifies opportunities and pitfalls of S&T cooperation between the two regions based on expert assessments of current collaboration. Chapter 6 looks into the future of bi-regional S&T cooperation and asks what is driving scientists to cooperate and what successful cooperation might look like in the year 2020. Chapter 7 complements the aspects touched upon in earlier chapters and offers relevant information for the implementation of a successful cooperation future: it takes a close look at the internationalisation strategies in ASEAN countries' S&T policies, their goals and patterns in the current practice. Finally, chapter 8 presents cases of bi-regional science cooperation tackling global challenges, which is a highly relevant issue for future cooperation.

1 European Union: 27 countries and 500 million inhabitants on 4.3 m. km²
2 WTO and European Commission international trade statistics
3 http://www.asean.org/64.htm
4 European Commission (2004): Commission Communication on a new partnership with South-East Asia, COM (2003) 399 final
5 SEA-EU-NET's own work on Southeast Asia and Europe (see chapter 6) as well as Boekholt, Patries et al. (2009): Drivers of International collaboration in research. Final Report, Brussels: European Commission

Quantitative evidence for science cooperation policy-making

The current state of science and technology (S&T) in Southeast Asian countries is varied: from global leader in research and technological development, Singapore, to countries only recently starting to invest in S&T, like Laos or Cambodia. The patterns of science cooperation of Southeast Asia globally, and with Europe in particular, are wide ranging and diverse in their form and maturity. There are no comparative datasets to measure the research performance of these countries and their inclusion in the global academic community. Bibliometric analyses were thus conducted by the SEA-EU-NET project (chapters 2 and 3) and commissioned by it (chapter 1) to partly fill this gap. This chapter provides quantitative evidence on research strengths of the Southeast Asian countries, as well as on the joint output of scientific cooperation between this region and Europe.

The primary aim of this work is to show there are pockets of scientific excellence across different thematic areas in Southeast Asia offering a rich cooperation potential. The second aim is to explore how to maximise the opportunities flowing from this cooperation potential. Identifying research priorities is a political task, taking into account joint visions and common social, environmental and economic challenges. However, there is much to be gained from taking into account current strengths in output and cooperation to identify new priorities and niche areas of common interest, and to effectively implement predetermined priorities.

Chapter 1 summarizes a comparative study of research output within Southeast Asia in a selected number of thematic areas, as well as its international impact. It also includes a comparative study of the research performance within top universities of Southeast Asia, partly drilling down to the level of individual researchers. Chapter 2 complements these findings by presenting trends and dimensions in academic co-publications that were published by European and Southeast Asian scientists collaboratively during 2000–2010. Finally, chapter 3 offers a breakdown of participation of the ASEAN countries in the EU's 7th Research Framework Programme (FP7, 2007–2013), providing supplementary information that enables a more comprehensive understanding of patterns, trends and developments in scientific cooperation between Europe and Southeast Asia.

The findings presented are extracts from the analysis work that was done within SEA-EU-NET during 2010 and 2011. For any specific data that is not accomplished in this chapter, you may refer to the authors of the different chapters or visit www.sea-eu.net/bibliometrics.

1 Research strengths of ASEAN countries

Peter Haddawy, Saeed-Ul-Hassan,
Pratikshya Kuinkel, Surendra Sekhai[6]

The following section summarises a comparative study of research output within Southeast Asia that was commissioned by SEA-EU-NET and conducted by UNU-IIST using quantitative bibliometric measures. The analysis presents overall country, as well as institutions' publication figures for the period from 2000 to 2008 and gives exemplary evidence on the most relevant individual authors.

1.1 Methodology

This chapter covers the following FP7 thematic areas[7]:
- Nanotechnology
- Information and Communication Technology
- Industrial Technology
- Energy
- Food, Agriculture and Biotechnology
- Environment
- Health

For thematic areas that match with a particular discipline, i.e. Energy and Environment, we have simply used Elsevier's defined Scopus subject areas for procuring publications. For interdisciplinary areas like Nanotechnology and for areas where there is a particular sub-area of the discipline to be emphasized like ICT, Industrial Technology, Food, Agriculture and Biotechnology and Health, a keyword based approach is used. The lists of keywords have been vetted by the relevant National Contact Points.

Analyses for each thematic area are conducted at multiple levels: ASEAN, ASEAN member countries, institutions, and individual researchers. First, the publication and citation volume of ASEAN in each area is compared to that of the EU in order to help identify areas of alignment of research strength, that is areas where Southeast Asian excellence in research matches European. Next, the performance of ASEAN is benchmarked with China, Japan, South Korea and Australia. This helps to understand the standing of ASEAN as a whole in Asia-Pacific region. Next, the research strength among all ASEAN countries and universities is examined. This provides an understanding of the distribution of research strengths in ASEAN. Drilling down further, top researchers in ASEAN in each thematic area are identified. This is useful to identify experts that can be called for consultation in programme planning.

When analysing ASEAN and the EU, papers published by authors in more than one country are counted only once, i.e. there is no double counting of publications.

1.1.1 Bibliometric indicators

A range of bibliometric indicators is used to measure research performance. Research strength is analysed in terms of publication and citation volumes, market share and research internationality. The absolute number of publications and citations are counted which provide actual research output and scholarly impact. The relative proportion of publications for each country gives the country's publication market share amongst the selected countries, and the relative proportion of citations shared by the country amongst the selected countries indicates its citations market share. This provides a direct quantitative measure of a country's relative research position. To analyse research internationality of countries, percentage international collaborations and international citations are calculated. Percentage international collaborations indicate the international research linkages relative to a country's total research output. It is calculated as the volume of publications produced by a country with an international co-authorship in a given research area divided by the total volume of publications produced by that country in that research area. International citations show the international impact of the research work produced by a country relative to its total research impact. It is calculated as the ratio of citations received by one country from all other countries to the total citations received by this country in the certain research area.

The analyses are conducted over the time period of 2000 to 2008, but a five year sliding window has been selected for ease and to smooth the graphs in order to make trends more evident. A publication time window of 2000–2004 shows the volume of publications during these five years. A citation time window of 2000–2004 shows the number of citations received during these five years by the papers published within this timeframe. Elsevier's Scopus database is used as data source for all analyses and the data was obtained in November 2010. Publication numbers reported represent all publication types indexed in Elsevier's Scopus database.

1.1.2 Chapter structure

This chapter is organized as follows:
- Comparison of ASEAN with EU across all seven subject areas in terms of publication and citation volumes.
- Five analyses for each subject area:
  - Global analysis in terms of publication volume
  - ASEAN versus some major countries in Asia-Pacific region in terms of publication and citation volumes and research internationality.
  - Analyses among ASEAN countries and top institutes in ASEAN in terms of publication and citation volumes and research internationality.
  - Top researchers in ASEAN region in terms of publication and citation volumes.

A comprehensive set of analyses is presented in the body of the subchapter for Nanotechnology. For the remaining thematic areas, only the most relevant findings are presented. The full analysis results are presented in the article: "Analysis of research strengths of SEA countries for SEA-EU-NET under task 4.9 bibliometric analysis of S&T strengths in Southeast Asia," which is available to download at www.sea-eu.net/bibliometrics.

1.2 Bibliometric analysis

Figure 1 compares scientific output (number of publications) and impact (number of citations) of the ASEAN country with the EU for the seven thematic areas analysed. Relative to the EU, ASEAN is strongest in Nanotechnology with 8.96 % the publication output of the EU and 6.40 % the citation count. ASEAN is also relatively strong in relation to the EU in the areas of ICT, Industrial Technology, and Energy. There is then a clear drop in relative strength to the next three areas.

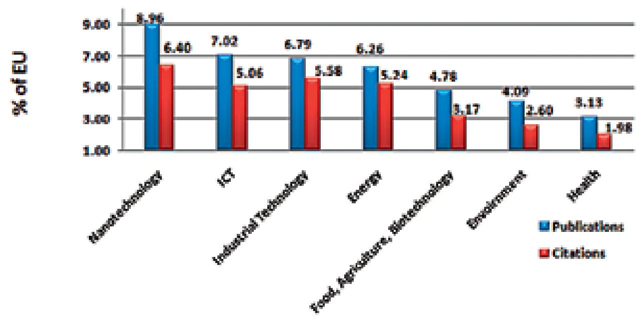

Figure 1: ASEAN research output relative to EU

1.2.1 Nanotechnology

The country level analysis has been conducted as two different sets: One compares the ASEAN region as a whole with some major countries of the Asia-Pacific region like China, Japan, South Korea and Australia. The other compares research strengths among the countries in ASEAN region. The comparison was made along the dimensions of publication and citation volumes, international collaboration and international citations.

Figure 2 benchmarks the research performance of ASEAN against that of China, Japan, South Korea, and Australia. China is leading in terms of publications in Nanotechnology, followed by Japan, then South Korea and finally ASEAN and Australia, which are close in terms of publication volume. Citations show a similar pattern to publications with China as the leading country followed by Japan, South Korea, ASEAN and Australia.

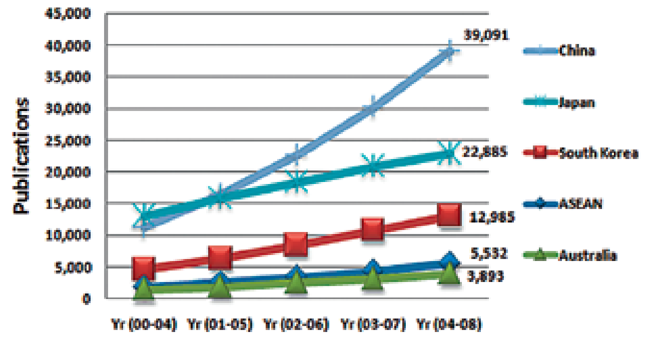

Figure 2: Publications (ASEAN vs. major countries in the Asia-Pacific region) in Nanotechnology

Figures 3 and 4 show the comparison of international collaborations and international citations for the benchmarking countries. Interestingly, ASEAN has overtaken Australia in recent years and now has the highest percentage of international citations. ASEAN is second, behind Australia, in terms of international collaboration. While China excels in publications and citations, it is quite low in terms of percentage of international collaboration and citations.

6 All authors are at UN University's IIST, Macao. Corresponding author's email address: haddawy@unu-iist

7 Analyses for additional subject areas are under way

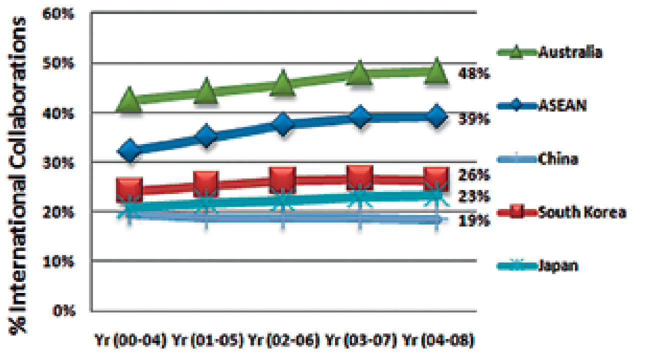

Figure 3: Percentage of international collaborations in Nanotechnology

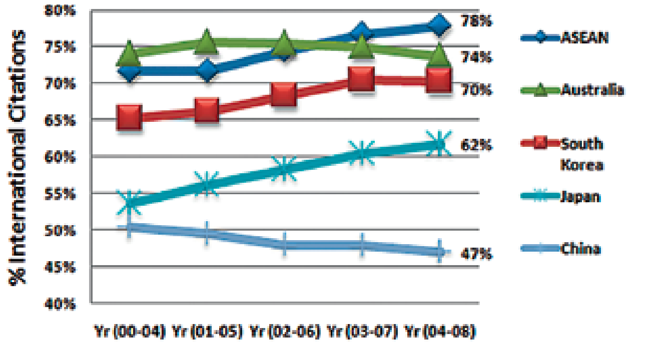

Figure 4: Percentage of international citations in Nanotechnology

Comparing relative strengths of the countries within ASEAN in Nanotechnology, Singapore is dominant, as can be seen in figure 5. The publication count for Singapore is almost 4000, which is significantly ahead of the second largest publishing country, Thailand (757). It is similar for citation volume. This evidences ASEAN's strength in Nanotechnology is driven by Singapore. Regarding the other ASEAN countries, we see that Thailand is relatively strong, followed by Malaysia and Vietnam.

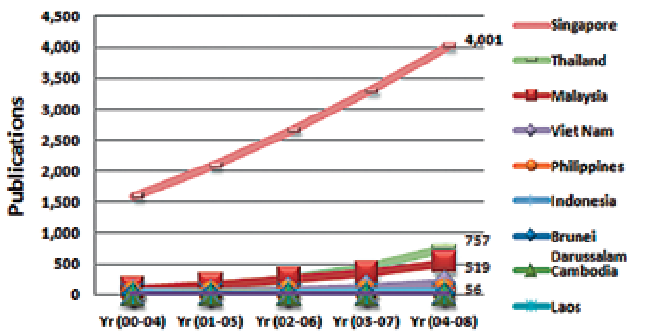

Figure 5: Publications (ASEAN countries) in Nanotechnology

Drilling further down to the University level, figure 6 shows the top universities within ASEAN in Nanotechnology in terms of publication volume. It is not surprising that Singapore's National University of Singapore and Nanyang Technological University are taking the lead. Both universities are close in publications but the National University of Singapore leads in terms of citation output.

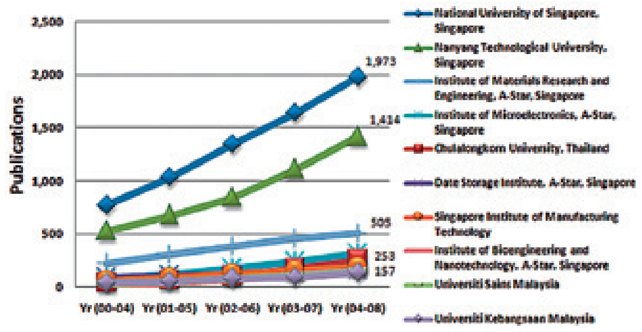

Figure 6: Publications (top universities in ASEAN) in Nanotechnology

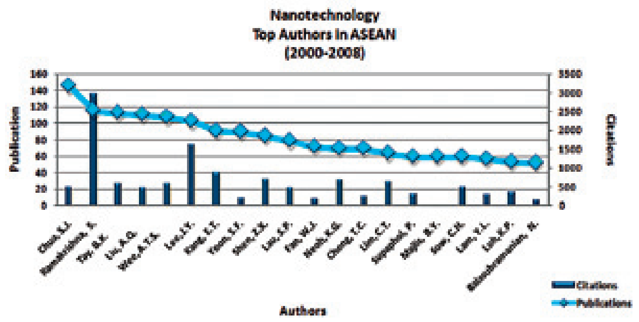

Figure 7: Top authors in ASEAN in Nanotechnology

The above figure shows the top authors in ASEAN in the field of nanotechnology. Their corresponding affiliations are listed in the table below. Affiliations shown in the SCOPUS database were manually verified. Nine of the top researchers in Nanotechnology in ASEAN are from National University of Singapore and seven are from Nanyang Technological University. Overall, Singapore is home to 18 of the top 20 researchers. The remaining two researchers are from Malaysia and Thailand.

Table 1: Southeast Asian authors with most publications in the field of Nanotechnology

Author	Affiliation
Kang, E.T.	National University of Singapore, Department of Chemical and Biomolecular Engineering
Lee, J.Y.	National University of Singapore, Department of Chemical and Biomolecular Engineering
Neoh, K.G.	National University of Singapore, Department of Chemical and Biomolecular Engineering
Chua, S.J.	National University of Singapore, Department of Electrical and Computer Engineering
Chong, T.C.	National University of Singapore, Department of Electrical and Computer Engineering
Lim, C.T.	National University of Singapore, Department of Mechanical Engineering
Ramakrishna, S.	National University of Singapore, Department of Mechanical Engineering
Sow, C.H.	National University of Singapore, Department of Physics
Wee, A.T.S.	National University of Singapore, Faculty of Medicine
Balasubramanian, N.	Nanyang Technological University
Shen, Z.X.	Nanyang Technological University, Division of Physics and Applied Physics
Loh, K.P.	Nanyang Technological University, School of Chemical and Biomedical Engineering
Lau, S.P.	Nanyang Technological University, School of Electrical and Electronic Engineering
Liu, A.Q.	Nanyang Technological University, School of Electrical and Electronic Engineering
Tay, B.K.	Nanyang Technological University, School of Electrical and Electronic Engineering
Yoon, S.F.	Nanyang Technological University, School of Electrical and Electronic Engineering
Majlis, B.Y.	Universiti Kebangsaan Malaysia, Department of Electrical, Electronic and Systems Engineering
Supaphol, P.	Chulalongkorn University, Petroleum and Petrochemical College
Lam, Y.L.	DenseLight Semiconductors, Singapore City

1.2.2 Information and Communication Technology

The Southeast Asian research output in Information and Communication Technology shows similar patterns to research performance in Nanotechnology, but although Singapore is dominant, it is not to the same extent as for Nanotechnology. In terms of publications in figure 8, we can see a clustering of countries with Singapore leading, followed by Malaysia and Thailand, and then followed by the other counties.

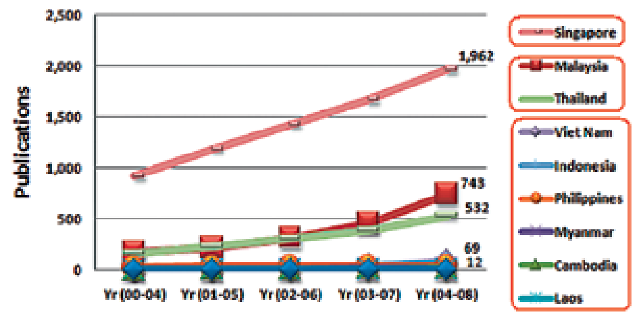

Figure 8: Publications (ASEAN countries) in Information and Communication Technology

At the University level (figure 9), Nanyang Technological University leads in number of publications while in terms of citations, the National University of Singapore takes the lead. Of institutions outside Singapore, Multimedia University of Malaysia has the highest number of publications.

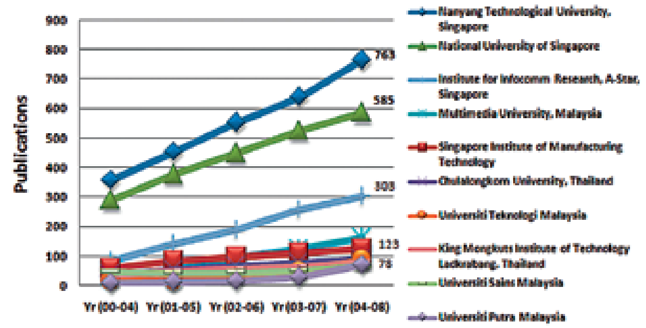

Figure 9: Publications (top universities in ASEAN) in ICT

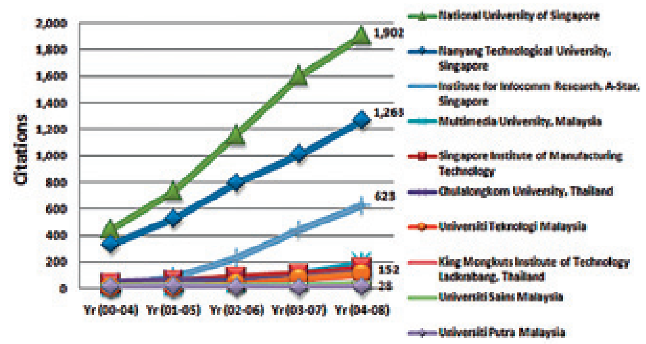

Figure 10: Citations (top universities in ASEAN) in ICT

1.2.3 Industrial Technology

As regards Industrial Technology, it can be clearly seen from figure 11 that within the time span of 2003 to 2008, there has been an explosion of research activity in China. The rate of growth is remarkably high.

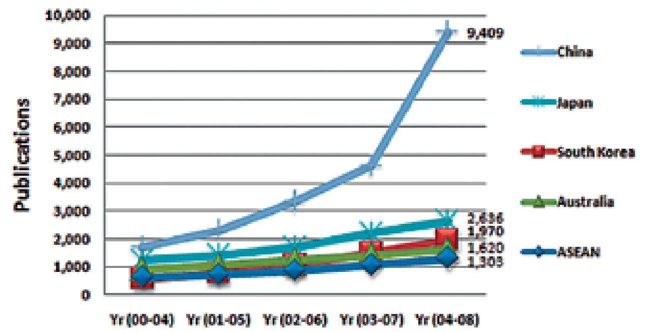

Figure 11: Publications (ASEAN vs. some major countries in the Asia-Pacific region in Industrial Technology)

The ASEAN country analysis resembles the results in the field of ICT. Figures 12 and 13 show some clustering with Singapore leading, followed by Malaysia and Thailand, and then the other countries.

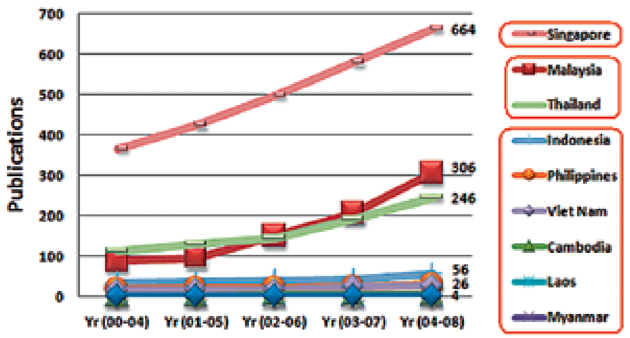

Figure 12: Publications (ASEAN countries in Industrial Technology)

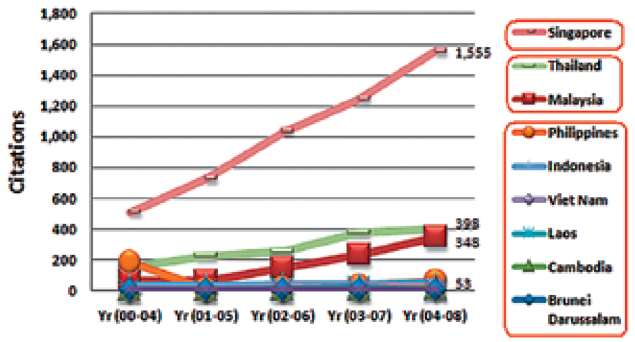

Figure 13: Citations (ASEAN countries in Industrial Technology)

1.2.4 Energy

In Energy, the picture looks different than that for previous subject areas where Singapore was dominant. Now Singapore, Thailand and Malaysia form one cluster in terms of publications (figure 14). Indonesia is also comparatively ranked higher in this subject area. However, in citations (figure 15), Singapore is again leading, followed by Thailand and Malaysia, and then the remaining countries.

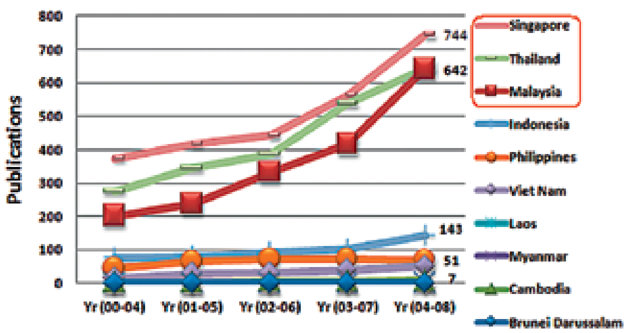

Figure 14: Publications (ASEAN countries in Energy)

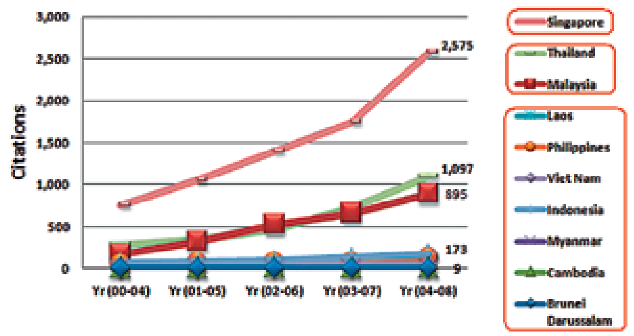

Figure 15: Citations (ASEAN countries in Energy)

At the university level, Nanyang Technological University is ahead of the National University of Singapore in both publications (figure 16) and citations. King Mongkut University of Technology, Thonburi of Thailand and Universiti Teknologi Malaysia, though not leading universities in their respective countries, are performing very well in the area of Energy. But in terms of citations, Chulalongkorn University of Thailand, which is considered as one of the flagship universities, is ahead of King Mongkut University of Technology. University of Malaya, which is considered as one of the flagship universities in Malaysia, is not performing so well in terms of both publications and citations.

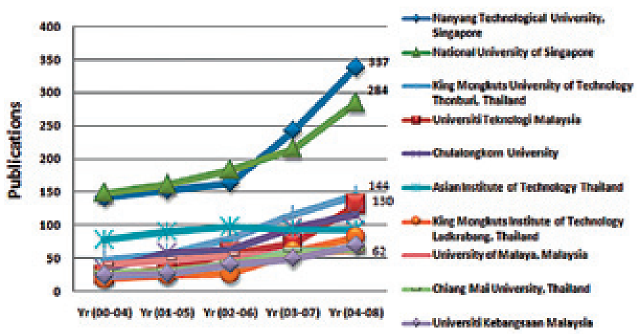

Figure 16: Publications (top ASEAN universities in Energy)

1.2.5 Food, Agriculture and Biotechnology

In Food, Agriculture and Biotechnology, Thailand is ahead of the other ASEAN countries in terms of publications (figure 17). We again see some clustering of countries: After Thailand, Singapore, and Malaysia, the countries Philippines, Indonesia, and Vietnam form one cluster, followed by the cluster of Cambodia, Laos, Myanmar, and Brunei Darussalam. In terms of citations, Thailand is ranked after Singapore (figure 18). Apart from Thailand and Singapore, we can see a cluster formed by Malaysia, Vietnam, Philippines, and Indonesia, with Cambodia and Myanmar clustered at the bottom.

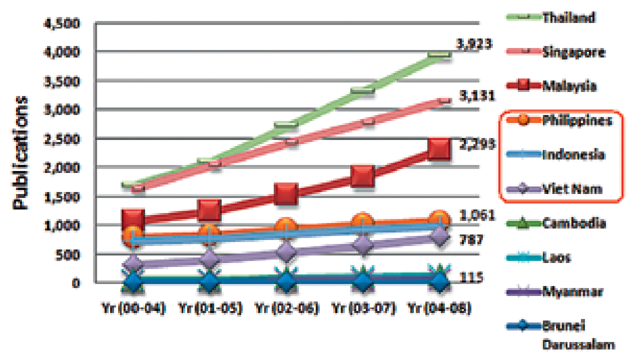

Figure 17: Publications (ASEAN countries in Food, Agriculture and Biotechnology)

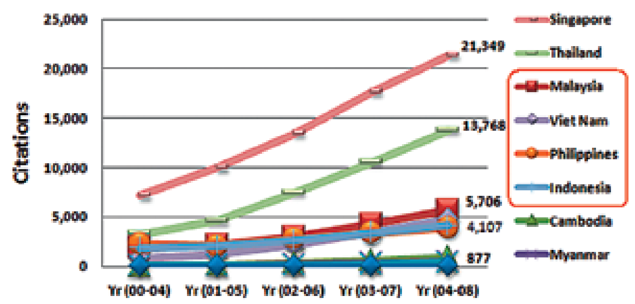

Figure 18: Citations (ASEAN countries in Food, Agriculture and Biotechnology)

Although Thailand leads in terms of publications at country level analysis, it is very surprising to note there are not any Thai universities on the top at university level publication analysis (figure 19).

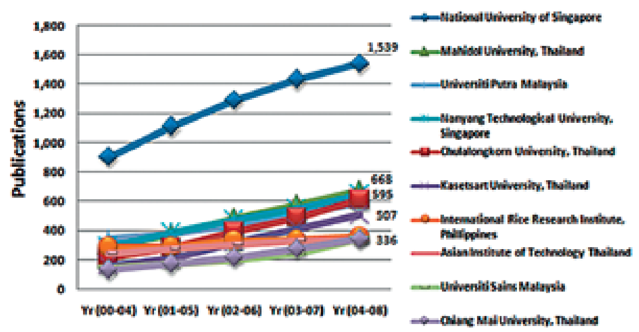

Figure 19: Publications (top ASEAN universities in Food, Agriculture and Biotechnology)

When we look at the publication market share (figure 20), we can see that there is no single Thai university which is leading in this subject area, but activity is distributed across many Thai universities.

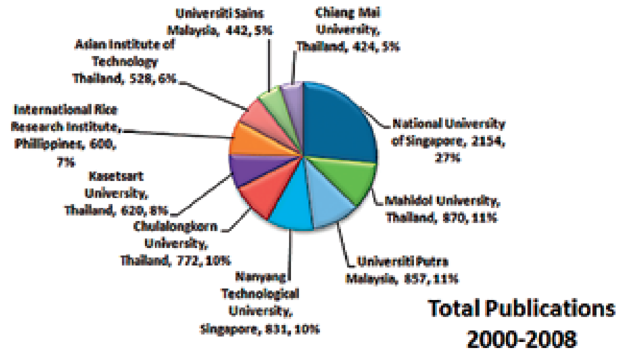

Figure 20: Publications market share in Food, Agriculture and Biotechnology among top 10 ASEAN universities

1.2.6 Environment

It can be seen from the diagrams below (figure 21) that South Korea and the ASEAN region have similar publication volume, but the percentage of international collaborations is higher for ASEAN than for South Korea.

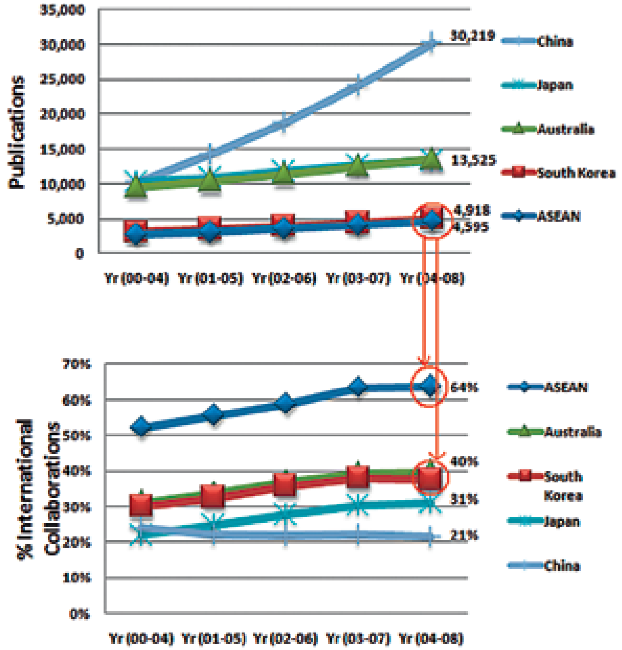

Figure 21: Publications and % international collaborations in Environment

In terms of citation volume (figure 22), ASEAN is ahead of South Korea and the percentage of international citations also shows a similar picture.

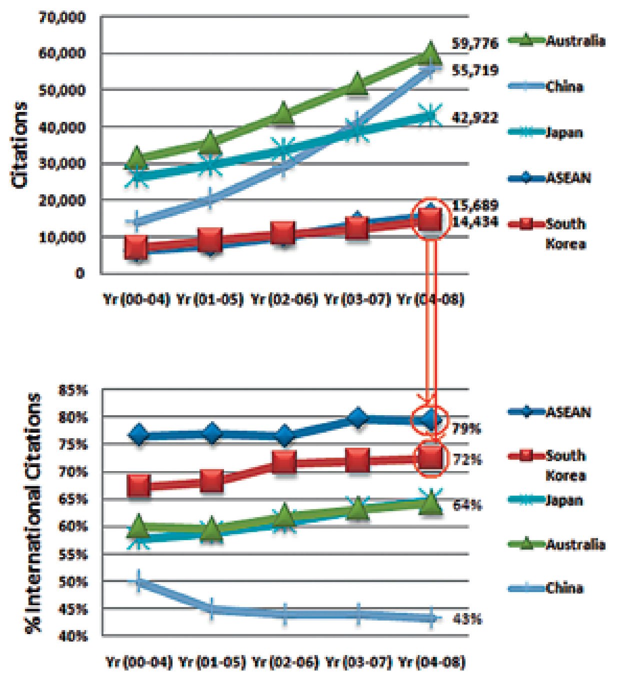

Figure 22: Citations and % international citations in Environment

When ASEAN countries are analyzed, Thailand and Singapore are leading in terms of publications (figure 23) with Malaysia not significantly behind these leading countries. Following these, two clusters can be identified: Indonesia, Philippines and Vietnam in one cluster and Cambodia, Laos and Myanmar in another. In terms of citations, Singapore leads with Thailand a close second.

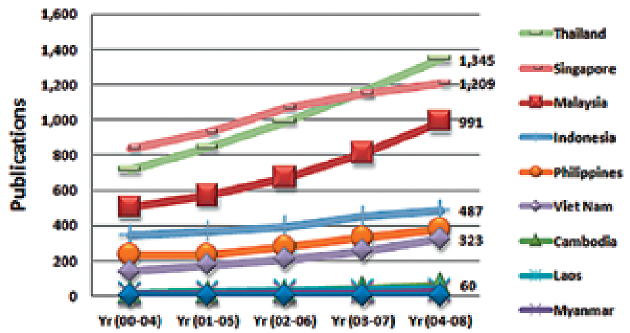

Figure 23: Publications (ASEAN countries in Environment)

University level analysis is similar to Food, Agriculture and Biotechnology. Although Thailand is leading in terms of publication volume (figure 24), no single Thai university has a exceptionally high number of publications and activity is distributed among the Thai universities in this subject area (figure 25). In terms of citations, the National University of Singapore is leading.

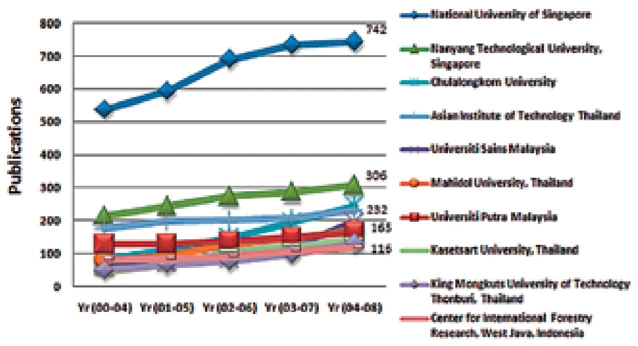

Figure 24: Publications (top ASEAN universities in Environment)

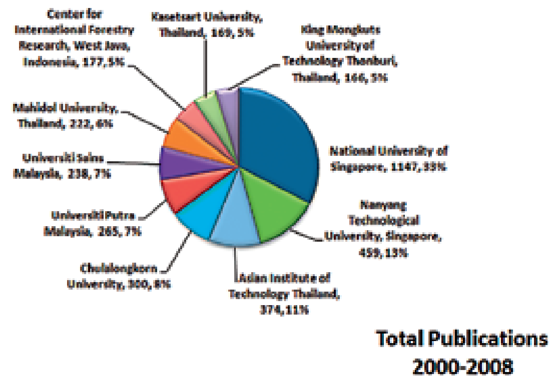

Figure 25: Publications Market Share (top ASEAN universities in Environment)

1.2.7 Health

When it comes to the area of health, at the country level analysis, Singapore and Thailand are close in terms of both publications (figure 26) and citation volumes. Malaysia is comparable in terms of publication volume but it has much lower citation volumes.

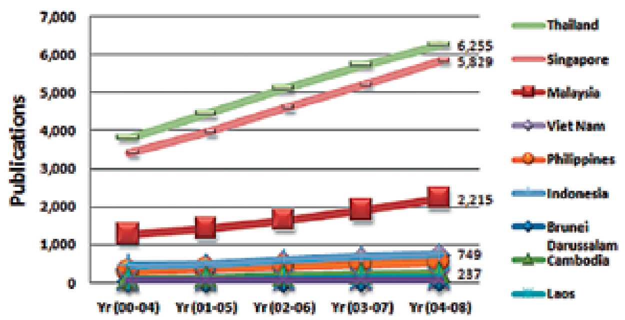

Figure 26: Publications (ASEAN countries in Health)

At the university level analysis, Mahidol University of Thailand is clearly leading in terms of publication volume (figure 27),while in terms of citations (figure 28), there is a tie between Mahidol University and National University of Singapore. The National University of Singapore is separated from the National University Hospital, Singapore because both have different affiliation IDs in Scopus.

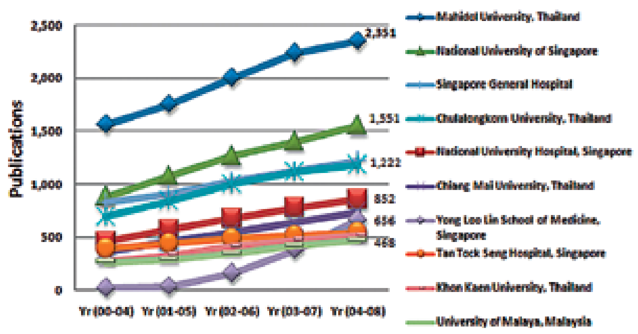

Figure 27: Publications (top ASEAN universities in Health)

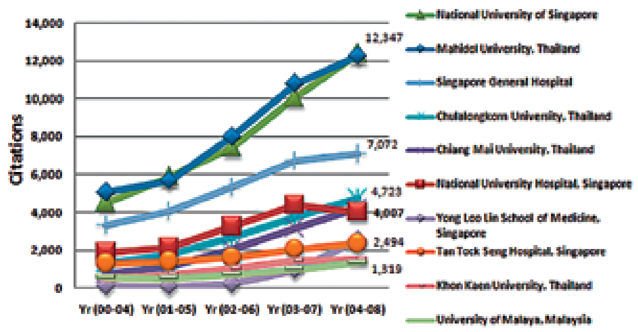

Figure 28: Citations (top ASEAN universities in Health)

1.3 Conclusion

Based on the analyses conducted at various levels, the following points can be concluded:

The ASEAN region's research output is comparatively strong compared to EU output in Nanotechnology, Information and Communication technology and Industrial Technology. Singapore is dominant among ASEAN countries in these areas, followed by Malaysia and Thailand.

In other areas, strengths are more distributed among ASEAN countries:

- In Energy, Singapore, Thailand and Malaysia are similar in terms of publication volume while Singapore is ahead in citations followed by Thailand and Malaysia and then Indonesia.
- In Food, Agriculture, and Biotechnology,
  - Thailand leads in publications, but has near half the citations of Singapore.
  - Research strength in Thailand is distributed among universities with no single dominant university in the area. This has important implications for Thailand in terms of leveraging their research strength in this area.
  - Good distribution of strength can be seen in the ASEAN region among countries like Thailand, Singapore, Malaysia, Philippines, Indonesia and Vietnam.
- In Environment,
  - Thailand and Singapore are close in terms of publication and citation volumes.
  - Thailand's strength is again distributed amongst different universities
  - There is a good distribution of strength among ASEAN countries like Thailand, Singapore, Malaysia, Philippines, Indonesia and Vietnam
- In Health,
  - The highest number of publications in the ASEAN region is in the area of health
  - Thailand and Singapore are close in publication and citation volume
  - Mahidol is dominant in publications, while it is essentially tied with the National University of Singapore in terms of citations.
- ASEAN has a high percentage of international collaborations and international citations

The preceding analysis results offer a detailed view into the scientific output of the ASEAN region, its individual member countries, the main research performing institutions as well as, individual researchers. For discussions on S&T cooperation between ASEAN and Europe, not only evidence on the respective strengths in terms of research output, but also insights into the current level of science cooperation can play a supportive role. The following two sections will offer these insights, first by looking at international academic co-publications between ASEAN and EU and then by reporting on the participation of ASEAN researchers in the EU's 7th Framework Programme.

2 EU-Southeast Asia co-publications: dimensions, patterns, trends

Alexander Degelsegger, Dietmar Lampert,
Johannes Simon, Isabella Wagner[8]

The following chapter identifies patterns and trends of scientific cooperation between Europe and Southeast Asia by analysing respective co-publications, i.e. publications with at least one author from each of the two regions. To have as comprehensive a picture of outputs as possible, within the scope of the given project resources, data for the years 2000–2010 was retrieved from Thomson Web of Science and Scopus.

2.1 Methodology

The SEA-EU-NET international co-publication study started as a preparatory part of the project's foresight exercise on the future of ASEAN-EU S&T cooperation. Together with the above work on research strengths in Southeast Asia, it has grown to analyse collaborative scientific output for increasing and deepening our analytical understanding to support the policy-dialogue. The study identifies current cooperation output patterns, which can be used as indicators helping to identify and implement strategic and emerging fields. The goal is to:

- generate evidence-based support for STI policy-makers in priority setting,
- help to implement politically chosen and socially relevant priorities (e.g. by indicating strong existing links to build upon) and
- perform other S&T policy planning tasks such as defining programme goals.

'Publication' refers to scientific publications in acknowledged scientific journals, or conference proceedings, such as papers, articles, letters, etc. that are indexed in one of the major academic databases. An international co-publication is a publication with at least two authors from institutions located in at least two different countries – in our case in at least one country in Southeast Asia (ASEAN Member States) and one within the European Union (EU27 plus candidate countries plus the countries associated to the 7th Research Framework Programme).

Our data is acquired from two different sources, namely the two major scientific literature and citation databases: Scopus (Elsevier) and Web of Science (Thomson Reuters). We retrieved meta-data of all co-publications published in the years from 2000 to 2010 by at least one Southeast Asia-based and one EU-based researcher. As the two sources might still be in the process of completing the data compilation for the year 2010, numbers for this year should not be considered final, although any pending modifications should be minor compared to the data already available. In addition, each of the two source databases has limitations in its coverage. Scopus offers better overall coverage of the region, whereas Web of Science reports higher numbers of publications particularly in engineering-related areas and in relation to Singapore. Non-English publications are inconsistently collected in both databases. However, by combining the two sources and with supplementation, we can minimise incomplete, faulty or missing records and improve data quality and coverage in order to offer insight from the broadest range of literature as possible.

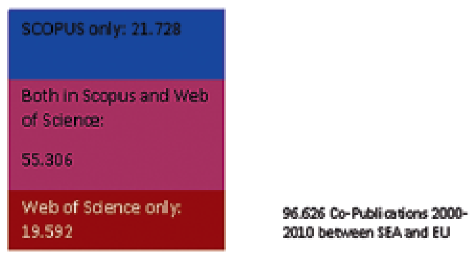

Figure 29: Data structure and its source

The data gathered to date consists of 96,626 SEA co-publications (with major world players like the EU, the US, Japan, etc.), of which 55,306 are included in both sources, 21,728 are only in SCOPUS and 19,592 only in Web of Science, as figure 29 shows[9].

The data has been standardised and normalised to remove variations from typing errors and different spellings of names, institutions and cities. Multi-step iterative algorithms are used to identify matching records contained in the datasets from both sources. For comparability on subject categories or scientific fields, both classification systems Web of Science and Scopus have been used and an equivalent for each defined. We also made use of the OECD Frascati Fields of Science and Technology for the purpose of assigning records to an established unified set of subject areas.

There are certain limitations in data coverage, for instance regarding total publication counts for each country: to date, the overall publication numbers per country are estimates provided by the Scopus database. It would have exceeded the project resources to retrieve all publications indexed in each of the databases for all 10 ASEAN countries and process them the same way we did with the subset of the ASEAN-EU co-publications. In addition, quantitative studies on co-publications always have to cope with the inability to qualitatively assess the extent to which publications have been produced collaboratively (i.e. to indicate how much each author has contributed.). In this instance, equal contribution from each author has been assumed as the best possible guess. It would be interesting and worthwhile to carry this work further by a qualitative analysis of the type and providence of subsets (or groups of cases) of the co-publications that we focus on, answering questions like: Are the co-authors mostly professors and students or colleagues at the same level of seniority? What contact has been established (actual physical contact at a conference or research stay; virtual contacts) between the authors? Who tends to contribute what? Although a comprehensive coverage is impossible, much could be learned from these studies for the task of translating STI cooperation programmes into cooperation and, ultimately, into publication impact.

2.2 Co-publication analysis

2.2.1 Comparing EU-ASEAN scientific co-authorship with ASEAN cooperation with other major players

Europe and Southeast Asia have become important partners in cooperative academic production. From 2000 until 2010, 33,524 distinct academic co-publications between Europe and the Southeast Asian region have been published and listed[10] in at least one of the two databases assessed for this analysis (Elsevier's Scopus and ISI's Web of Science). Co-publication rates have accelerated at the beginning of this decade and have been at a continuous high over the past seven years.

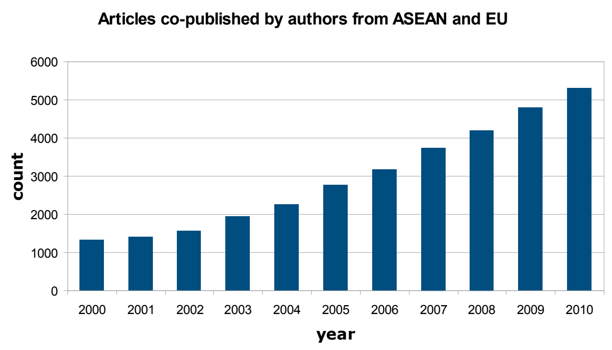

Figure 30: Articles co-published by authors from the ASEAN countries and the EU

In order to contextualise these figures, we have also retrieved and analysed co-publications between Southeast Asian researchers and those based in one of the major scientific players worldwide. Based on pre-analyses and qualitative evidence from SEA-EU-NET work (cf. chapter 7 on ASEAN countries' internationalization strategies) we identified Australia, China, Europe, India, Japan, Taiwan, South Korea and the USA to be the global S&T players most important to ASEAN.

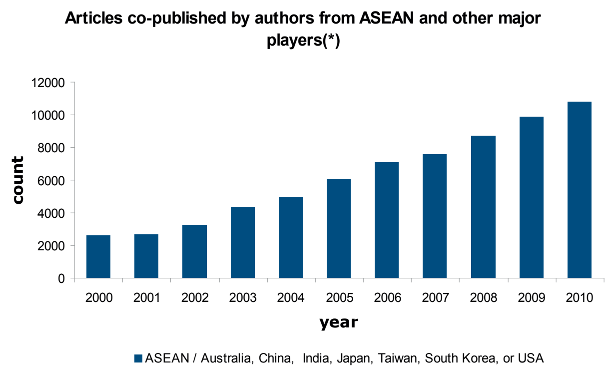

Figure 31: Articles co-published by authors from the ASEAN countries and other major players

The total count of all ASEAN co-publications with these major players (excluding Europe) between 2000 and 2010 were 67,991. Amongst them, the USA is the most important cooperation partner with 28,120 co-publications, followed by China with 15,337.

The following figure compares ASEAN-EU co-publication numbers with the amount of co-publications between ASEAN authors and scientists from each of the other major players individually.

8 All authors are at the Centre for Social Innovation (ZSI) in Vienna/Austria. Correrspronding author's email address: degelsegger@zsi.at

9 This variability in data coverage by Scopus and Web of Science should also be taken into account when interpreting the results in chapter 2: there might be research strengths detectable in Web of Science, but not in Scopus (just as there certainly are research strengths that can only be identified by using Scopus data).

10 As articles, letters, proceedings, etc.

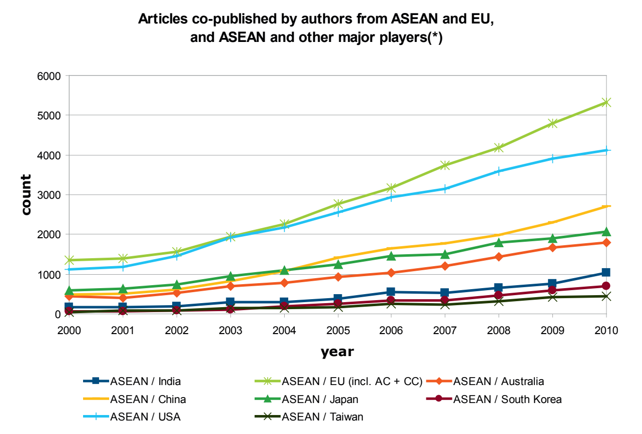

Figure 32: Articles co-published by authors from ASEAN and the EU and ASEAN and other countries

Looking at ASEAN's internationality with regard to its neighboring countries, China is the most important co-operation partner in the Asian region, followed by Japan and Australia.

As can be seen from this data, co-publication numbers have been growing between ASEAN and all major scientific communities. However, in comparing the growth rates over the same time series, one can see that ASEAN-Indian and ASEAN-South Korea co-publications registered the highest relative growth rates (together with the highly fluctuating ASEAN-Taiwan co-publication growth rate).

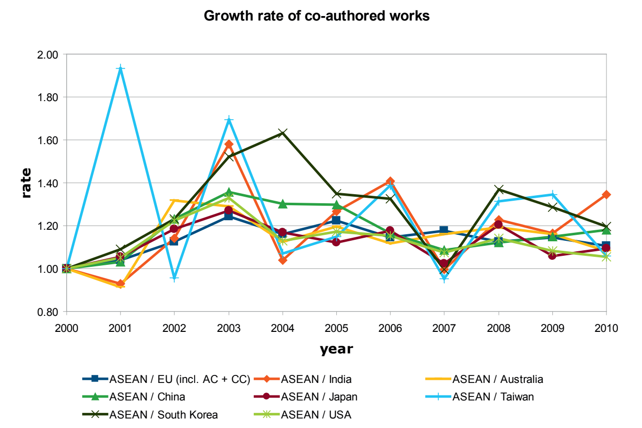

Figure 33: Growth rate of the number of co-authored publications between ASEAN and other regions

The growth rates in the number of co-publications could in principle stem from a growth in overall publications with a constant rate of co-publications per number of overall publications. A look at the following graph shows that ASEAN-EU co-publications have been growing at a similar pace as Southeast Asian publications: they have approximately quadrupled since the year 2000. Overall EU publications have slightly less than doubled over the same period.

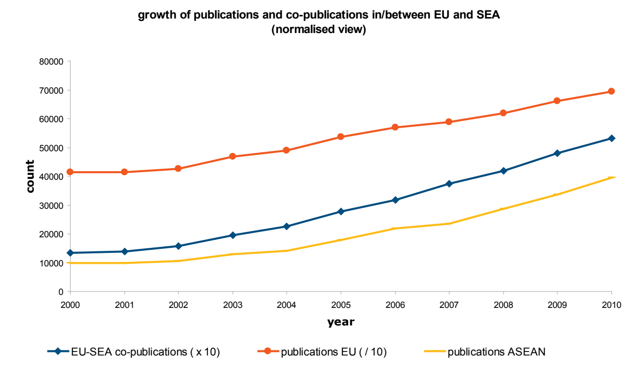

Figure 34: Number of publications and co-publications in/between EU and SEA (normalized view)

Comparing absolute co-publication counts of the individual ASEAN countries with other major world regions (USA, Japan, China and Europe) during 2005-2010, thus disintegrating the above data, Singapore is leading with more than 20,000 co-publications. It is followed by Thailand with almost 15,000 co-publications, while the other countries show less than one third of the Singaporean co-publication output.

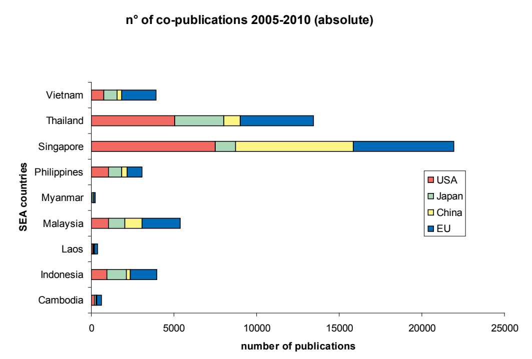

Figure 35: Number of co-publications 2005-2010 (absolute)

When looking at the relevance of each of the four major world regions co-publishing with Southeast Asian authors, the US is the dominant partner for Singapore, Thailand and the Philippines. For all other 7 ASEAN member countries, Europe is the most important partner region for co-publications. Summarizing the co-publications relatively, strongest scientific linkages between Europe and Southeast Asia are to be found with Malaysia, Vietnam and Indonesia in terms of absolute numbers and with Vietnam, Cambodia and Laos in terms of relative share.

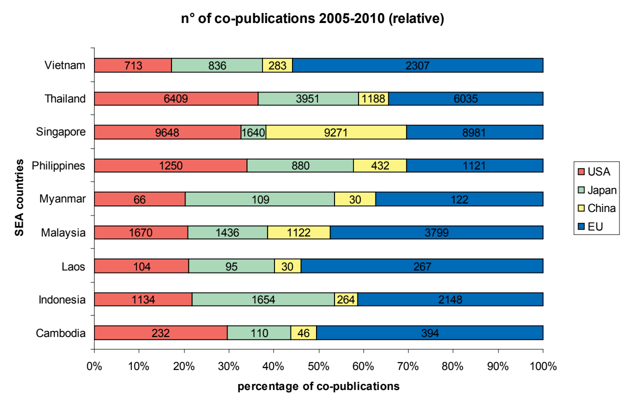

Figure 36: Number of co-publications 2005-2010 (relative)

With regard to the European countries, the United Kingdom is the leading research partner of the Southeast Asian countries, being most present in academic co-publications with Brunei, Indonesia, Laos, Malaysia, Singapore, Thailand and Vietnam.

2.2.2 Thematic fields of cooperation[11]

This section gives insight into the thematic patterns of the Southeast Asia-Europe cooperation. The thematic fields are taken from Scopus' ASJC subject categories. These over 300 categories are journal subject categories, i.e. each journal is attributed to one or more (in our data set, to an average of 2,3 different) thematic categories. Co-publications are assigned to the thematic field of the journal where they appear. Co-publications can appear in different thematic fields when the journal is assigned more than one subject category.

To measure the average impact of co-publications in the different subject areas, a data query on the number of citations made within each of the thematic fields has been analysed. The results show that the thematic areas that have the highest output (number of published articles) are not at all congruent with the impact (number of citations) of the scientific writings within these subject areas.

Table 2: The ten most relevant ASJC journal subject categories in ASEAN-EU co-publications and their impact

Rank (# of articles)	Subject category name	# of articles	# of times cited	Ratio
1	Infectious Diseases	2,441	30,287	12.41
2	Condensed Matter Physics	1,965	12,920	6.58
3	Engineering, Electrical & Electronic	1,838	12,417	6.76
4	Medicine (all)	1,630	43,836	26.89
5	Ecology, Evolution, Behavior and Systematics	1,458	11,621	7.97
6	Biochemistry	1,380	17,044	12.53
7	Molecular Biology	1,372	22,186	16.17
8	Chemistry (all)	1,306	11,250	8.61
9	Parasitology	1,162	12,762	10.98
10	Electronic, Optical and Magnetic Materials	1,155	6,877	5.95

11 Given the different thematic categorizations used by Web of Science and Scopus, this section is based on Web of Science data only.

It has to be taken into account that citation cultures (i.e. average citation per article rates) vary between different scientific communities and disciplines. Hence it is not necessarily surprising that average citation rates in the area of, for instance, engineering are not among the highest.

In order to reach to a final conclusion on the significance of the average citation rates for co-publications, they would have to be compared with average citation rates in the overall publications of the respective thematic area. The necessary requests and analyses would have exceeded the project's resource limits.

The following table sorts thematic areas following their amount of average citations per article. We see that Infectious Diseases or Electrical & Electronic Engineering are not among the most cited fields while health and biology-related fields are. In some categories, the numbers of co-publications are too low to get reliable results (medical-surgical; neuropsychology, chemistry miscallaneous)

Table 3: Thematic fields (ASJCs subject categories) in ASEAN-EU co-publications with highest average citation rates

Rank (ratio)	Subject category name	# of articles	# of times cited	Ratio
1	General	432	26,170	61.83
2	Medical-Surgical	1	36	36.00
3	Medicine (all)	1,630	43,836	26.89
4	Neuropsychology and Physiological Psychology	19	444	23.37
5	Nephrology	71	1,567	22.07
6	Gastroenterology	163	3,485	21.38
7	Neuroscience (all)	161	3,174	19.71
8	Chemistry (miscellaneous)	10	190	19.00
9	Physiology (medical)	117	2,187	18.69
10	Cancer Research	465	8,314	17.88
11	Immunology and Allergy	556	9,627	17.31
12	Management and Information Systems	32	553	17.28
13	Genetics	1,040	17,883	17.20
14	Cell Biology	849	14,535	17.12
15	Oncology	468	7,934	16.95

Summarizing all EU-ASEAN co-publications with regard to their thematic focus in Frascati terminology[12], our analyses show that biological sciences (over 12.000 co-publications since 2000), health sciences/medicine (over 11.000 in clinical medicine, over 6.000 in health sciences and over 4.000 in basic medicine), physical sciences (over 6.000), chemical sciences (over 3.000), and earth and related environmental sciences (over 3.000) are the top fields of collaboration.

The following table shows each Southeast Asian country with its most important cooperation partner and the subject category, in which cooperation with this partner is strongest. Great Britain is dominant in most of the ASEAN countries, but there are variations in the cases of Cambodia, Philippines and Myanmar. In terms of thematic fields of the strongest country-country links, health, environmental sciences, plant sciences and engineering are most prominent.

Table 4: Most important country linkages and ASJC subject categories for ASEAN countries in co-publications with the EU since 2000

ASEAN country	EU country	Subject area	N° of co-pub. since 2000
BN	GB	Ecology	10
ID	GB	Ecology	71
KH	FR	Infectious Diseases	38
LA	GB	Tropical Medicine	43
MM	FR	Paleontology	10
MY	GB	Engineering, Electrical & Electr.	103
PH	DE	Plant Sciences	40
SG	GB	Electrical and Electronic Engineering	382
TH	GB	Infectious Diseases	600
VN	GB	Microbiology	88

Each of the co-publication linkages between the ASEAN countries and their European partner can be shown in regard to their thematic outlines and visualized in the form of a radial chart. Some of the most prominent SEA country-EU country linkages are depicted below. All the other country-country combinations will be made available at www.sea-eu.net/bibliometrics.

12 A limited number of larger subject areas that we assigned journal subject categories; co-publications can appear in several Frascati subject areas (this is particularly relevant in the health-related topics). It should also be taken into account that the Frascati areas of biological, health and physical sciences cover larger groups of journals than, for instance, civil engineering. To a certain degree, it is thus natural that these 'big' subject areas appear as the most relevant ones.

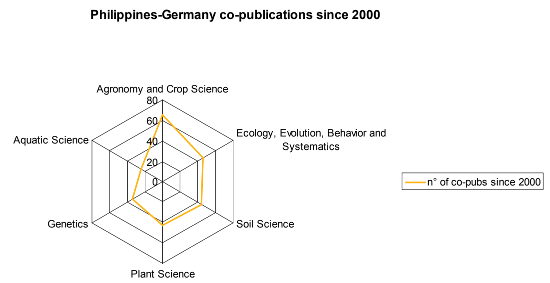

Figure 37: Philippines-Germany co-publications: thematic field (ASJC journal subject categories)

This form of analyses can show us, for instance, that German and Philippine authors publish cooperatively above all in the depicted thematic fields within the areas of plant and environmental sciences. In the case of Thailand's links with the UK, medicine is the most prominent topic:

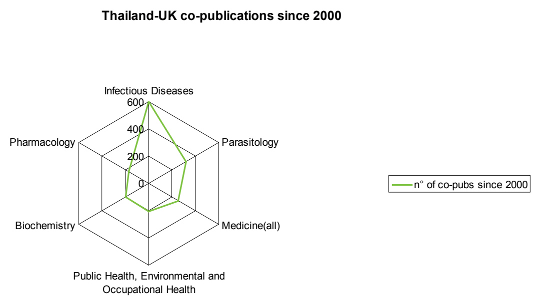

Figure 38: Thailand-Great Britain co-publications: thematic fields (ASJC journal subject categories)

If we compare this with UK's co-publication activity with Singapore, we get a different picture again. Links are also strong in areas relating to engineering, physics and materials sciences. Readers who know Singapore's innovation system in more detail might find parallels of co-publication patterns to the country's industrial landscape. It is interesting to see that most of the relevant industry branches are also the ones most active in academic publications with international partners. Ophthalmology seems to be a specifically important case in cooperation with the UK only. Co-publications between Singaporean authors and scientists from other major European countries do not focus on this issue.

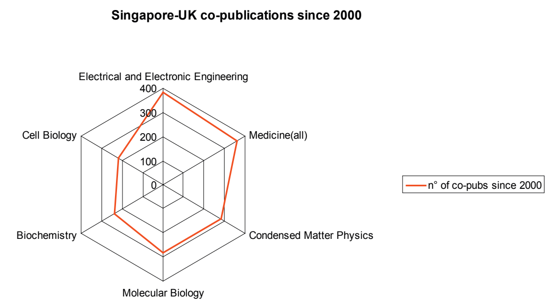

Figure 39: Singapore-Great Britain co-publications: thematic fields (ASJC journal subject categories)

By means of comparison, we add radial charts displaying the main subject categories in co-publication linkages between Indonesia, Vietnam and Malaysia with some of their strongest European partners (we selected the European country with which the ASEAN country shows the strongest ASJC subject category link).

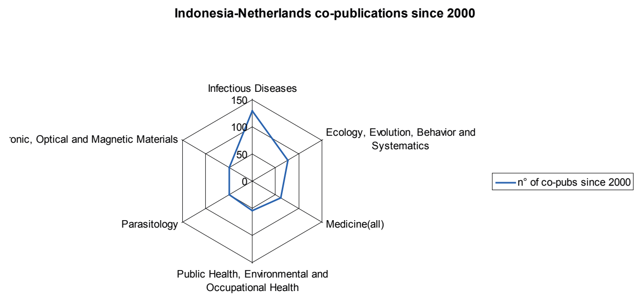

Figure 40: Indonesia-Netherlands co-publications: thematic fields (ASJC journal subject categories)

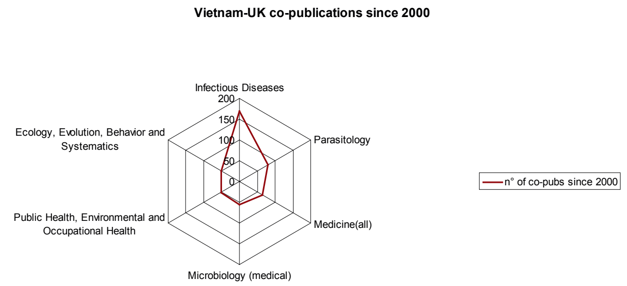

Figure 41: Vietnam-UK co-publications: thematic fields (ASJC journal subject categories)

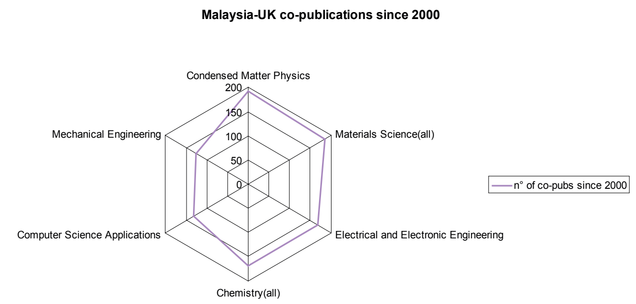

Figure 42: Malaysia-UK co-publications: thematic fields (ASJC journal subject categories)

After analysing the strongest co-publication links, we have compared the thematic focus of country co-publication links with the six ASEAN Plan of Action on Science and Technology (APAST) flagship programmes as they were outlined at the 13th ASEAN Ministerial Meeting on Science and Technology (AMMST) in Singapore in 2009. This table shows for each of the flagship programmes' ASEAN lead country its strongest European partners in this area:

Table 5: Most important cooperation partners for ASEAN countries leading flagship programmes

APAST flagship programme on	Lead country	Strongest co-publication links of the lead country with:*
Biofuels	Malaysia	Great Britain, Germany, Netherlands, France, Denmark, Italy, Belgium, Spain
Open Source Systems	Indonesia	Netherlands, Germany, Great Britain, Norway, France
Functional Food	Thailand	Great Britain, Germany, Israel, Netherlands, Poland, Austria, Switzerland, France
Health	Singapore	Great Britain, Germany, France, Sweden, Switzerland, Spain, Italy, Denmark, Poland
Climate Change	Philippines Vietnam	Great Britain, Germany, Netherlands France, Switzerland, Belgium, Denmark, Germany, Netherlands
Early Warning System	Indonesia	(no co-publication data)

*by order of amount of co-publications; only major partners are mentioned

Continuing to relate the thematic priorities in co-publications to policy framework's and regional programmes' thematic focus, we will now turn to Europe's regional priorities. In the following, we present co-publication data for the seven FP7 thematic areas the preceding chapter has focused on, therefore delivering comparable results. To this aim, the data source was limited to Scopus for this subsection and co-publications in FP7 thematic areas were retrieved using keyword clusters and Scopus categories as it is outlined in 2.1.1.

2.2.3 Co-publications in FP7 priorities thematic areas

Following the utilisation of Scopus journal subject categories to provide an overview of thematic patterns in EU-ASEAN co-publications, keyword-based queries will be utilised to analyse co-publication patterns in the same FP7 thematic areas that were used in the chapter above. This exercise is particularly interesting for two reasons. First, it allows us to draw a more detailed picture of co-publication patterns, which is comparable to our analysis of research strengths in ASEAN. Secondly, it offers a different perspective on some subject areas that would not be possible when using journal subject categories or the Frascati terminology.

Here is a table with the number of ASEAN-EU co-publications from 2000 until 2010 in the seven FP7 thematic areas taken into account:

Table 6: EU-ASEAN co-publications in 7 FP7 priorities

	EU + at least one ASEAN 2000–2010	EU + any ASEAN, multiple count 2000–2010*
Nanotechnology	519	524
ICT	223	226
Industrial Technology	54	55
Energy	365	379
Food, Agriculture, Biotechnology	1,890	2,041
Environment	1,678	1,822
Health	3,191	3,639

*In this second column, co-publications involving one or several EU 27 (+AC/CC) and one or several ASEAN countries are counted n times for each ASEAN country involved. In the first column, each co-publication in the respective subject field is counted only once, regardless of the number of ASEAN countries involved.

What can be seen from the differences between the two columns in this table, is that in the field of nanotechnology, for instance, EU-ASEAN co-publications tend to involve one ASEAN country only, while in the area of health, it is more common that authors from more than one ASEAN country are involved in the same Europe-ASEAN co-publication.

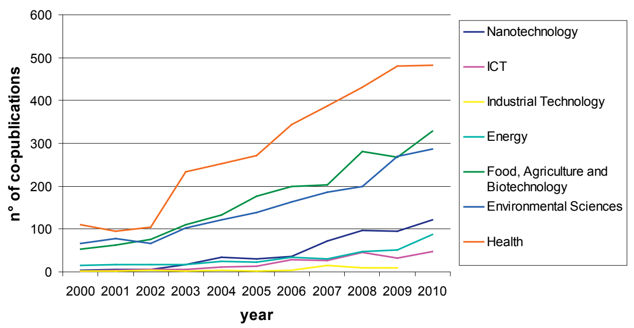

Figure 43: Number EU-ASEAN co-publications, all ASEAN countries per year/priority

Looking at the total counts in table 6 as well as at figure 43, we also observe that health is the dominant field of co-publications since 2000. If we compare this with the data presented above, we see that it is also the topic which shows highest scientific output on a regional level in ASEAN. It is followed by Food, Agriculture and Biotechnology and then Environment and Nanotechnology, both in terms of publications as well as in terms of co-publications (with Nanotechnology relating to a dominant number of publications from Singapore and a rather low percentage of co-publications).

If one counts relatively, i.e. setting co-publication counts in relation to overall ASEAN publications, the picture changes: Environment is then the most important field (that is the field with most ASEAN-EU co-publications per ASEAN publication), followed by Energy and Food, Agriculture and Biotechnology, the latter two being very close.

The following graphs show the development of co-publications between the individual ASEAN countries and the EU27 (incl. AC/CC) in these four thematic fields.

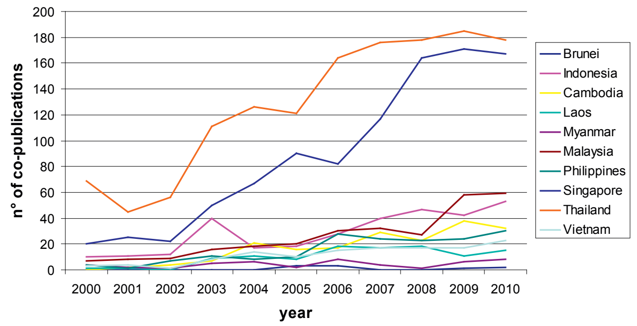

Figure 44: Number EU-ASEAN co-publications per ASEAN country per year in health

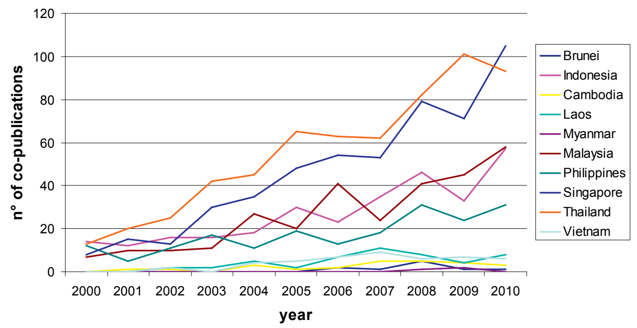

Figure 45: Number EU-ASEAN co-publications per ASEAN country per year Food, Agriculture and Biotechnology

2 EU-SOUTHEAST ASIA CO-PUBLICATIONS

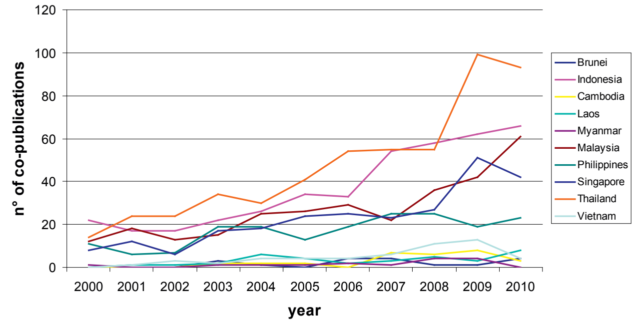

Figure 46: Number of co-publications per ASEAN country per year in Environment

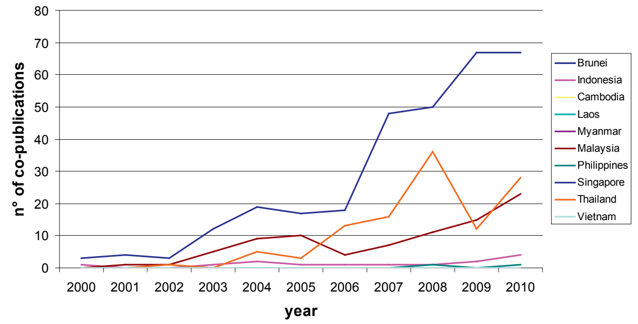

Figure 47: Number of co-publications per ASEAN country per year in Nanotechnology

Different to the general publication trends, Singapore is not leading when it comes to EU-ASEAN co-publication within the thematic fields of FP7 priorities. Here, Thailand is heading with a total count of 2,849 co-publications with Europe in the areas scrutinized here during the years of observation, followed by Singapore with 2,310 and then Indonesia with 1,095 cooperative scientific papers.

While the first two countries cooperate mostly in health, environment is dominating the Indonesian- European cooperation. Considering that Indonesia is the biggest Archipelago worldwide with a huge biodiversity, this seems understandable. With 1,077 co-publications, Malaysia is very close to Indonesia, with most of its co-publications with Europe in the areas of environment and food, agriculture and biotechnology. In the following table, we depict the co-publication share of each of the Southeast Asian countries.

Table 7: Number of ASEAN-EU co-publications in seven FP7 priorities, 2000–2010 ASEAN country share

	FAFB	Nanotech	ICT	Industrial Technology	Health	Environment	Energy
Brunei	10	0	0	0	9	18	5
Indonesia	300	14	8	0	318	411	44
Cambodia	25	0	3	0	189	30	4
Laos	49	0	0	0	109	35	0
Myanmar	3	0	0	0	47	15	0
Malaysia	294	86	36	16	284	299	62
Philippines	192	2	4	0	170	186	17
Singapore	511	308	130	25	975	253	108
Thailand	611	114	42	13	1,409	523	137
Vietnam	46	0	3	1	129	52	2

2.3 Summary

2.3.1 General trends and patterns of ASEAN-EU co-publications

When analyzing publications published by European and Southeast Asian researchers collaboratively, and comparing this cooperation with co-publications between ASEAN countries and other major scientific players, we observe that Europe has become the most important scientific cooperation partner of ASEAN. ASEAN-EU co-publications grow at a pace comparable to ASEAN publications. Relative growth rates of European publications are lower than ASEAN's.

Looking at total figures, Great Britain is the most important cooperation partner for Southeast Asian countries. However, particularly in the case of Cambodia, Myanmar and the Philippines, France and Germany are among the most important partners as well (for Cambodia, France is the most important partner). Comparing the ASEAN countries, Thailand and Singapore have the highest co-publication output. Analyzing ASEAN countries' cooperation with Europe in relation to their cooperation with other major players, Vietnam and Laos have the biggest share of co-publications with Europe.

Assessing data alongside the thematic fields given in the Frascati manual, ASEAN's links with Europe are closest in the following areas: biological sciences, health sciences/medicine, physical sciences, chemical sciences, earth and related environmental sciences.

With the exception of ICT (which is more relevant in ASEAN participation in FP7 than in co-publications), this corresponds well with FP7 participation figures outlined in the following chapter (taking into account that physical sciences do not so prominently figure in the FP7 Cooperation programme).

The most prominent detailed subject category in EU-ASEAN co-publications in absolute numbers is infectious diseases.

The fastest growing subject area in EU-ASEAN co-publications since 2000 has been oncology together with a series of other health/medicine-related fields; biological sciences and physical sciences/engineering have also shown constant growth.

2.3.2 Co-publications in FP7 thematic areas

With regard to the total number of European-Southeast Asian co-publications listed in Scopus, a significant proportion (30.24 %), falls into one of the seven FP7 thematic areas scrutinized here. Comparing the number of co-publications with the overall number of publications in these thematic areas, Health shows by far the highest counts in collaborative publications. The thematic fields Environment and Food, Agriculture and Biotechnology are dominant too.

Comparing the overall co-publications of the ASEAN countries with EU partners, Singapore is the leading cooperation partner followed by Thailand. However, in terms of co-publications in the FP7 areas analysed here, Singapore is not significantly leading ahead of the other ASEAN countries in overall national publications. Especially Environment shows a different situation with Thailand being dominant and Singapore behind Indonesia and Malaysia. Thailand is ahead of Singapore if one summarises co-publication counts in all the seven FP7 areas.

Comparing co-publication numbers with overall publications per priority in the ASEAN region, Environment is clearly the area with most co-publications per publication, followed by Energy and Food, Agriculture and Biotechnology. Taking into account total counts of publications in Europe, Environment has the highest rate of co-publications per publications, followed by Energy. Third is Nanotechnology but Food, Agriculture and Biotechnology is only a minor step behind. The overall share of EU-ASEAN co-publications in overall European publications in the respective priorities is much lower than in the ASEAN countries, as are the differences between the different thematic fields.

With the exception of ICT, the results presented in this section correspond well with the participation of ASEAN countries in FP7 projects as will be outlined in the following chapter.[13]

[13] We have seen above that physical sciences are a prominent field in EU-ASEAN co-publications. The fact that they do not appear as prominent in this and the next section results from the fact that FP7 has no specific focus on physical sciences (only parts of the work in the field falls under the nanotechnology heading).

3 Analysis of ASEAN participation in FP7

Olivier Küttel, Veronique Sordet[14]

The last chapter in this part deals with the participation of scientists and institutions from ASEAN within the European Research Framework Programme 7, overall statistics will be presented first, followed by a focus on priorities and, subsequently, on countries.

3.1 Methodology

Data was gathered by counting the total of research proposals or applications within FP7 and comparing them along the dimension of the country of origin of the applicants. Source data was taken from the proposal database eCorda release number 6 in October 2010.

These data represent the outcome of the evaluation process before negotiation. Some projects might not have made it through the negotiation phase while some others from the back up list might have got funded. The eventually funded projects are stored in the funded project database of eCorda only.

3.2 Analysis

In the following, we show the main results as they were visualised in graphs. The general statistics show absolute numbers per country, first in the whole comparative region, and then for ASEAN only (figures 48 and 49).

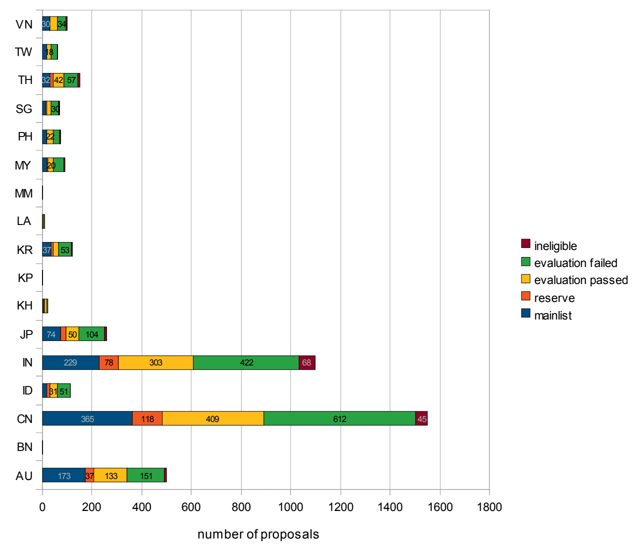

Figure 48: Overall statistics per country all priorities (absolute)

It becomes quite clear from this graph that China, followed by India and, with quite some distance, Australia, is the country home to the highest number of FP7 third country participants. The participation figures of Southeast Asian countries are, understandably, lower with Thailand, Indonesia and Vietnam hosting the highest number of proposal applicants.

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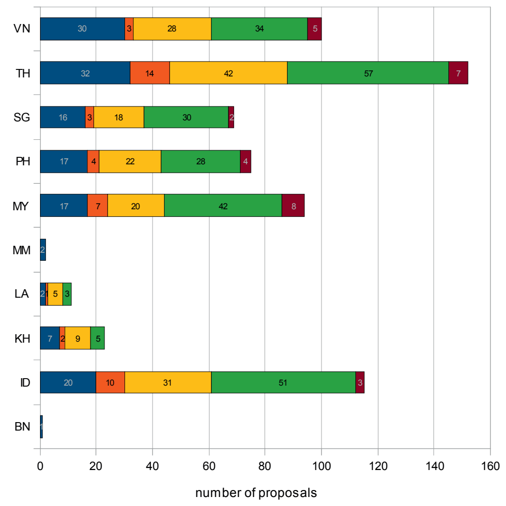

Figure 49: Overall statistics per country all priorities, ASEAN only (absolute)

Compared within the ASEAN region, we can read relations between main-listing, and the several steps of the evaluation process in figure 50 showing relative numbers.

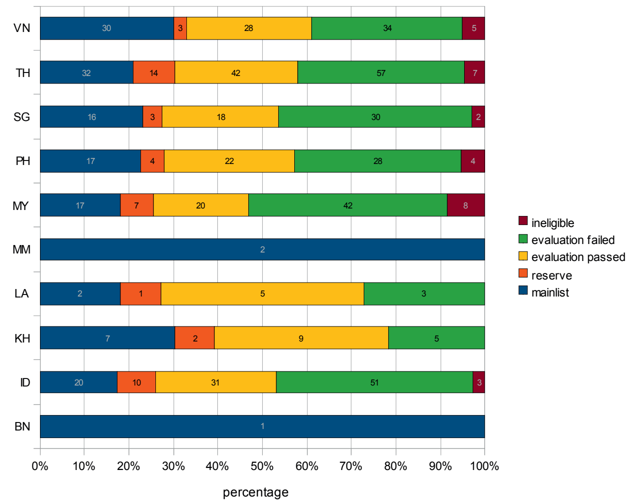

Figure 50: Overall statistics per country all priorities, ASEAN only (relative)

As visualised below, ASEAN countries have different foci towards the priorities analysed, first in absolute figures (figure 51), then in a relative form of display (figure 52).

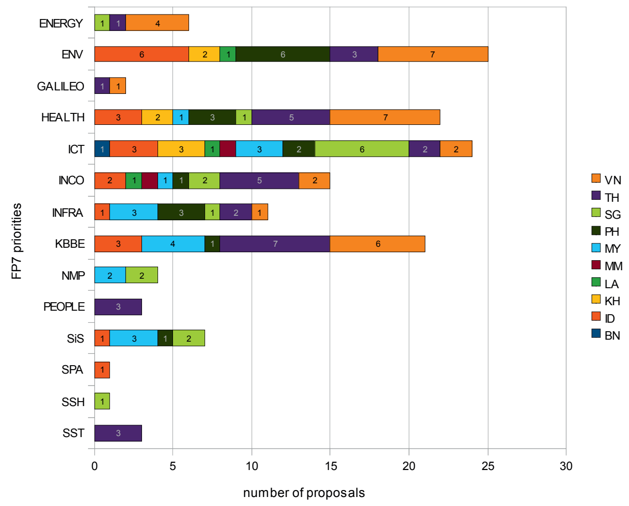

Figure 51: Overall statistics of main-listed proposals priority, ASEAN only (absolute)

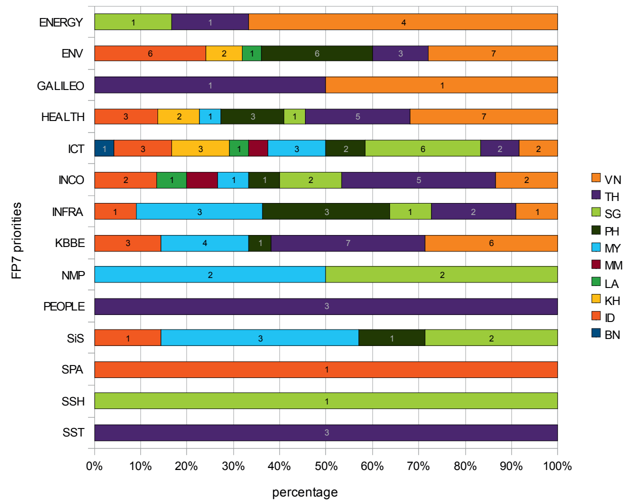

Figure 52: Overall statistics of main-listed proposals per priority, ASEAN only (relative)

In the following graphs we narrow down our focus to the main priorities and subject areas that have been of interest in the preceding sections and look at the applications from all countries in the ASEAN region (as far as proposal participants came from one of these countries) in absolute numbers.

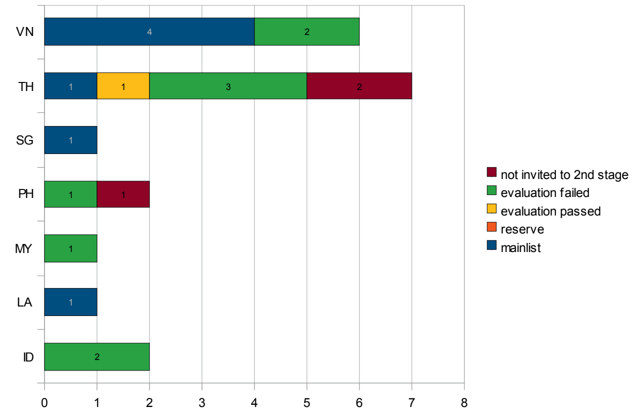

Figure 53: Energy ASEAN only (absolute)

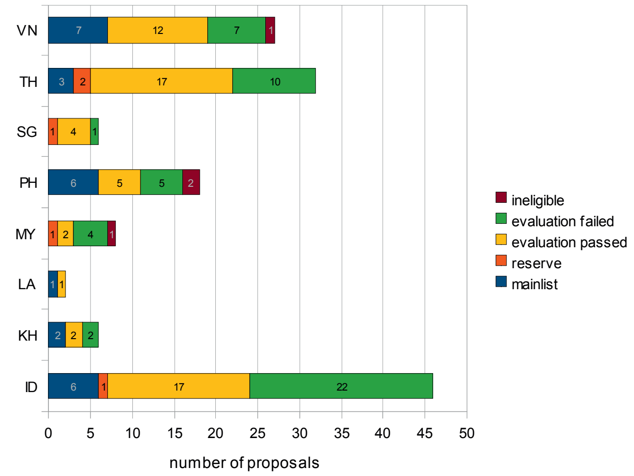

Figure 54: Environment ASEAN only (absolute)

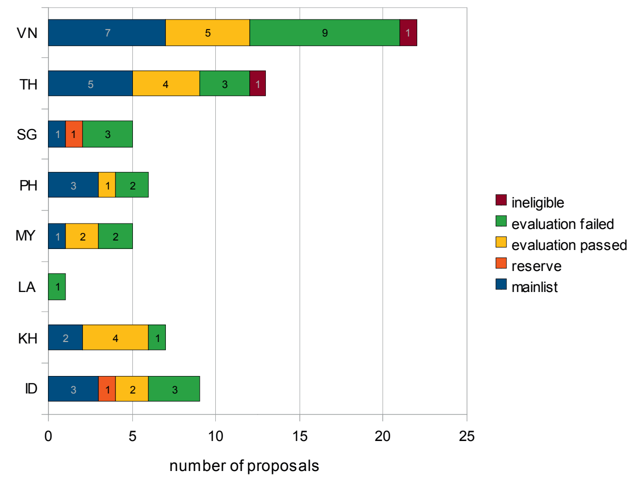

Figure 55: Health ASEAN only (absolute)

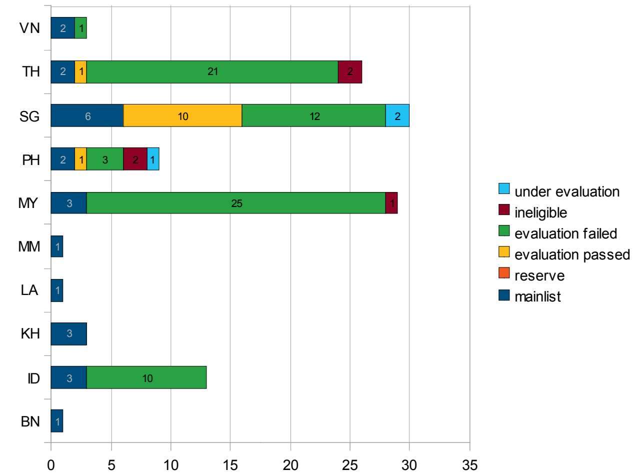

Figure 56: ICT ASEAN only (absolute)

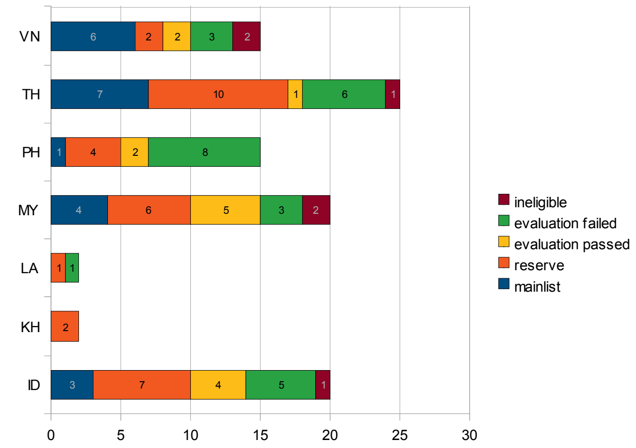

Figure 57: KBBE ASEAN only (absolute)

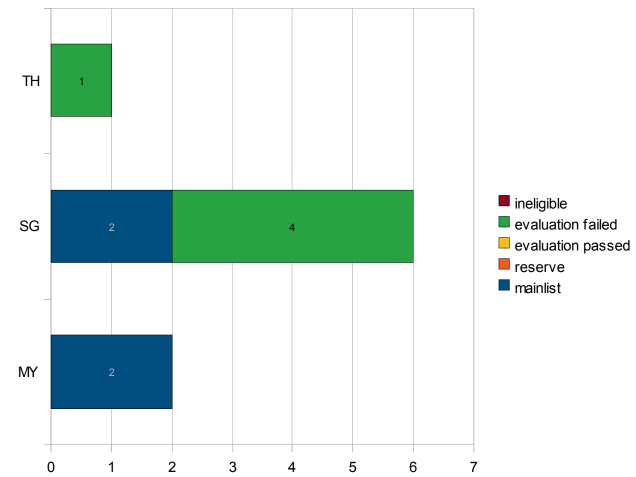

Figure 58: NMP ASEAN only (absolute)

In figures 59 and 60 we deal with the specific programmes, ERC and Galileo and the evaluation successes for those countries of ASEAN that have had submissions.

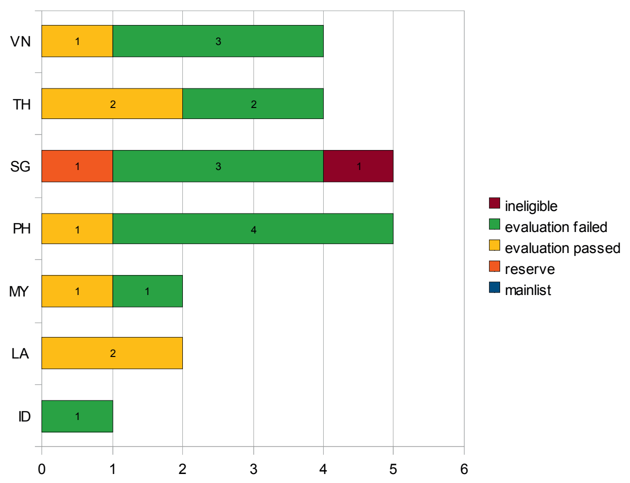

Figure 59: ERC ASEAN only

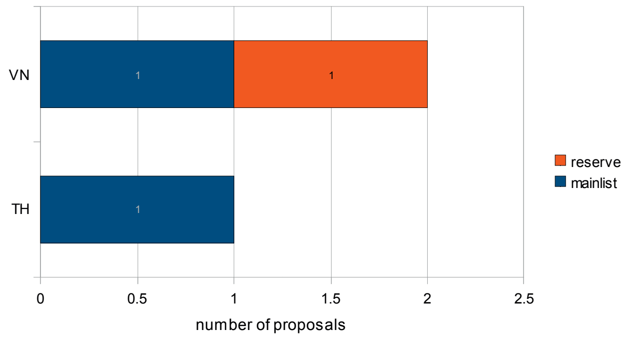

Figure 60: Galileo ASEAN only

3.3 Findings

As findings for the general statistics on the overview of the ASEAN region's participation in FP7, we notice that some countries have very low participation activity, for example Brunei, Cambodia, Laos and Myanmar. Any statistical data and conclusions on these countries are neither reliable nor significant.

China leads the list of most active countries in FP7 with 365 main-listed proposals, before India (229) and Australia (179) in the given selection of countries (ASEAN, Australia, China, India, Japan, Korea, Taiwan).

A division into two classes within the ASEAN region can be observed: While Brunei, Cambodia, Laos and Myanmar show low participation, Thailand, Vietnam, Indonesia, Malaysia, the Philippines and Singapore feature higher participation numbers. Thailand with the highest activity of all ASEAN countries is followed by Indonesia and Vietnam (in terms of applications; Vietnam shows a higher number of mainlisted proposals than Indonesia); together they form an amount of mainlisted proposals that equals to two tenths of Chinese participations.

As a rough average, around one quarter of the applications is likely to be funded effectively. Average success rates range from 20 % to 30 %, while Indonesia has 17 % and Vietnam 30 % approvals.

Regarding the FP priorities, for ASEAN countries the most relevant areas are Environment, Health, Information and Communication Technologies (ICT), as well as Food, Agriculture, Fisheries and Biotechnology (KBBE), while Health proposals seem to have comparably higher success rates. The Infrastructure, International Cooperation (INCO) and Science in Society (SiS) subprogrammes play a role too, but to a lesser extent, which is not that surprising as more resources are made available in FP7 in the ten thematic areas of the Cooperation programme (thus supporting more projects).

With priority, we refer to the sub-programmes of FP7, independent if it was a so-called "bloc", like the PEOPLE programme, or a thematic priority like HEALTH. Within the various areas we find different submission patterns between the different ASEAN countries.

What is interesting, for instance, is the fact that in the field of Environment, Indonesia is highly involved with many submissions, but due to a lower success rate, we eventually find the Philippines, Thailand and Indonesia having the same amount of main-listed projects. With regard to the other priorities, success rates seem more stable and comparable, with Vietnam generally achieving higher rates.

Comparing the individual ASEAN countries application patterns, scientists from Thailand have a very broad interest from Environment (ENV) to Information- and Communication Technologies (ICT), Food, Agriculture, Fisheries and Biotechnology (KBBE), PEOPLE, Social Science and Humanities (SSH), Sustainable Surface Transport (SST) and ENERGY, while Vietnam is mostly focused on ENV, HEALTH and KBBE.

Focussing on the PEOPLE programme, analysis becomes a bit more complex. As the programme consists of different so-called Marie-Curie-actions, namely IEF, IIF, IOF, IRSES, IAPP, ITN and Cofund, one has to understand the different actions in order to make meaningful analyses of the eCORDA data. For more information in this context see the EUresearch info sheets (www.euresearch.ch).

One important conclusion to draw here is that the ASEAN countries are nearly absent in the PEOPLE programme. While Australia (45 %), China (35 %) and Japan (27 %) have a very high PEOPLE part of the mainlisted proposals, the ASEAN countries do not have any participation or only very few (Thailand), depending on the sub-programmes. This is to large parts due to the fact that researchers from Southeast Asia cannot participate in all activities of the PEOPLE programmes; partly it might be an issue of disseminating information.

After these insights into FP7 participation from Southeast Asia, we will conclude the quantitative chapters with a short overall summary before subsequently proceeding to presenting the project's qualitative analyses' results.

Preliminary conclusions

The analyses in the preceding chapters clearly demonstrate that Southeast Asia is enjoying constant growth in research output and has developed pockets of excellence in several thematic research areas. The earlier chapters have looked at total research output, research output in relation to EU output, ASEAN-EU co-publication output and participation in FP7 to indicate where ASEAN research strengths are. Depending on the indicators used, there is a degree of variation in the set of research areas identified as strong.

Comparing ASEAN research output with EU output, ASEAN output is greatest in the areas of nanotechnology, ICT and industrial technology. However, looking at overall research output, the highest volume of ASEAN publications were produced in the areas of health, 'food, agriculture, fisheries and biotechnology' (FAFB), as well as environment.

With a few exceptions, the thematic strengths in research output are also reflected in ASEAN scientists' co-publications with Europe, as well as in levels of ASEAN participation in 7th Research Framework Programme (FP7) funded projects. Health, FAFB and environment figure as the most prominent thematic areas. However, there are some deviations in the patterns identified. For instance, the dominance of ICT as an area where there is great ASEAN participation in FP7 is not reflected by equal strength in volume of co-publications. Nevertheless, ASEAN does perform well when comparing ASEAN overall research output in ICT to European research output in this field. In this instance, the explanation for the variation might be that there is more cooperation potential and/or that the current cooperation has the potential to increase its impact by producing collaborative output. There are additional 'soft factors,' which should be taken into consideration, such as in ICT, for strategic reasons, international co-publication might be less common, although cooperation is taking place. More qualitative research is required to answer this question.

The most significant FP7 thematic areas for EU-ASEAN collaboration, as identified in the analysis, are health, FAFB and environment, which have the highest overall research output, co-publication and FP7 participation numbers (with ICT being particularly important in FP7 participation). It is noteworthy that the number of co-publications per publication is much higher in the area of environment than in other thematic areas (comparing figure 23 in chapter 1 and table 6 in chapter 2 with other thematic areas). ASEAN countries also have one of the highest FP7 participation rates in environment, although ASEAN total research output is only the fourth highest in environment in the seven FP7 thematic areas under consideration in the preceding chapters.

Trends in individual country strengths in the FP7 thematic areas can also be mapped across the different analyses. The Philippines, for instance, has relative strengths in the areas of environment and FAFB. The analyses also identify some peculiarities that call for additional qualitative research and discussions. For instance, Indonesia is amongst the top co-publishing partners of European authors in FAFB and environment, whilst it is not one of the best performing countries in terms of overall research output in this area. This could indicate that Indonesian scientists in this area primarily co-publish or that the research is primarily driven or exploited by the European and not the Indonesian partners.The thematic focus of ASEAN countries' FP7 participation is, predominantly, consistent with their research strengths and co-publication patterns (with the exception of Singapore which has different conditions for participation in FP7 projects compared to other ASEAN countries). For instance, Thailand is strong in FAFB participation in FP7 projects, as well as in publication output and co-publications. Malaysia is performing well in nanotechnology and FAFB across the board. Vietnam, however, is among the top ASEAN performers in FP7 projects in the areas of energy, environment, health, and FAFB, but it is not yet amongst Europe's most relevant co-publication partners in the ASEAN region in these areas, nor producing a particularly high research output. If the FP7 participation triggers impact, both Vietnam's research output and the amount of co-publications can be expected to rise in these areas given this current performance of the country in FP7.

Although different indicators point to some variety in the thematic areas of greatest strength across ASEAN, some clear strengths can be established. In addition to these clear strengths, precisely the highlighted varieties and apparent discrepancies can inform debate and help identify the most strategic and promising areas for future S&T cooperation between Southeast Asia and Europe. For instance, areas where FP7 participation is strong, but joint publication output low, can be expected to (or supported to) produce a higher impact of joint research in the future. Areas where research output on both sides is strong, but co-publication and cooperation levels low, indicate fields of future potential. Thematic areas where co-publication levels are high, but FP7 participation is low might hint at strong bilateral programme links or might teach us when and where cooperation functions apart from dedicated international programmes. The next part of this book presents the results of SEA-EU-NET's qualitative analyses which can further enrich precisely this kind of discussions.

Qualitative evidence for science cooperation policy-making

The first part of this book compiles quantitative studies on ASEAN research strengths and the state of ASEAN-EU research cooperation. It analyses geographic and thematic patterns of bi-regional collaborative research including co-publication levels and ASEAN participation in FP7 projects.

In the second part, cooperation is analysed from a series of qualitative viewpoints, using different social scientific and participative methods to produce recommendations to drive future S&T cooperation. These results should be used in conjunction with the quantitative results in the first part of this book. The authors hope to inspire and inform policy debate in both regions as well as to support the bi-regional dialogue on S&T cooperation and related programme-making.

The contributions are structured as follows:

First, there is an overview of the importance and nature of international S&T cooperation as well as the shared characteristics and challenges of both regions. It further introduces major S&T policies of selected Southeast Asian countries.

This introduction is followed by two chapters focusing on opportunities and pitfalls of current (5) as well as on motivations and driving forces of future S&T cooperation between Southeast Asia and Europe (6). These sections are based on participatory, expert and stakeholder driven consultation processes - an adapted SWOT methodology was utilized for the former, and a small-scale bi-regional cooperation foresight exercise on the 2020 future of S&T cooperation between the regions was utilized for the latter. Chapter 6 offers a short success scenario of 2020 S&T cooperation between both regions that aims to inspire further debate about what successful collaboration means and about how we can implement it.

Chapter 7 then offers a detailed view of the Southeast Asian countries' S&T landscape and, more concretely, their S&T policies' thematic and geographic priorities for international collaboration. The result is a comprehensive guide to main ASEAN member states' goals and practices of international S&T cooperation. The information collected is crucial when considering how to implement recommendations presented in the previous two chapters. They are particularly relevant when engaging in joint thematic priority setting, building on the quantitative evidence on current cooperation and strengths presented in the first part of this book, and the existing inner-regional or national priorities of the dialogue partners.

Chapter 8 looks at one of the major driving forces for current and, especially, future cooperation, namely using research to jointly solve global challenges. The analysis considers existing collaborative research, and looks at the opportunities and challenges involved in this collaborative research. Several relevant case studies are considered in this analysis.

4 Signpost to success

SEA-EU-NET analysis team

International scientific collaboration is highly important. The world today is faced with global challenges, which require global solutions developed from co-ordinated international research. Scientific collaboration can increase the standard of living of all citizens around the world, and assist in capacity building in less-developed nations. It is important for the advancement of individual researcher's careers. Research funders can stimulate greater scientific collaboration through the creation of favourable conditions for collaboration, as well as ensuring resources are directed to areas where there are the greatest opportunities for mutual benefit. Southeast Asia[15] is one of the key partners for European international scientific collaboration and partnerships. Southeast Asia has several characteristics such as a unique and diversified topography and prevalence of infectious diseases, making it an important partner of choice for Europe. When trying to direct resources to Europe-Southeast Asia collaboration, it is challenging to identify which thematic areas of research provide the greatest gains for both regions. However, certain areas such as within health or environment research provide obvious win-wins for both regions.

4.1 The rise of and global importance of international collaboration

The world today is faced with global issues. Science has long since overrun national borders to find global solutions to these global issues, which are faced by every national government. Solutions are required to address climate change, energy security, epidemics, food safety and security, and water security.[16] Neither individual institutions nor national governments have sufficient resources to engage in the R&D to address any one of these issues nationally, let alone all of them. Thus, for both scientific and economic reasons, there is a trend towards increased international collaboration[17], which has been facilitated by the rise of instant communication, international travel and international funding programmes for collaborative research.

Ease of communication is widely recognised as key to the development and success of cooperation. We now live in an age where we can access vast quantities of information from all around the world and interact with a diverse range of people.[18] Researchers no longer need to be in the same place at the same time. Increasingly available information has also augmented the role of science in the lives of citizens, generating a public demand for scientific solutions to address global issues. As government awareness and public demand for 'global science' has increased, so has the availability of funding for international cooperation through international collaborative research and development funding programmes.

The value of international collaboration and resultant need for international funding programmes for research and development is undeniable. Research and development cannot and will not advance at the same pace without collaboration. It is further necessary to enable researchers to gain access to a wide range of resources (human, research facilities, funding, data and samples). Collaboration, where targeted to key areas of mutual importance, results in mutual benefit for individuals, organisations, societies and national states.

A corollary benefit of increased cross border cooperation is the role research collaborations play in international development. Science and innovation are intricately linked to development and vital to enable developing countries to move up the value chain. People who live in the developed world often forget the role science has had in transforming their lives. However, in the process of mapping out development plans for emerging nations, many industrialised countries have recognised the role that science and innovation have played in their own development.[19]

Life changing scientific developments to date include vaccinations, penicillin, high yield agriculture, electricity, silicon chips to name but a few… Scientific developments often go beyond their primary outcomes and scientific advances often spur economic growth, and lead to an improved standard of living.[20] The challenges faced by developing countries cannot be addressed without scientific and technological solutions.[21] Scientific knowledge and technologies generated from collaborations can be applied to specific development challenges and further, assist in the achievement of the Millennium Development Goals. Thus, international funding programmes can assist in the development of poorer countries, as well as engage in scientific excellence.

The majority of international partnerships are 'best with best' collaborations, indicating the research collaboration is between international experts, who have world leading knowledge and experience in their research field. Each partner will contribute equally to the joint research, and these partnerships significantly further scientific advancement. The European Commission's Cooperation programme within the Seventh Framework programme focuses on 'best with best' research partnerships, funding research projects with the leading researchers in Europe, as well as in the rest of the world.

International collaboration is not a new phenomenon. International collaboration has always been an integral part of scientific activity.[22] However, the raised profile of global issues, increased ease of communication and rise of international funding programmes has increased the incidence of cooperation. Moreover, many projects thrive on international collaboration. Collaboration is also essential for the advancement of individual researchers' careers and to enable researchers to become international leaders. The increased participation in international collaboration is visible in the increase in the number of international co-publications as a total of all publications, evidenced below over the 11 year period from 1992 to 2003.

Table 8: Share of international co-publications of total publications[23]

	UK	France	Germany
1992	20.5	27.1	25.1
1995	24.0	30.1	29.0
1998	31.3	35.8	41.7
2001	35.8	40.9	46.2
2003	39.2	43.7	43.0

4.2 The nature of international collaboration results in an infinite number of forms

Every international collaboration is unique.[24] There are a multiplicity of different situations in which collaborations can arise between different countries and in different research disciplines.[25] Resultantly, international collaborations exist in a variety of different forms. The OECD provides the following scale of collaborative projects:[26]

- "Research collaborations between individual scientists. These can be relatively informal, for example by exchange of letter, with little or no exchange of funds.
- Similar, but bigger, agreements between research institutions. Usually a more formal approach is required, particularly if funding for the participants comes ultimately from government itself, or from associated agencies.
- Collaborations requiring significant injection of capital or operational funding. Even if funds do not cross national boundaries, a more formal approach is usually inevitable, with correspondingly more complex arrangements. Such collaborations can be based on an existing facility or facilities, or may require the establishment of a new structure.
- Collaborations designed to provide a new capital facility, for example a facility that would not be within the capability of a single partner country."

International projects have a range of outcomes with varying degrees of societal and economic impact. An outcome may be as simple as achieving a project objective or as far reaching as providing a solution to an issue which will benefit society as a whole. Programmes need to take account of the variety of circumstances in which projects exist, including national and cultural considerations. Southeast Asia is a very diverse region and although it shares some similarities with Europe,

15 In this context, Southeast Asia is taken to mean the 10 countries of ASEAN: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.
16 List of global challenges recognised by international community including UN
17 Global Science and Innovation Forum (2006): a Strategy for International engagement in research and development, p. 12
18 Ibid., p. 3
19 Calestous Juma in Conway, G, / Delaney, S. / Waage, Jeff (2010): Science and Innovation for Development, London: UKCDS, page xiv; and Solow, R. (1957): Technical Change and the Aggregate Production Function, in: The Review of Economics and Statistics, 39(3), pp. 312–320: "In a seminal paper published in 1957, Nobel laureate Robert Solow showed that the previous 40 years technical change had contributed more than 87 % of gross output per person while the increase in capital investment explained only about 12 %."
20 Wagner, Caroline S. (2008): The New Invisible College: Science for Development, Washington DB: Brookings, p. 1
21 Conway / Waage (2010), p. 7
22 INCO-Net MIRA Workshop on scientific cooperation & impact measures intro paper, p. 2
23 Compiled from data on Cordis website: cordis.europa.eu/
24 OECD Global Science Forum (2003): Study on International Scientific Co-operation, Report of the Workshop on Best Practices in International Scientific Co-operation, p. 2
25 INCO-Net MIRA Workshop on scientific cooperation & impact measures intro paper, p. 2
26 OECD Global Science Forum (2003), p. 2

the regions are also very distinct in a number of characteristics. These biregional differences must be acknowledged and addressed in international funding programmes.

It is also worth acknowledging that international collaboration is important to researcher career development and international recognition. European researchers must engage in international collaborations to be international leaders. This has corollary benefits - if European researchers are at the forefront of international research, Europe will continue to be one of the most dynamic and competitive knowledge based economies in the world.[27] It is very important for international funding programmes, such as the European Framework programmes, to provide, a mechanism to establish and fund collaborative research between the member and associated member states of the EU and the countries of Southeast Asia.

4.3 Opportunities for collaboration with Southeast Asia

4.3.1 Europe and Southeast Asia share many characteristics

Europe and Southeast Asia, both regionally and at the individual state level, are threatened by the same challenges which form a common background for research: water, energy, and food safety and security challenges, sea level rises, biodiversity loss, increasing burdens on public health systems from aging populations, lifestyle diseases and rapid spread of infectious diseases. These global challenges require global solutions and can only be addressed through international collaborative research. The scale of problems faced by every nation in Europe and Southeast Asia requires international action.

The similarities run deeper than the common challenges faced by both regions. Both regions have similar population sizes, are composed of many individual states with different cultures, races and languages, and are in different states of development. (Singapore alone has a population predominantly formed of 3 separate ethnic groups and has 4 national languages, all of which are different from the dominant ethnic groups and national language in Thailand, the Philippines, Cambodia… Singapore is also significantly more economically developed then the rest of the region.) The differences in size and location between the individual states of the two regions are broadly comparable (Indonesia with its vast number of islands has been compared historically with the Mediterranean countries such as Greece or Turkey). The two regions also share broadly similar patterns of historical development.

That is not to undermine the significant differences that exist, ranging from Southeast Asia being predominantly rural whereas as Europe is predominantly urban, the different geographical locations and resultant climatic conditions, and the differences in the people and cultures between the two regions. However, these differences result in greater and deeper opportunities for both regions to significantly gain from research collaboration. There has never been a stronger need for collaborative research by Europe and Southeast Asia.

4.3.2 Introduction to Southeast Asia

Southeast Asia is a highly populated region rich in natural resources and biodiversity, with pockets of scientific excellence. Southeast Asia has been densely populated for a long time but its population is becoming increasingly urbanised, creating a new set of challenges for the region.

The countries of Southeast Asia have broadly similar geographical, ecological and climatic conditions, but there is a large disparity between the national development and research and development capacities of each country. The majority of Southeast Asian countries are still developing countries, albeit rapidly developing. Significant opportunities for EU-Southeast Asian collaboration currently exist, but as the region as a whole becomes more developed, the opportunities for scientific cooperation will increase appreciably.

Taking gross national income (GNI) per capita (Atlas method) as the strongest indicator of international competitiveness, representing a country's ability 'to earn income,' the countries of Southeast Asia are divided across four income brackets: high income, upper middle, lower middle and low income.[28]

Table 9: Gross national income per capita (atlas method) for countries of Southeast Asia[29]

High income countries (GNI US$ 39,345–US$ 7,878)*	Upper-middle income countries (GNI US$ 7,878–US$ 3,260)*	Lower middle income countries (GNI US$ 3,260–US$ 2,078)*	Low income countries (GNI US$ 2,078–US$ 524)*
Singapore (US$ 34,760)	Malaysia (US$ 6,970)	Thailand (US$ 2,840)	Philippines (US$ 1,890)
Brunei (US$ 26,740)		Indonesia (US$ 2,010)	Vietnam (US$ 890)
			Laos (US$ 740)
			Cambodia (US$ 600)
			Myanmar (estimated to be low income)

*World Bank GNI per capita (atlas method) world average figures

27 European Heads of Research Councils (2009): EUROHORCs EU Regulatory Framework for Research Actions. Basic Principles for Robust Rules, p. 1

28 GNI is the best indicator of a country's ability to earn income but does not capture income from informal or casual employment

29 World Development Indicators database, World Bank, 7 October 2009

As can be seen, the majority of Southeast Asian countries are categorised as lower-middle income to low income countries. However, the pace of development in most of these states is extremely rapid and Southeast Asia is forecasted to be the next generation of scientifically proficient middle income countries. Furthermore, Southeast Asia is regarded as a rising economic powerhouse. In addition to the scientific benefits of collaborating with Southeast Asia, it will further develop important future ties with this emerging economy of global importance.

The current disparities in wealth in Southeast Asia are generally mirrored by equal disparities in science and technology capacity. Singapore, which enjoys the highest GNI per capita, has a very strong science and technology (S&T) base with world class research facilities and further pursues strong S&T policies, including a human capital policy to build up a supply of national research talent and attract the best researchers globally to Singapore.[30] Singapore was also recently ranked the world's most innovative country.[31] Singapore has a high gross expenditure on research and development (GERD), and although GERD contracted during the recent economic downturn (2009), the government has set a target of achieving a GERD of 3.5 % of total GDP by 2015. In contrast, and as an exception to the trend of higher GNI per capita being accompanied by a more developed S&T base, Brunei's high GNI per capita does not correlate to a strongly developed S&T infrastructure or high ratio of GERD to GDP. Brunei's GERD is less than 0.1 % of GDP.[32] With the one exception of Brunei, rapid economic development in the region has been accompanied by rapid S&T development. Thailand and Malaysia's R&D intensity more than doubled between 1996 and 2007.[33] In 2009, Thailand achieved a GERD of 0.26 % of GDP[34] and Malaysia 0.69 %.[35] Vietnam has a GERD of 0.45 % in 2010[36] and Indonesia and the Philippines have GERDs of less than 0.1 % of GDP.[37] All the countries of Southeast Asia have expressed a desire to develop their S&T bases and most have national S&T policies outlining their preferred way to achieve this and which thematic areas the countries will focus upon.

4.3.3 Unique characteristics of Southeast Asia

Before discussing the national S&T policies in Southeast Asia, it is worth outlining some of the unique characteristics of the region, which make it an obvious partner for EU–Southeast Asia collaboration.

Biodiversity

Southeast Asia has a unique richness of biodiversity. The region covers 3 per cent of the world's total surface, but has 20 per cent of all known species. Furthermore, the region has 3 (Malaysia, Indonesia and the Philippines) of the world's 17 'megadiverse' countries[38] and 7 of the world's 25 officially recognised biodiversity hotspots.[39] Southeast Asia has a wide range of landscape and habitat diversity with more than 24,000 islands, a coastline of about 173,000 km, significant marine areas (including mangroves and coral), large but declining forest coverage (43 % of the total land area) and diversified topography.

Health

Southeast Asia has a unique position between two worlds, suffering from both infectious diseases and diseases of the developing world, as well as increasing cases of 'lifestyle' diseases. The region is increasingly becoming a hub for medical tourism, whilst healthcare must still be provided for the poor. The healthcare systems face a double burden and must simultaneously treat malnutrition brought about by poverty, and obesity and diabetes caused by lifestyle choices.

Southeast Asia is one of the world's hotspots for the emergence of new infections and drug resistance. Malaria and dengue are prevalent in the region, along with many other diseases that threaten Europe with changing climatic conditions. In 2009, the first malaria parasites resistant to the life-saving drug artemisinin were discovered in Cambodia, which the WHO predicts "could seriously undermine the success of the global malaria control efforts." Further, with the proximity of people and lifestock and the related problem of interspecies transference of disease, the region is perceived to be an area from which future global epidemics could emerge and spread.

Climate change and environment

Southeast Asia as a region is highly vulnerable to changes brought about by climate change. The UK's Met Office[40] predicts that a four degree rise in temperature, could decrease rice yields by up to 30 %, which is the stable food of most of Southeast Asia. If the sea-level rises by 53 cm, 33 million people would be flooded in Southeast Asia. Further significant threats include the

30 Ministry of Trade and Industry (2006): Science and Technology Plan 2010, Singapore

31 Boston Consulting Group / The Manufacturing Institute / National Association of Manufacturers (2009): The Innovation Imperative in Manufacturing

32 UNESCO Institute for Statistics, September 2009

33 UNESCO Institute for Statistics, September 2009

34 UNESCO Institute for Statistics, September 2009

35 APEC, http://www.apecisti.org/IST/abridge/rep/my_rep.pdf

36 Ministry of Science and Technology, Vietnam, 2010

37 UNESCO Institute for Statistics, September 2009

38 Conservation International, http://www.conservation.org/documentaries/Pages/megadiversity.aspx

39 Conservation Internal, http://www.biodiversityhotspots.org/Pages/default.aspx

40 UK Met Office, sponsored by the Foreign and Commonwealth Office, http://www.fco.gov.uk/en/global-issues/climate-change/priorities/science/

salination of crops, significant increase in the incidence of droughts (1 in 10 year droughts occurring twice as often if a 4 degree rise in temperature occurs) and an increase in extreme weather.

In addition to the above unique characteristics of the region, there are further factors which make Europe-Southeast Asia research complementary. The two regions have very different environments and climatic conditions. Whereas Europe broadly has a temperate climate, Southeast Asia has a broadly tropical climate thus creating two very different sets of conditions for research and technology development. (E.g. research and development of a battery for an electric vehicle must take into account the effect of the different climatic conditions on the battery, as well as the different user patterns and requirements this will result in.) The two regions have very different populations, which have shown different susceptibility to different diseases. (E.g. higher incidence of stomach cancer but much lower incidence of breast cancer in Asian populations compared to European populations.) By partnering, researchers can explore a broader data set, and different conditions. There are significant advantages from Europe and Southeast Asia collaborating across a broad range of disciplines.

4.3.4 National science and technology policies of Southeast Asia

Southeast Asia is broadly a developing region, but each country has identified the importance of developing a strong science base and to do so, has produced a national science and technology policy. The region already has well established pockets of excellent research and each plan identifies, from the top down, where the greatest perceived opportunities will be in developing specific research capabilities or where national challenges need to be addressed through research, and thus where each country will be directing public funding resources. S&T plans also play an important role in capacity building in less-developed nations with developing S&T bases.

Focusing on Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam, all have produced S&T policies to drive the strategic direction of public R&D. The predominant objective of the S&T policy set out in each plan is to develop S&T to generate sustainable economic development for the state. Each S&T plan is briefly considered in turn to identify where each country is channelling resources, which may (depending on the success of the plan and evolution of scientific research) form the future strengths of the countries and be future key collaboration opportunities. This must be evaluated within the context of the actual strengths of the country (potentially driven bottom up from researchers) and against the unique characteristics of the region which make partnership with it so important.

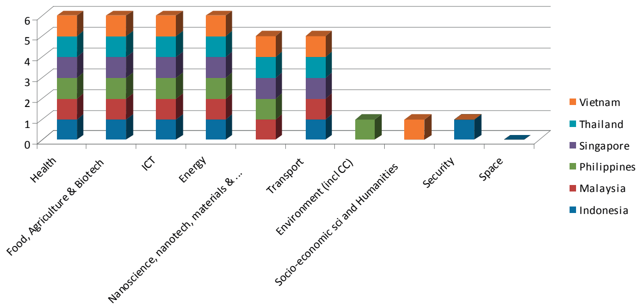

Figure 61: Diagrammatical representation of priorities in national science and technology plans of Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam.

Indonesia

Indonesia has developed the 'Vision and Mission 2025'[41] which aims to establish S&T as the main driving force for the sustainable development of the economy and the people. The plan sets out that this will be achieved by building an ethical foundation for developing S&T, creating a solid national system of innovation to increase global competitively, consolidating all Indonesian S&T actors, building up S&T human capital and by creating a knowledge based society. In addition to this policy, Indonesia has developed six focus programmes, which originally ran from 2005 to 2009, but which have been extended to run from 2009 to 2014[42] to develop core S&T capacities in specific thematic areas. The government is focusing resources on:

- Food and agriculture: Food resilience through agriculture systems; aquaculture; agro-industry and agro-business
- Energy: Sustainable energy supply through the creation and use of new and renewable sources energy
- Transportation: Creating an effective and efficient multi-mode transportation system based on land, space, and sea transportation.
- ICT: Utilising information communication technology to increase economic prosperity and good governance
- Health and pharmaceutical: Utilising technology for pharmaceutical products (including herbal medicine) and medical equipment
- Defence: Develop defence technologies in ammunition as well as land, water and space military vehicles.

41 State Ministry of Research and Technology, Indonesia, http://www.ristek.go.id/english/home.html
42 Confirmed by State Ministry of Research and Technology, Indonesia, October 2010

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Malaysia

Malaysia's science and technology plan, 'Malaysia's S&T Policy for the 21st Century,'[43] is geared towards economic growth – generating value for the economy and jobs for the Malaysian people. Malaysia identifies itself as a 'relatively' resource deficient nation in the plan, underlying the need to allocate resources in line with national policies to transform the country into a knowledge-driven economy. The idea of harnessing S&T for economic growth is reinforced continuously throughout the plan, which aims to develop a framework for improved performance and long term growth of the Malaysian economy by:

- Strengthening research and technological capability and capacity;
- Promoting the commercialisation of research outputs;
- Developing human resource capacity and capability;
- Promoting a culture for science, innovation and techno-entrepreneurship;
- Strengthening institutional framework and management of S&T and monitoring of S&T implementation;
- Ensuring the widespread diffusion and application of technology leading to enhanced market driven R&D, resulting in new and improved technologies; and
- Building competences for specialisation in key emerging technologies.

During the course of the S&T Plan, Malaysia aims to increase gross expenditure on R&D to at least 1.5 % of total gross domestic product, as well increase the total number of researchers, scientists and engineers (RSEs) in the workforce to at least 60 RSEs per 10,00 of the labour force. Malaysia set 2010 as the year by which these targets should be attained and the results should shortly be available.

Malaysia prioritises funding research programmes in selected new and emerging technology areas that it considers will yield the greatest economic gains, and where Malaysia perceives it has a natural advantage. In the S&T plan, Malaysia identifies the following technology areas in which they will focus resources and develop a knowledge base to build sustainable support for Malaysian industry:

- Advanced manufacturing;
- Advanced materials;
- Microelectronics;
- Biotechnology;
- Information and Communication Technology;
- Multimedia Technology;
- Energy;
- Aerospace;
- Nanotechnology;
- Photonics and
- Pharmaceuticals.

The Malaysian government set aside RM 9.5 billion (€ 2.38 billion) for this S&T plan.

Malaysia does not focus on its unique biodiversity in the S&T plan, which is a great future opportunity for Malaysia. Malaysia has been identified by the UN Environment Programme as one of the world's top 12 'megabiodiverse' countries with over 2,000 unique higher species of flora and fauna. Southeast Asia's, and especially Malaysia's unique biodiversity is a very important global resource and provides extensive important EU-Southeast Asia partnership opportunities. Furthermore, habitat loss is particularly exceptional in Southeast Asia, which has the highest relative rate of deforestation of any major tropical region and could lose three quarters of its original forests by 2100 and up to 42 % of its biodiversity. The consequences (including economic) of biodiversity loss are widely recognised but poorly understood. This is one key opportunity in a large number of partnership opportunities resulting from Malaysia's unique ecosystems and environment.

Philippines

The National Science and Technology Plan[44] (NSTP) of the Philippines runs from 2002 to 2020, and was formed as a reaction to the government's call for S&T to be the foundation of future economic development. R&D, technology transfer, human resource development, S&T promotion, information dissemination and networking are identified as key elements to achieve short term growth, which in turn, are key to long term growth.

The NSTP outlines the national challenges which the Philippines wants to overcome, which range from slow economic growth to the depletion of natural resources resulting in limited investment, especially in S&T, and talent being drained away from the Philippines to more attractive opportunities overseas. The Philippines experienced a decreasing gross expenditure on research and development as a percentage of GDP during the 1990s. However, the Philippines has pockets of excellence (especially identified within areas of health research) and has one of the highest percentages of high-tech exports in Southeast Asia, although this is concentrated in electronics.

The NSTP sets out a vision for the Philippines to have a wide range of globally competitive products and services with a high technology content by 2020, as well as world class universities in S&T, a well-developed S&T based SME sector, internationally recognised scientists and engineers and for the Philippines to be considered a model for S&T management and governance.

To achieve these aims, the Philippines will focus on

43 MOSTI (n.d.): Malaysia's S&T Policy for the 21st Century

44 DOST (n.d.): National Science and Technology Plan 2002–2020, Manila, online: http://region1.dost.gov.ph/index.php?option=com_docman&task=doc_download&gid=10&Itemid=92

niching and clustering, addressing pressing national problems, developing human resources, providing support to industry (especially SMEs), accelerating technology transfer, building the S&T infrastructure, strengthening linkages between government and industry, improving S&T governance and promoting S&T.

The Philippines identifies 12 thematic priority areas for S&T development, where resources will be focused under the NSTP:

- Agriculture, Forestry and Natural Resources
- Health and Medical Sciences
- Biotechnology
- Information and Communications Technology
- Microelectronics
- Materials Science and Engineering
- Earth and Marine Sciences
- Fisheries and Aquaculture
- Environment
- Natural Disaster Mitigation
- Energy
- Manufacturing and Process Engineering

The plan goes into specific detail on which areas of R&D should be prioritised within each thematic area. For example, the agriculture theme aims to harness S&T to increase agricultural productivity through the modernisation of agriculture and development of new technologies. The Philippines has already developed core capabilities and pockets of excellence in the health and medical sciences, as well as ICT whereas biotechnology is a new area but perceived to have the greatest potential for the Philippines. Microelectronics is the top export earner and expected to continue to be so. Materials are expected to play an important part in the country's industrial development and earth and marine sciences, as well as aquaculture, are thought to be key to increasing the country's food supply. The Philippines wants to lessen its dependence on imported fossil fuels and thus is devoting resources to R&D on energy. They are also keen to channel resources to R&D related to the natural disasters the Philippines is prone to, as well as to the environment. The plan rounds off with the implementation and monitoring plans to realise their goals.

The Philippines has a strong international strand running through its science plan, mentioning technology transfer, to concern over brain drain, and a performance indicators related to the international recognition of Philippine scientists. This indicates a clear focus on international research and collaboration.

Singapore

Singapore has the most developed S&T base in Southeast Asia, with state-of-the-art infrastructure including Biopolis co-locating public and private biomedical R&D, Fusionopolis housing physical sciences, engineering and ICT research, and Mediapolis under development, which will be a state-of-the-art interactive digital media research facility. Singapore has 5 yearly Science and Technology Plans. The current plan, the Science and Technology Plan 2010[45] (STP2010) runs until the end of March 2010. The details of the next plan the Research Innovation and Enterprise Plan 2015 (RIE2015), including the thematic focus, are not yet publically available. The RIE2015 will provide € 8.9 billion for R&D over the 5 year period from April 2010 to March 2015, which is a 20 % increase in budget from the current science plan. Both the STP2010 and RIE 2015 aim to contribute to the nation's development, promote economic growth and create jobs. The new plan is expected to increase the emphasis on enterprise and the economic outcomes of research, and a requirement for publically funded research to demonstrate collaboration with industry is anticipated.

Under the STP 2010, € 7.9 billion was earmarked to promote R&D for the duration of the 5 year plan. STP 2010 sets out the strategic direction for S&T policy for 2006 to 2010 and will anchor Singapore's transition into a knowledge and innovation driven economy through the following key strategies:

- Use Singapore's innovative capacity as a source of competitive advantage to find and create a comparative advantage in the changing economic landscape.
- Focus the strategic direction for S&T policy upon the 5 strategic thrusts identified by the Ministerial Committee for R&D (see below)
- Create an enabling technology environment for sustained industry growth, through the concentration of resources in niche areas within industry clusters.
- Develop and manage R&D human capital through pro-local and pro-foreign policies to draw the best global talent to Singapore and groom the brightest Singaporeans.
- Promote private sector R&D.
- Strengthen technological innovation capabilities in SMEs.
- Increase the commercialisation of public research through IP policies.
- Establish and maintain a world-class research infrastructure.

In parallel to the STP 2010, the Research, Innovation and Enterprise Council, which is chaired by the Prime Minister, identified five strategic thrusts to direct national research and development in Singapore:

- To intensify national R&D spending to achieve 3 % of GDP by 2010;
- To identify and invest in strategic areas of R&D;
- To fund a balance of basic and applied research within strategic areas;
- To provide resources and support to encourage private sector R&D; and
- To strengthen linkages between public and private sector R&D.

45 Ministry of Trade and Industry (2006): Science & Technology Plan 2010, Singapore

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The STP 2010 also sets 3 key targets to be achieved before the end of 2010: achieve a Gross Expenditure on R&D (GERD) of 3 % of GDP; increase the private sector's share of GERD to two thirds; and increase research manpower to support increased R&D activity. STP2010 goes into more specific detail on the specific targets to be achieved by key players in Singapore.

Singapore focuses its R&D policy and funding across two broad research councils: the biomedical sciences and science and engineering. The overall aim of the policy focusing on the biomedical sciences is to stimulate economic growth for Singapore through the advancement of human healthcare. The four overriding industry sectors that the plan is targeting are pharmaceuticals, medical technology, biotechnology and healthcare services and delivery. The five key areas of research identified in the plan where Singapore could play a critical role include:

- Drug discovery
- Bioimaging
- Stem cells
- Cohort studies
- Biomarkers

These translational programmes interface with the basic biomedical capabilities that already exist in Singapore in bioprocessing, chemical synthesis, genomics & proteomics, molecular & cell biology, bioengineering and nanotechnology and computational biology.

Science and engineering research supports Singapore's four key manufacturing industry sectors in electronics, infocomms, chemicals and engineering. Research conducted in the science and engineering sectors develop relevant technologies and capabilities to meet the needs of the manufacturing industries. Four interdisciplinary areas were identified in which to focus all R&D:

- Nanotechnology,
- Digital and interactive media,
- Environmental technologies
- Energy technologies.

Developing R&D in the above areas will build upon existing capabilities in data storage, microelectronics, infocomm sciences, materials sciences, chemical sciences and manufacturing technologies.

Singapore is significantly more scientifically advanced than the rest of the region with worldclass research. Singapore acknowledges that it is a small country with limited resources and therefore targets a limited number of areas in which to focus research where it thinks it can be a world leader.

Singapore has a very strong international focus running throughout its national science plan. Singapore has set up international advisory panels bringing together world leading researchers to advise their science agencies and research councils, and strongly encourages international collaboration with other institutions around the world. Singapore also have human capital policies which aim to, and have successfully, attracted world class talent to come and work in Singapore.

Thailand

Thailand's science plan, the National Science and Technology Strategic Plan, runs from 2004 to 2013 and aims to develop S&T capability and use it to enhance the competitiveness of targeted sectors of industry, boost the economy and increase the quality of life in Thailand. The plan has six strategies focusing on:

- Developing and strengthening industrial clusters
- Strengthening the community economy and quality of life
- Developing S&T human resources
- Developing the S&T infrastructure
- Building public awareness of S&T
- Improving the administration and management of the system.

The plan adopts a clusters approach to developing sectors of industry through R&D, with a particular focus on four core technology areas: biotechnology, ICT, materials technology and nanotechnology. The clusters, to which three quarters of the research budget is directed, are targeted at addressing Thailand's needs. The following clusters have been identified:

- Automobile and Traffic
- Alternative Energy
- Environment
- Food and agriculture
- Medical and health
- Rural areas and the underprivileged
- Software, microchips and electronics
- Textiles

Within each of the clusters, specific programmes have been developed with the greatest number of programmes being focused on food and agriculture, followed by the software, microchips and electronics cluster then the energy cluster. Each programme focuses on a specific research challenge. Thailand is aware that it still needs to build up its research capacities and one quarter of the research budget is directed towards capacity building.

As part of Thailand's S&T Plan, they are also restructuring its administrators of public R&D.

Vietnam

The Science and Technology Development Strategy[46] (STDS), which ran from 2006 to 2010, aimed to promote research which would assist in the modernisation and industrialisation of Vietnam, as well as assist in international economic integration. Vietnam is in the process of formulating its new science plan, which is set to be finished and published in 2011.[47]

46 Ministry of Science and Technology (2003): Science and Technology Development Strategy by 2010, Vietnam
47 MOST, December 2010

STDS aimed to speed up basic research in natural sciences, social sciences and humanities, as well as direct necessary attention to applied research in areas where Vietnam has the greatest strengths. The STDS also aimed to strengthen the R&D capacities of domestic technologies and master modern technologies, as well as build up S&T human capital. Specific mention is also given to investing in S&T related to national defence and security.

In addition to building capability in the social sciences and humanities, and natural sciences, Vietnam identifies key technologies which will have a significant impact on the modernisation of the economy, and ensuring national security, as well as make use of Vietnam's tropical agriculture and abundant agricultural labour force:

- Information-communication technology
- Biology technology
- Advanced material technology
- Automation, mechanics and machinery technology
- Technology in energy
- Preserving and processing technology of agricultural products and foods
- Cosmology technology

For each sector, Vietnam outlines what research is prioritised and the objective of carrying out this research. Vietnam has developed significant strengths in food and agricultural related research over the last few years, capitalising on agricultural industry, as well as trying to ensure food safety and security for Vietnam as climatic changes change in a country very vulnerable to climate change. Analysis of the country's previous plan and new thematic and policy directions will be available in mid-2011.

Other countries of Southeast Asia

The other countries of Southeast Asia (including Cambodia, Laos, Myanmar) are now also focusing on growing their S&T bases. They show a strong intention to develop and strengthen their S&T bases to become regionally and globally competitive. Southeast Asia, as a region, is rapidly developing, and with this, there is a clear trend of stronger research capabilities and resultantly, further partnership opportunities with the region.

4.3.5 Research Strengths of Southeast Asia

Taking the total number of publications and citations produced annually as a measure of the overall strength of research capacity (and acknowledging the limitations of this measure[48]), Europe produces a greater number of total publications and receives more total citations annually than Southeast Asia does.[49] However, Southeast Asia is rapidly developing and going forward, is likely to see a significant rise in the total publications and citations from the current level. Current publications and citations from Southeast Asia have a high percentage of international collaborations and international citations, indicating a high impact of research output and quality and experience as an international partner. The percentage of international collaborations and international citations is high in comparison with other countries, notably the rest of Asia (China, Japan, South Korea) and Australia. Over the period 2004 to 2008, Southeast Asia has the highest publication and citation output in relation to the output of the EU in research in the fields of nanotechnology, followed by ICT, then industrial technology, then energy, and the lowest percentage of research output in relation to the EU in health research. Southeast Asia produced the highest overall number of publications and received the highest number of citations in health research in 2008, indicating health research is a significant strength and priority of research conducted across Southeast Asia.

In terms of the number of publications produced by Southeast Asia (2008), the highest number was produced in health, followed by research related to food, agriculture and biotechnology and then nanotechnology. The highest number of citations of Southeast Asian papers (2008) followed the same pattern with the highest number of citations in health, then followed by food, agriculture and biotechnology research, then nanotechnology.

Table 10: Total research output of ASEAN in 2008[50]

Thematic area of research	Total publications produced by ASEAN	% international collaborations	Total citations generated by ASEAN	% international citations
Health	16,066	47 % (av. Asia-Pac. = 29 %)	86,610	87 % (av. Asia-Pac. = 77 %)
Food	11,966	57 % (av. Asia-Pac. = 37 %)	55,375	84 % (av. Asia-Pac. = 70 %)
Nanotechnology	5,532	39 % (av. Asia-Pac. = 31 %)	28,777	78 % (av. Asia-Pac. = 64 %)
Environment	4,595	64 % (av. Asia-Pac. = 39 %)	15,689	79 % (av. Asia-Pac. = 65 %)
ICT	4,516	-	5,394	-
Energy	2,311	-	4,920	-
Industrial Technology	1,303	39 % (av. Asia-Pac. = 26 %)	2,456	80 % (av. Asia-Pac. = 66 %)

48 Limitations include inadequate inclusion of a measure of the international rating of specific publication titles, SCOPUS does not list non-English language publications, thus not all Southeast Asian publications will be captured.

49 Sciverse Scopus, www.info.sciverse.com/scopus, data from 2008

50 Sciverse Scopus, www.info.sciverse.com/scopus, data taken for research output in 2008. Average figures for Asia-Pacific include the outputs of ASEAN, Australia, China, Japan and South Korea.

Health research

Southeast Asia has the highest research intensity in health, and a strong research impact in this thematic area. Although it does not produce as many publications and citations as other Asian countries (Japan, China and South Korea), Southeast Asian research has the highest impact in Asia when you look at the percentages of those publications which are international collaborations and international citations – this is much higher in Southeast Asia than in other Asian countries. Nearly all Southeast Asian citations were international citations. Thailand and Singapore, which produce the greatest number of publications and citations, are close in the number of publications and citations they produce, with Thailand slightly ahead in the number of publications, but Singapore ahead in the number of citations.[51] Currently, the National University of Singapore produces the greatest number of citations and Mahidol University, Thailand, the greatest number of publications.

Health is identified as a priority focus of research in each of the aforementioned national science plans, with public R&D channelled into health research across Southeast Asia. This will catalyse capacity building in health research across the region, further strengthening research capacity, output and impact.

Furthermore, with its unique environment with cases of both 'developing world' and 'developed world' diseases, in addition to the likelihood of the emergence of drug resistance strains and the identification of Southeast Asia as a region from which major epidemics could emerge and spread, threatening the health of citizens around the globe, including Europe, health research is a key area and should be a clear priority for research partnerships between the EU and Southeast Asia. One example from Southeast Asia, is the outbreak of H5N1 virus in poultry in Vietnam in 2004, which was transmitted to humans and caused human cases of severe respiratory disease with high fatality.[52]

Food, Agriculture and Biotechnology

The second highest research output of Southeast Asia, in terms of citations, is in research relating to food, agriculture and biotechnology (research in this field generates the third highest number of publications coming out of Southeast Asia). Similar to health, in 2008 Thailand led in producing the greatest number of publications of any country in Southeast Asia, but Singapore produced about twice the number of citations as Thailand. Whereas, there are clear strengths in health research in Thailand and Singapore, continuing to use total publication and citation output as a measure of research strength, Southeast Asia as a whole is consistently strong in food, agriculture and biotechnology research, with Thailand, Singapore, Malaysia, the Philippines, Indonesia and Vietnam producing similar numbers of publications. Cambodia produces around half the number of publications as the Philippines, Indonesia and Vietnam, but this is significant given the level of development of this less developed Southeast Asian nation. The National University of Singapore produces both the greatest number of publications and citations, with Mahidol University, Thailand, producing the second highest number of publications.

Food, agriculture and biotechnology research is identified as a national priority in the S&T plans of Singapore, Malaysia, Thailand, Indonesia, Vietnam and the Philippines. Singapore and Malaysia are focusing resources specifically on biotechnology, whereas Thailand, Vietnam and the Philippines are focusing on both biotechnology, and food and agriculture as research priorities. Indonesia includes food and agriculture as a national priority.

Singapore has identified biotechnology as an industry growth area that promises great economic and societal value. Biotechnology underpins a range of industry clusters in Singapore including biomedical sciences, electronics, precision engineering, transport engineering, chemicals, engineering services and the food industry, but Singapore's strengths lie predominantly in medical and health biotechnology, (the biotechnology industry in Singapore is a vibrant and growing industry and six out of the top ten pharmaceutical companies have manufacturing facilities in Singapore) rather than agricultural biotechnology.

Thailand is one of the largest agriculture and food exporters in the world, and the world's top rice exporter. Vietnam remains a predominantly agricultural country with 75 per cent of the labour force engaged in agriculture, forestry and fisheries. Agriculture also continues to play an important role in Malaysia despite its move away from being an agriculture based economy in the 1970s. Malaysia has significant untapped natural resources, primarily in terms of the wide diversity of its native flora and fauna, and compounds derived from native organisms may have applications in human and animal healthcare, food production, environmental sustainability and related technologies.

With widespread strengths across the whole of Southeast Asia, coupled with the importance of the food and agricultural industry and its vulnerability to climate change, food, agriculture and biotechnology research is a key area for Europe-Southeast Asia research partnerships.

Nanotechnology

Nanotechnology is an important area of research in Southeast Asia, being a strength of the region in terms of the number of publications and citations produced

51 Sciverse Scopus, www.info.sciverse.com/scopus, research output in 2008

52 World Health Organisation, http://www.who.int/influenza/human_animal_interface/en/

annually, as well as national research priority for Malaysia, Thailand and Vietnam. Nanotechnology is also identified as an important technology cutting across six of the eight target industries Singapore is focusing upon in its S&T plan, and therefore a key focus of research in Singapore. Singapore dominates the research output in nanotechnology in Southeast Asia, producing more than four times the number of publications than the next highest countries (Thailand and Malaysia) and more than twelve times the number of citations than any other country in Southeast Asia. Unsurprisingly, Singapore universities and research institutions dominate publications and citations coming out of Southeast Asia with highest number of publications and citations coming from the National University of Singapore, Nanyang Technological University and two public research institutions: the Institute of Materials Research and Engineering, A*STAR, and the Institute of Microelectronics, A*STAR.

By the above measure, Singapore is currently the only country in Southeast Asia with significant research intensity in nanotechnology. However, nanotechnology has also been identified as a national research priority across Malaysia, Thailand and Vietnam and with these national S&T plans acting as the stimuli for developing capacity, these countries may also shortly increase their research intensity in this area, which is likely to become an important for future partnerships with the region beyond Singapore.

Environment

The thematic area in which Southeast Asia has the next highest research output, is environment. Research outputs across Southeast Asia are well distributed in environment research. Thailand and Singapore lead in the number of publications and citations produced but Malaysia and Indonesia are very close to Singapore and Thailand in research output, and strengths are also seen in the Philippines and Vietnam. There is a significant future opportunity for Europe-Southeast Asia research in this field. Southeast Asia has a unique richness of biodiversity, seventeen of the world's 'megadiverse' countries[53] and seven of the world's twenty five officially recognised biodiversity hotspots.[54] Southeast Asia additionally has a wide range of landscape & habitat diversity with a large coastline, significant marine areas (including mangroves and coral), and large forest coverage. Environment research provides a huge potential growth area because of the unique biodiversity and global importance of this resource. Southeast Asia's high level of vulnerability to climate change is an additional reason for research partnerships in this area.

53 Conservation International, http://www.conservation.org/documentaries/Pages/megadiversity.aspx
54 Conservation Internal, http://www.biodiversityhotspots.org/Pages/default.aspx

Other thematic areas

ICT and energy both feature highly in the national S&T plans of the countries of Southeast Asia – all identify ICT and energy as specific national research priorities. However, when considering publication and citation outputs, these are growth areas rather than current strengths of the region. There are a broadly similar number of publications produced by Southeast Asia in ICT research as compared to environment, but there are much fewer citations in ICT research.[55] ICT research in Southeast Asia is dominated by Singapore, which produces the majority of publications and approximately three quarters of the total citations.

Southeast Asia generated less than 20 % of the number of publications and citations in energy research compared to its output over the same period in health research. Singapore, Thailand and Malaysia produce a more or less equal number of publications in energy although Singapore generated a greater number of citations than the other two countries in 2008. Although energy research is not currently a key strength of Southeast Asia as measured by number of citations generated, it is a priority for each country nationally, as well as an area of great importance for the region as a whole, each country acknowledging the need for future energy security and a sustainable energy supply.

One additional area that the countries of Southeast Asia are broadly focusing upon is transport related research – prioritised in the national S&T plans of Indonesia, Vietnam, Thailand, Malaysia. Individually, Vietnam is the only country prioritises research in socio-economic and humanities sciences in its national S&T plan, to assist in the transition to a modernised industrial nation, and Indonesia is the sole country prioritising security related research.

4.3.6 Supplementary evidence: Southeast Asian participation in the Seventh Framework Programme

Researchers from Southeast Asia have actively participated in the EC's Framework Programmes. There has been a significant increase in Southeast Asian participation in the European framework programmes from FP6 to FP7. During the 6 years of FP6 a total of 149 SEA partners from SEA participated, receiving €16.4 million EC contribution. These figures were nearly met within the first 2 years of FP7[56] and the success rate of projects with Southeast Asian partners in FP7 (over 30 %) is above the average success rate which ranged between 10 % and 25 %, depending on the thematic area. The success rate of projects with SEA partners is above average for projects in specific thematic areas, notably Health and Food/Biotech. However, the success rate of projects is below the average in other thematic areas, notably Environment and ICT.

55 See table 10
56 European Commission, http://cordis.europa.eu/fp7/home_en.html

Thailand has the highest participation in FP7 measured by number of FP7 applicants (32 successful applicants), and also receives the one of largest sums for a specific project, receiving €1.13 million for a project within the health thematic. Vietnam receives the largest sum for one project, receiving €1.45 million for participation in a project in the health thematic. Nine of the ten countries of Southeast Asia are participating in a project in the ICT thematic, compared with seven countries participating in projects in the health thematic, six in environment, five in food, agriculture and biotech projects and only Singapore participating in a project in the nanosciences, nanotechnology, materials and new production technologies thematic. Vietnam is the only country participating in a project in the energy thematic and Thailand the only one participating in a project in the transport thematic. The greatest amount of FP7 funding received in Southeast Asia is directed to the health thematic, which is not surprising given Southeast Asia's strength in this thematic area, as well as the unique selling points of the region.[57]

Southeast Asia's high level of participation in health thematic FP7 projects is not a surprise – it a clear strength of the region, a national priority for individual countries, and the region has a unique and interesting research environment brought about by the prevalence of both infectious diseases and 'lifestyle' diseases.

One unexpected trend in Southeast Asian participation in FP7, when compared to the particular strengths of the region (measured by the number of publications and citations produced by the region), is the high level of participation in ICT related projects. Vietnam is the only ASEAN country not participating in an ICT project in FP7. In 2008, Singapore produced more than twice as many publications and nearly eight times as many citations as the country in Southeast Asia with the next highest output in ICT research.[58] Other than Singapore, the total number of publications and citations generated by the rest of Southeast Asia is not a very large number. ICT does, however, feature in the six national S&T plans earlier analysed, which would have resulted in government support in ICT related research, as well as ICT capacity building across the region.

When specifically analysing both the strengths of the region in terms of papers and citations produced, as well as the thematic foci of the national S&T plans, another unexpected trend in Southeast Asia's FP7 participation, is the participation of six countries in projects in the environment thematic, whereas fewer countries (five) participate in food, agriculture and biotechnology. The region has a significantly higher publication and citation output in food, agriculture and biotechnology than environment, and food, agriculture and biotechnology feature broadly across the national S&T plans of Southeast Asia, whereas environment does not.

57 Ibid.
58 Measured by the total number of publications and citations generated for each ASEAN country in 2008 and captured on Sciverse Scopus, www.info.sciverse.com/scopus/

4.4 Concluding comments

There are many measures of research intensity and impact, and it is hard to evaluate which is the most important measure in determining the particular research strengths of a country or region. The national S&T policies, the annual level of output of scientific publications and citations, as well as participation in the EC's seventh framework programme have been briefly outlined for Southeast Asia to try to provide an indication of the research strengths of the region, and thus where are the greatest opportunities for scientific collaboration between Europe and Southeast Asia.

From the analysis, it becomes apparent that, with a few exceptions, there is a lack of correlation between the level of Southeast Asian participation in the different thematic areas of FP7, the annual level of publications or citations produced by Southeast Asia in these thematic areas, or the thematic priorities outlined in the national science and technology plans of the region. This lack of correlation could be caused by a number of factors.

Firstly, there is an obvious limitation in measuring research strength by the number of publications and citations produced annually. Although this is an interesting primary level of analysis, it does not give any indication of the citation impact of the research published. Publishing in certain journals has significantly more weight and impact than an article published in other journals. Thus, pure numbers of publications fails to identify the quality of the work or its greater impact on further research, or economically and socially. However, this can partially be mitigated by identifying whether the publication was the result of an international collaboration or if the publication was cited internationally. Publications either resulting from international collaboration or cited internationally generally have a greater impact than those which have no international element.

Secondly, most international collaborations (and joint publications) are stimulated from bottom up driven initiatives – researchers who know each other from previous research positions or from meeting at scientific conferences, or if one researcher has read and is interested in the work of another. Looking at the national S&T policies only considers the top down mechanisms to developing S&T capabilities and overlooks individual strengths or pockets of excellent research in niche areas which might result in specific international collaborations.

Thirdly, considering the national S&T policies, the annual level of output of scientific publications and citations, and Southeast Asian participation in the EC's seventh framework programme, overlooks any unique or special characteristics. It might be fair to assume that national S&T policies would focus on the unique resources or characteristics of their state. However, this is not always the case. Malaysia, for example, does not mention its unique biodiversity in its S&T plan, and refers to the country as a largely resourced deficient nation. The lack of tailoring S&T policy and funding towards specific national characteristics might be caused by a limitation of resources (considered to be a global problem) coupled with a desire to focus on areas perceived to have the greatest economic growth potential.

However, even without a significant correlation between the national S&T policies, the annual level of output of scientific publications and citations, and Southeast Asian participation in specific thematic areas of the EC's seventh framework programme, it is still possible to identify key opportunities for Europe-Southeast Asia scientific collaboration in specific thematic areas.

The most obvious area for scientific partnership is where both regions share the same challenges which form a common background and joint need for research. These common challenges will evolve over time, but currently both Europe and Southeast Asia regionally, as well as on an individual state level, are faced with challenges to ensure their future water, food and energy security, as well as protect the health of their citizens and protect against the threats posed by climate change. These are huge challenges which cannot be dealt with on an individual state or even individual regional level and are therefore key areas for international collaboration.

In addition to identifying the above global challenges, it is possible to identify certain key areas that should be a focus of Europe-Southeast Asia collaboration from the unique characteristics of the region, the volume of publications and citations produced, the national priorities of the countries, supplemented by the level of participation in particular thematic areas in the EC's seventh framework programme.

Going forward, a vital area for Europe-Southeast Asia collaboration is health research. Research funders should ensure there are adequate mechanisms to enable funding opportunities for this research. Health is a key research strength of Southeast Asia, demonstrated by the volume of publications and citations generated by the region, the higher level of FP7 participation in projects in the health thematic, as well as the focus on health research in all national S&T policies. Furthermore, there are key opportunities for research in Southeast Asia that do not currently exist in Europe, but which poses a threat to the lives of citizens of Europe. Southeast Asia has a high incidence of infectious diseases not currently found in Europe, but which will threaten Europe when temperatures rise due to climate change. Southeast Asia is a hotspot for the emergence of new infections which could turn into global epidemics (e.g. the outbreak of highly pathogenic H5N1 avian influenza originated in Southeast Asian in mid-2003), as well as drug resistance. If Europe does not partner Southeast Asia, they lose access to significant research data and resources, as well as significant learning experiences that Southeast Asia could share with Europe. Southeast Asia will also significantly benefit from the lessons that European researchers can share, as well as from access to the research base in Europe, including top equipped facilities. Further, there are significant shared challenges between Europe and Southeast Asia in research challenges such as obesity, diabetes, cancers. The different populations of both regions provide complementary research opportunities for these shared challenges.

Europe-Southeast Asia collaboration in research relating to the environment is also very important. Southeast Asia has a relatively high annual output in publications and citations and there have been a significant level of Southeast Asian participation in FP7 projects in the environment thematic. Furthermore, the EU hosts a unique set of natural diversity and Southeast Asia has one of the highest levels of biodiversity in the world, as well as a wide range of landscape and habitat diversity, significant marine areas and large forest coverage. However, habitat loss is particularly exceptional in Southeast Asia and many species in Southeast Asia are currently threatened. Research is required to demonstrate the value of Southeast Asia's ecosystems and environment, as well as to protect both regions against the serious consequences threatened by climate change.

Another area of great significance for Europe-Southeast Asia collaboration is food, agriculture and biotechnology research. Research in this thematic area is strength across the whole of the region (high publication output from all countries of Southeast Asia) and an ideal area in which to partner in a best-with-best project with partners across Southeast Asia. Southeast Asia also has a significant agricultural output (Thailand is the world's largest rice exporter). Research in food, agriculture and biotechnology is of further importance because of threat to world's food supply caused by climate change, placing European and Southeast Asian citizens at risk of insecure food supplies. Joint research is needed to find solutions to this global problem.

Southeast Asia's rapid economic development and S&T plans should develop stronger S&T capacities nationally. The national priorities for research will evolve over time and 2011 is a year of transition for many countries in Southeast Asia as they produce new S&T plans, potentially shifting priorities, but the core capabilities that are currently being developed will strengthen the research intensities of each country.

Although it is possible to identify key areas for Europe-Southeast Asia collaboration, it must also be remembered that the majority of collaborations will still arise from bottom up approaches and individual researcher interactions. For these individual collaborations to develop, there must be a conducive environment. Therefore, it is equally important for policymakers to create the ideal environment to enable research

collaborations to flourish, as well as identify the key areas where collaborations are likely to create the greatest mutual benefit. Policymakers must ensure there is a sufficient mix of reactive, as well as directed research funding.

International funding programmes must have the necessary characteristics to enable the programme to be attractive and easy to participate within. They must have simple but clear regulations, and flexible but precise financial policies. All programmes need the flexibility to allow researchers to take risks in their research, as well as promote creativity, whilst simultaneously ensuring funds can be traced and misuse guarded against. It is important that international programmes are conducive to research, offering the most attractive framework for collaborative research. It is important that the European Commission's framework programmes continue to and further encourage collaboration with this important region.

4.5 Outputs of the SEA-EU-NET project

SEA-EU-NET has prepared a list of policy recommendations to identify the key thematic topics for future Europe-Southeast Asia collaboration (see concluding chapter at the end of this book), as well as to guide the development of future Framework Programmes and other funding programmes for international collaborative R&D, and create the best environment for collaborative research between Europe and Southeast Asia.

In addition to the policy recommendations for the development of successful programmes for research, SEA-EU-NET has developed a set of best practice guidelines for developing and participating in international projects (see conclusion, as well). Lessons learnt from the development, participation and evaluation of international projects are rarely shared, resulting in an unnecessary waste of resource and repetition of effort.[59] It is generally deemed undesirable to have a prescriptive list of best practice guidelines for researchers establishing international projects, especially because there is such a diverse range of international projects. However, it is possible to identify common successes and issues which are shared by most projects. These common factors form the basis of a list of best practice recommendations which can be utilised by researchers wishing to establish international projects and optimise the potential outcomes.

59 OECD Global Science Forum 2003, p. 2

5 Opportunities, pitfalls, and recommendations for S&T cooperation

Rudie Trienes, Jack Spaapen, Jacco van den Heuvel[60]

5.1 Major opportunities and pitfalls

This chapter presents an analysis of the opportunities and pitfalls with regard to S&T cooperation as assessed by experts from SEA and Europe, and it advises on a number of policy changes in order to further enhance scientific cooperation. The content is based on an analysis of information obtained in a number of activities and events that have been organised especially for this analysis. These include workshops and focus groups, semi-structured individual and group interviews with researchers and policy advisors both in Southeast Asia and Europe, and a number of dedicated feedback sessions at the SEA-EU-NET conference in Bogor, Indonesia, in 2009.

The major conclusion of both workshops, interview and feedback sessions is that by far the most important priority in developing S&T cooperative relationship between SEA and Europe is building a more sustainable soft and hard S&T infrastructure for research and development. In this, the prime focus should be on creating or enhancing strong knowledge hubs that have both a stimulating effect on the wider environment (other parts of the research system and society at large), and form an attractive place for young talented students and researchers. A good infrastructure is of pivotal importance in redressing the imbalance between researchers from SEA going to Europe and European researchers currently not going to SEA. A good research infrastructure and ample training opportunities would create a strong base of national researchers in SEA. It would also assist in shifting the focus of research cooperation from gathering samples and conducting field and laboratory work to establishing more continuous and sustainable R&D networks that consider the potential benefits to the economy and society of both regions.

At meetings between SEA and Europe at the highest political a more strategic SEA-EU dialogue should be cultivated to identify strategic interests for SEA-EU collaborative R&D projects, to take priority setting decisions for collaborative research programmes, and to engage all partners and stakeholders in the planning and design of funding calls targeted at the collaboration with SEA.

Cooperation in science and technology (S&T) between Southeast Asia (SEA) and Europe is beneficial to both regions, provided attention is paid from the start to the differences in major interests on both sides, both of researchers as well as policy makers. This is not easy, given the differences between both regions with regard to the level of investment in S&T, the level of development of research infrastructures and the differences in needs on both sides as a result of this. From a more positive perspective, however, there are not only differences between these two regions, but substantive common features as well. Both regions are of similar size in terms of number of inhabitants, have long historical relationships (which are still visible in parts of the S&T systems) and are, despite internal diversity, trying to develop a common regional policy (through the political bodies of ASEAN and EU).

In other words, both regions are thoroughly familiar with each other, and are able to understand the difficulties in developing a common policy, despite the differences between their various nations. A major force behind the growing urge towards a more integrated policy across individual countries is arguably the rise of global problems, such as climate change, energy related issues, and infectious diseases.

There are many examples of fruitful scientific collaborations and linkages between researchers in Europe and Southeast Asia (SEA). Such partnerships are beneficial to all parties involved, and the resulting advancements in research delivers improved quality of living, life saving medicines and economic returns to both regions.

Bilateral cooperation between countries from both regions has been important for centuries. After the lopsided relationship in colonial times, a more balanced relationship has been slowly developing over the last decades. Differences in the field of S&T between Europe and SEA are also diminishing: emerging economies of Southeast Asia are catching up, and budgets for education and research are steadily rising.

Opinions on how to establish long-term and sustainable R&D networks between SEA and Europe vary, but a limited number of issues stood out in discussions with experts of both regions. Whenever setting up international cooperative projects or programs, serious attention should be paid to the following major opportunities and pitfalls.

Major opportunities

- The balance between research interests of both regions, a win-win situation, co-writing proposals, co-publications, co-patenting (all still biased towards Europe);
- The importance of including attractive arrangements for young talented researchers (brain drain-brain gain issues);
- The different policy agendas and interests with regard to establishing research infrastructure (there are still huge differences in the region, there's no one size fits all approach);
- The options for more mutual learning in the region and North-South-South cooperation.

Major pitfalls

- The lack of clarity on what EU programmes entail, on criteria for application, on potential partners;
- The absence of special EU policy and funding for SEA;
- The difficulty of attuning the interest of researchers on both sides (the balance between basic research and application; long term capacity building, connecting to the international scientific community);
- The lack of mutual learning, in particular from good practices (like e.g. institutes for good governance in Thailand, new research institutes in Vietnam, joint research labs in Taiwan).

5.2 SWOT analysis of SEA–Europe cooperation: why and how

SEA-EU-NET has performed an analysis to identify the best opportunities and potential pitfalls for scientific cooperation between SEA and Europe. We have used a methodology that is based on the well known instrument of SWOT analysis (Strengths, Weaknesses, Opportunities, Threats). However, for reasons explained below, we have not conducted a full SWOT analysis, but we have focused instead on identifying only the best opportunities for cooperation and the potential pitfalls.

A limited SWOT analysis: aims and basic methodology

Originally, the SWOT analysis was developed in the business community, with the purpose of discussing the strategic options for future development of business enterprises. Later, the approach was picked up by academia (Harvard business school among others) and over the years it has become increasingly more common in the research world. The main pre-condition for a SWOT analysis is the availability of robust data about the entity that you want to research. In the case of SEA-Europe cooperation there is no clearly defined entity, such as a research program, or a number of institutes that cooperate. The focal point of SEA-EU-NET is to stimulate bi-regional S&T cooperation between countries in Southeast Asia and Europe. These entities are too wide and diverse to collect the necessary data in the limited scope of this study.

Therefore, we have decided to conduct a more restricted analysis by compressing the SWOT analysis. First, we put strengths and opportunities together in a single category and weaknesses and threats in another. We refer the first category as Best Opportunities and to the second as Potential Pitfalls. Secondly, since we cannot use all available data (in principle all data produced by S&T cooperation projects between the regions Europe and SEA), we have limited ourselves to (1) some overall statistical data regarding collaborations between Europe and SEA as they are available in the FP6 and FP7 programs and (2) expert information of people who have knowledge of S&T cooperation in the context of SEA and Europe.

For the latter type of information, we have used focus groups and interviews as main instruments. We did so both in SEA and in European environments. To gather data from the SEA context, we used the ASEAN Committee on Science and Technology (COST) conference that was held in Bali in May 2009. For the European context we organised a workshop in Amsterdam on 21 September. In November 2009 we presented a draft version during the Week of Cooperation in Bogor, and conducted a number of dedicated feedback-sessions.

Some details of the overall approach: The aim of our analysis is to combine information from a wide variety of sources, both from the SEA and the European perspective, and from policy makers and researchers. Furthermore, we use a wide range of cooperation experiences, in terms of scientific field, country, and cooperative arrangement. In the meetings in Bali and Amsterdam we used a similar approach, i.e. a combination of interviews and focus groups, but with a difference: During the Bali meeting we used two separate groups of informants: experts that we had invited to participate in the focus groups, and other experts that were participating in the ASEAN COST conference and were available for individual interviews. In Amsterdam, where there was no larger conference, we interviewed the participants that we invited for the focus groups at

60 All authors are at the Royal Netherlands Academy of Arts and Sciences, corresponding author's email address: rudie.trienes@bureau.knaw.nl a separate moment individually. The experts that participated in the focus groups in Bali were mostly members (sometimes chair) of subcommittees on specific scientific fields of the ASEAN COST. For the interviews we selected participants of the conference, paying due attention to the distribution over fields and countries. The experts in the Amsterdam meeting came from different European countries. They were either suggested by SEA-EU-NET partners, or identified through the FP6 and FP7 databases, and in a few cases through the network of the Royal Netherlands Academy of Arts and Sciences (KNAW).

For the interviews we used a semi structured questionnaire of which we had two versions, adapted to researchers and to policy makers.

The focus group approach was as follows: We divided the participants into groups of six to eight people and let them discuss six topics. The topics were loosely related to the questionnaires. It was emphasized in advance that the goal of a focus group is not to reach consensus, but to exchange information and experiences and open up perspectives. That is why the group has to be relatively small, and yet diverse enough to entail a variety of fruitful perspectives. After the discussion in the focus groups, participants came together for a plenary session in which the main results were discussed and common grounds were explored. This resulted in a list with opportunities and pitfalls. After the Amsterdam workshop, the results of both meetings were brought together and a draft list was presented to the Bogor conference in November 2009. During this conference separate, dedicated feedback sessions were organised during break-out sessions, and the comments of the conference participants were taken up in the final text.

From the desk study that we performed in the first phase of our study we selected the six main topics that we used as a base for both the interviews and the focus groups:

- Benefits of growing international S&T cooperation for local research
- Benefits of growing international S&T cooperation for the wider society
- Pros and cons of SEA-Europe or other international cooperation
- Government policies to stimulate SEA-Europe S&T cooperation
- Interaction between public and private research
- Pros and cons of funding policies in both regions

While the six topics all represent the interface between science and politics, between research endeavours and policy intentions and measures, the first three are slightly slanted towards the side of S&T, the latter three to the policy side. By discussing these issues with experts from both regions, we were able to shed some light on the following topics in the next sections of this chapter:

- Existing and emerging opportunities for international cooperation
- Potential pitfalls
- Challenges for regional, national and supranational policies
- International S&T cooperation: with Europe and other parts of the world

5.3 Existing and emerging opportunities for international cooperation

Researchers everywhere in the world try to connect with their colleagues internationally, in order to share new scientific knowledge, exchange research methods, start up joint projects, and thus improve the quality and dissemination of their work. At the same time, policy makers focus on achieving a wide variety of societal goals, in order to improve living conditions for the general population, by advancements in sectors such as education, health, and infrastructure. In this, the objectives of science and government policy at times overlap, but at other times deviate to some extent. In general, the relation between science and society, and the differences in goals and interests between both communities, has received a lot of attention all over the world from policy makers and scientists alike. A main reason for this can be found in the growing awareness of the urgency of a number of global problems, such as changing climate, energy issues, water management, and health matters. Growing global competition between countries and regions also forces governments to expect more help from science to address societal problems.

When we compare research policies in Europe and Southeast Asia, we see differences and similarities. While in most European countries policy makers try to find a balance between the support for excellent fundamental research and for research relevant for societal goals, the accent seems to be on the former. In most Southeast Asian countries, the necessity for research and international research collaboration to focus on societal problems seems to be self evident, given the wide array of challenges in these countries, calling for applications of new knowledge.[61] This is clearly the case in areas that regard the use of natural resources, sustainable environment, disaster mitigation, more efficient agriculture, or health. But while these areas imply a prime focus on application orientated research, the development of a solid base for more fundamental research is felt necessary too. Here we have to keep in mind that, even within individual research institutes, a clear line between "applied" and "fundamental" research is often difficult to draw.

When looking for opportunities for R&D cooperation between Europe and SEA, both drivers for innovation should be equally addressed, that is a match should be sought between what motivates researchers in international collaboration, and the needs of the region or the society at large. This is a fundamental issue, which need to be dealt with properly from the very beginning when looking for good opportunities to collaborate in international programmes. This is of course not to say that bottom up collaborations between researchers of different countries or regions that focus on basic research should be discouraged. However, for improved collaboration at a bi-regional level, as a rule based on large funding schemes, the societal relevance is a point that needs more attention. When discussing existing and emerging opportunities for cooperation we refer on the one hand to positive experiences with present schemes and on the other to opportunities that open up thanks to changing circumstances. While trying to develop successful new initiatives, it is useful to consider what already works and what we can learn from this. In the next subchapters we use the results of discussing the six topics mentioned in chapter 5.2 with our respondents, focussing on benefits and challenges of international cooperation.

5.3.1 Benefits of and challenges to international R&D cooperation

From the point of European researchers, one of the major benefits of collaboration with Southeast Asia is the availability of samples, due to the vast natural resources. As such this provides experimental fields for a wide variety of research themes. But European research institutes also see benefits for enhancing capacities of researchers in their own organisation by cooperating with SEA partners.

From the point of view of SEA researchers, the motivation for collaboration is likely to be different. For them, access to international funding schemes is important given the low level of investment in SEA countries (except Singapore and arguably Malaysia), and the possibility to co-author articles in high ranking journals. International cooperation is often seen as a way to stimulate the number of international publications of an institute, in order to improve the institute's reputation. Other motives can be options for co-patenting, joint use of new instruments, exchange of students and new research facilities.

The rationale for international research cooperation within Southeast Asia might also differ from country to country, for example with regard to the relative weight that is put on issues such as physical research infrastructure, access to international publications, general scientific and technical knowledge sharing.[62] These differences should be taken into consideration when setting up international collaborations. It requires a level of awareness by policy makers on both sides. Examples from our SWOT analysis show that in Vietnam for instance, both capacity building and access to technology and facilities are among the prime motivations for cooperation, while in Indonesia there is more focus on knowledge sharing and access to international publications. These differences become apparent when looking at concrete examples of collaborations. In Vietnam therefore, the focus is much more on building new institutes and reorganizing the higher education sector, while in Indonesia the focus is more on joint endeavours between researchers and research institutions.

But there are also issues that are important for all countries alike. Clearly, the training of young researchers, as a specific form of knowledge transfer, is one of the main motives for international cooperation in most countries. Though there is always the danger of brain drain, in most Southeast Asian countries it seems to be the case that a large majority of students return to their home countries. This focus on capacities of young researchers makes it both worthwhile and necessary to invest in international research networks with a long term perspective. On the other hand, there is another danger when looking at the benefits for the academic sector: it is often difficult to keep excellent students in the academic part of the R&D system, as many prefer working in the commercial sector. Mobility of researchers however, can be seen as an indicator of both quality and relevance of the institute that 'produces' these researchers. The influence of international cooperation regarding this point is felt to be important by researchers and policy makers alike.

In several countries, policy makers and researchers also hope for positive influence of cooperation on the general level of research and teaching at their universities. Sending (PhD) students abroad is an important aspect of this development strategy. Many SEA researchers would like to improve this mobility by making it more of a reciprocal process, that is, by also having more EU students going to SEA. This arguably would also enhance the European understanding of SEA research systems and provide more insight in opportunities and pitfalls for cooperation. For SEA institutes, more short term practical arguments also play a role in the need for cooperation: as a spinoff of joining an international network, they hope to gain experience in formulating proposals for future international funding.

At the policy level, for both regions, economic and social development are important motives for international S&T cooperation. Specifically, most SEA countries are trying to raise both the strength of their economies and the level of welfare of its citizens in order to be able to operate on a more equal level in relation to presently more developed countries. In order to work towards such a "knowledge equilibrium" international R&D cooperation is a necessity. More importantly, global issues (such as the climate change, sustainable energy, infectious diseases) can only be addressed by global coop-

61 For a short discussion of theoretical concepts concerning international S&T cooperation, see Schüller et al., International Science and Technology Cooperation policies of Southeast Asian Countries. Consultation prepared for the EU Commission on the occasion of the first bi-regional science and technology policy dialogue, EU-ASEAN (2008), pp. 4–6

62 Schüller et al., International Science and Technology Cooperation policies of Southeast Asian Countries eration. It is also clear, however, that countries in SEA face several specific challenges, the diminishing shrinking level of natural resources, or the vast impact of certain diseases such as aids or malaria. Because of this, many of the region's scientists and governments also see international collaboration as an important starting point to face these challenges.

Finally, the ratio between public and private investments in R&D is an important issue worldwide, but is perhaps somewhat more urgent in Southeast Asia, as many countries in this region have limited budgets for R&D (but some are rapidly catching up). In many countries there is also little private investment in R&D, as global companies tend to locate their R&D departments elsewhere, and many countries do not have a lot of medium or large sized companies with sizeable research facilities. In global comparison, the general state of the Southeast Asian research infrastructure is still weak (with exceptions). While it is clear that the public and private sector need to work together to form a successful innovation system, it seems also clear that the initiative for stimulating such cooperation in the R&D system needs to lie within the public sector. Singapore's Agency for Science, Technology and Research (A*STAR) is often mentioned as an interesting example within SEA.[63] The EU framework programmes in principle form a good opportunity for such development since they are very open to public-private collaboration, especially for small and medium enterprises (SMEs). However, in many SEA countries, where private R&D is limited, an extra effort from EU and/or ASEAN seems to be needed to actually reach and attract companies.

A specific point of attention in this respect is the available level of expertise within a country, also tied to brain drain issues. Indonesia has difficulties in setting up cooperation between private organisations and public research institutes, because of a lack of experts for example in nanotechnology. Excellent researchers, both in publicly and privately funded research, tend to leave the country. It is important to be aware of the fact that this problem exists as much for commercial R&D as it does for publicly financed research institutes.

5.3.2 Learning to find the best opportunities

Above we have described the major benefits and challenges as they were brought to the fore by our respondents. Here we reflect on some of the consequences for developing new collaborations. Obviously, the circumstances differ in the various SEA countries with regard to best opportunities for developing new cooperative arrangements. Efforts to improve cooperation between EU and SEA obviously have to be sensitive to these differences. This also requires good informed policy makers and civil servants on both sides. But it also requires the willingness to learn from each other. Below, we highlight by way of example some arrangements and policies in different countries that might provide lessons for other countries.

Interactions between research, industry and government

A good innovation system only works when there are good connections between the different parts of the system: research, industry and government. Singapore, and to a somewhat lesser extent Malaysia, arguably have succeeded in building such connections. Malaysia has invested in private sector R&D development, in particular to make risks acceptable for local companies. This policy of the Malaysian government indeed encourages tripartite cooperation between government, industry and research institutes. It is worthwhile to see whether this model may be useful for other national governments and/or ASEAN.

The next generation of researchers

Any S&T system can only be sustainable as long as it manages to renew itself on a permanent basis, in particular through educating and training a next generation of researchers. We see various policies in different countries. For example, Indonesia cooperates with China via programmes through which Indonesian students are funded to study in China. Indonesia also has some positive experiences with the so-called twin city approach, where on a local or regional level one SEA city or urban agglomeration connects to another in the EU. In such arrangements, several instruments can be included, for example exchange of students, cultural exchange, and cooperation with regard to environment related issues.

Arrangements like these might work for other countries too, especially when there is limited experience in international cooperation. Such small scale cooperation can lead to useful knowledge exchanges, and if successful can eventually create possibilities for larger networks.

Brain drain–brain gain issues obviously need attention too in the context of education and training. In the case of Vietnam for instance, explicit attention is paid to returning students from abroad to facilitate their reintegration in the national university system. Since this issue is important for all countries, it is worthwhile to assess whether or not these Vietnamese arrangements could work in other countries too.

Pros and cons of old ties

Historically, strong ties existed between certain parts of Europe and countries in SEA, and these still to a large extent have a direct influence on cooperation. In Laos and Cambodia, for example, a substantial part of the international cooperation consists of bilateral links with France. While these ties are certainly beneficial, for example in the health sector, the Cambodian and Laotian governments also want to further integrate into the region, and develop their own strategic priorities, for example with a focus on cooperation in agriculture, fishery and forestry. Both governments could support each other in developing their own priorities, for example by focusing on human resource management. A huge demand exists for more accessible mobility schemes.

5.3.3 Wrap up

Match different interests, learn from each other

The main conclusion of the above is arguably that while formulating topics for new research cooperation initiatives, there has to be a match between the interests of researchers in Europe and SEA.. But it is also important to be aware of promising opportunities in national or regional S&T policy and to learn from them. For example, when initiating a new cooperation and subsequently face by the issue of brain drain brain gain, one should look at those countries or policy measures that are successful in dealing with this specific challenge. Vietnam, for instance, seems relatively successful in reintegrating students that went abroad into the university system. What can be learned from this in other cases? Alternatively, the focus could be on the creation of long/term research centres where new knowledge can be developed, and by doing so offer an attractive environment for returning students and scholars. Good examples are the Asian Institute of Technology (AIT) which has its main campus in Thailand and the International Rice Research Institute (IRRI) with its main location in the Philippines.

Create strongholds

The role of strong and recognisable research centres in Southeast Asia in stimulating interregional cooperation should be explored when setting up new initiatives, especially on themes that are directly relevant to the region, for instance on marine biology, coastal regions, fishery, forestry. Such centres arguably are attractive for foreign researchers, and thus can stimulate interaction with local researchers. The centres can thus also provide a stepping stone for European researchers into the region.

Focus on problems that affect SEA

To cooperate especially on topics that affect both regions seems to be obvious, yet this is not always the leading principle. This is partly due to lack of attuning different interests in the research and policy systems. There is a need for a strong focus on international problems that hit the SEA region seems self evident. Climate change and CO_2 emissions constitute global problems, as do energy related issues and the spread of contagious diseases. Successful cooperation depends largely on mutual benefits for partners from both sides.

Involve policy makers from the outset

To create better opportunities for successful international collaboration, it is imperative to involve as early as possible policy makers and other relevant stakeholders. By doing so, projects can be better linked with national and EU interests. Emphasis should be put on sustainability of measures taken on basis of insights gained through the project. A lack of follow up after a limited project of three, four or five years is detrimental to building research capacity and jeopardizes long term perspectives on development of the region´s S&T systems.

5.4 Potential pitfalls

In the previous section we discussed the opportunities that exist for international collaboration and the options to explore these, within the context of SEA and Europe. This chapter concentrates on potential pitfalls when setting up and maintaining international R&D cooperation between SEA and the EU. By "pitfalls" we refer, on the one hand, to pitfalls that despite being common and well known don't receive enough attention, and on the other hand to mainly practical issues that might hamper international cooperation, whether this takes place at the level of institutes or programmes, or at the level of individual researchers participating in international projects. Section 5.4.2 deals with some of the more common pitfalls that might occur in most of the cooperations set up by countries in SEA or Europe. Section 5.4.3, will go into more specific and practical examples, and to differences between countries in this. More overarching problems related to present national, ASEAN and EU policies will be discussed in chapter 5.6.

5.4.1 General pitfalls

Most Southeast Asian countries are developing countries, but in very different stages of development. While Singapore is generally seen as the most developed country in the SEA region with a well advanced S&T system, countries like Laos and Cambodia are considered as lagging behind, whilst other countries such as Vietnam or Indonesia are seen is taking middle positions. In cooperation with Europe, most of these countries have to face a rather uneven situation. A main cause of this is the fact that the level of national investment in the science and technology sector is relatively low.

Especially for the lesser developed countries in SEA, tackling these problems is like aiming at a constantly moving target. In Laos, for example, production stand-

63 For more information, see http://www.a-star.edu.sg/a_star/2-About-A-STAR/

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ards were being raised to comply with western standards, but in the time these improvements took place, European standards were raised as well. But the fact remains that Laos (and other countries) are in need of additional applied research into production standards combined with short term implementation of results.

Related to this, another common problem is the lack of adequate and sufficient research equipment. Collaboration with Europe may be helpful here, but cooperation with other countries or institutes in Southeast Asia itself should also be further developed. The unbalance between Europe and SEA, and within SEA, also works out in another way. In several Southeast Asian countries, huge differences exist between regions or provinces. It is not uncommon that this results in a focus by foreign researchers on institutes in a dominant region or province only, thus adding to an already existing unbalance.

A rather different, but equally important potential pitfall is the brain-drain-brain-gain issue. Many projects with partners from Europe and SEA have an element of capacity building. However, institutes in the more developed countries are also trying to attract to most excellent researchers, to come and work for them, sometimes on a long term basis. These two counter-acting motives can exist within a single project (it is rather attractive for young students to spend time in an institute in a foreign country, especially if it is a renowned organisation). There seems to be a growing awareness among policy makers that one needs to set up special schemes to have the best of both worlds, on the one hand creating opportunities for talented researchers to learn in a different environment, on the other hand to profit from their knowledge in the home country in a later stage.

One of the issues most frequently mentioned by Southeast Asian scientists is the topic of intellectual property rights (IPR). These are clearly seen as a potentially beneficial outcome of international cooperation, but IPR remains a controversial issue, and often underestimated or sometimes downplayed by European partners. It appears to be very difficult to make arrangements concerning potential new patents at the start of new research cooperation. If this is not clearly dealt with at the beginning through clear contracts, especially in projects in the applied sciences, the collaboration tend to end when possibilities of commercialisation begin. In Southeast Asia in general, there is a need for less strict IP policies in order to productively share information.

And last but not least in this section, arguably more important than clear regulations and agreements for cooperation, there is the issue of building mutual trust, which is of great importance for sustainable cooperation of any kind, but certainly in S&T. Research collaboration projects that only run for a limited time are not only a waste of capital and human investment, but usually do not solve the problems that they were set up for in the first place.

Clearly, one needs to take into account intercultural differences too in approaching and setting up international projects. The colonial image of the Western researcher who comes to Asia to gather specimens or information may be a fading caricature, but shadows of this picture are persistent, with possible threats to fruitful mutual understanding. But also, and more importantly, the ways in which decisions are made about the project formulation, and in general the power balance between the different potential partners is an issue that needs attention from the start. A different level of information about conditions for funding usually exists and this in itself might already be enough to become a barrier for cooperation.

In any event, it is absolutely necessary to have a good and active network to set up international cooperation, both with Europe and within SEA. For this purpose, thematic bi-regional conferences and matchmaking events are considered very helpful.

5.4.2 Pitfalls in actual cooperation within Framework Programmes

In addition to the more general pitfalls mentioned in the previous section, a number of problems can emerge when actual cooperation comes into sight, both within or outside EU Framework Programmes. This can be before, during or after a cooperation takes place.

A problem frequently mentioned by our respondents from SEA is the lack of clear information about Framework Programmes, not only on paper but also coming from NCPs. While the lack of clear information about framework programs is often seen as a problem also in Europe (though much has improved over the years), this is even more often than not the case in SEA. The language problem is frequently underestimated. Researchers from Laos, for example, express the need for assistance with writing applications for international projects, due to the general level of language education. This calls for better dissemination both prior to and at the beginning of a project and also brings out the importance of competent and experienced project leaders. It is obviously very helpful for cooperation with Southeast Asian partners if the project leaders have some experience in working with organisations from these countries. For successful Framework Programme projects it is also very important to have a good EU contact person (the project officer or scientific officer), preferably a person with some direct knowledge and experience of working with Southeast Asian institutes and the specific challenges such institutes are confronted with.

Many of our researcher respondents from both Europe and Southeast Asia perceived a lack of formal consultation possibilities during the process of formulating key areas for international research funding. They feel the need to raise the level of involvement of researchers themselves in defining key research areas for cooperation.

Such involvement is also necessary because many Southeast Asian researchers consider EU funded

projects as far more complex to participate in as other forms of international (bilateral) cooperation. The amount of funding in bilateral projects is sometimes also higher (e.g. cases were mentioned with the Netherlands and France). More attention should be paid to overlap between bilateral arrangements and EU projects, in particular because it opens up learning possibilities (best practices, and building upon each other's experiences, sharing information or facilities).

More practical issues were also raised. Representatives of research institutes in Southeast Asia feel they do not have enough information on the specificities of financial accountability. Framework programmes have a reputation of creating huge bureaucratic burdens, and many in SEA ask themselves whether this is worth investing in in terms of the balance between costs and benefits.

Time frames of EU calls are considered by many to be too short to properly work out a joint proposal, especially between European and Southeast Asian researchers. This problem is at least partly related to a skewed distribution of information, where Europe is in a more comfortable position. And both Southeast Asian and EU researchers experience difficulties in pinpointing appropriate partners.

EU project durations of e.g. three, four or five years do not match the national timeframes in Southeast Asia when it comes to national matching. Often budgets within SEA countries need to be acquired on a yearly basis, where the process of receiving such funding takes another year. Usually during this process several national organisations or departments play a role. The upshot is that in Southeast Asia co-funding mechanisms are more often than not inappropriate for successful participation. Because of this organisational mismatch, many promising opportunities cannot be realized. Long term financial commitment from SEA governments is sometimes further blurred by not completely consistent policies, and lack of transparency in the decision making process. China, on the other hand, uses five years time frames, on account of which matching of international projects is not a problem.

5.4.3 Wrap up

From the above we can distil a number of concluding remarks that might help prevent some of the major pitfalls in future cooperation. We will do this with regard to cooperation in a wider sense with regard to cooperation in the context of Framework programs.

Cooperation in general

Cooperation between Europe and Southeast Asia has to deal with a number of general potential pitfalls, some of them well known but still sometimes underestimated, and some less known or of more recent date (for example the current economic problems). Differences in development stage between (most) European countries and (most) Southeast Asian countries calls for a more specific approach in setting up programs. It is not appropriate to expect the same potential input from different possible partners: one size definitely does not fit all. Specific attention should be paid to local or regional problems and a major consideration should be the connection of these to global problems. As specific points of attention the brain-drain-brain-gain issue and the question of IPR were mentioned.

A problem for many national ASEAN governments is that they are currently unable to match for longer periods, not only due to the global financial crisis, but also due to governmental and administrative restrictions. Mutual adaption of budgeting system is called for.

Since there is a general criticism about lack of information about relevant research partners from Europe, it seems pivotal to improve the information and the dissemination about partners. Bi-regional thematic conferences and matchmaking events by EU and ASEAN together would stimulate building networks.

As a final point, it could help to improve the transfer of results outside academia. This could lead towards a better involvement of industrial stakeholders in projects and programs.

Framework Programmes

It seems imperative that more effort should be put in disseminating knowledge about the Framework programmes, in particular regarding the more practical aspects and consequences for administration and accountability.

What would help is also to improve intermediary functions, for which both the NCPs and EU project officers need to be available. This could also help mitigate the problem of different timeframes: for submitting EU projects time is usually too short for Southeast Asian partners. Prior to the opening of calls, pre-announcements should also be disseminated in Southeast Asia, via active National Contact Points.

Cooperation between Europe and Southeast Asia would benefit from involving Southeast Asian partners in defining a programme from the outset. It not only would raise the commitment of researchers and stakeholders, it also would help balance the local/regional interests and the European goals. In general, joint EU-ASEAN identifying of key priority areas should be encouraged.

Mutual learning should be made a priority. For example, coordination between bilateral and bi-regional schemes can be improved, so as to avoid overlap, and to generate best practices. Framework programmes should explore building on existing bilateral programmes.

There could also more emphasis on impact and clear follow up strategies as part of a project can improve the results of temporary international projects.

5.5 Challenges for regional, national and supranational policies

Based on the axiom that global problems require global solutions, for which international cooperation is necessary, an important question is how S&T agendas of ASEAN and Europe can be attuned in a meaningful way. Questions in point are:

- how to overcome existing differences in S&T interests and policies in both regions;
- how to determine the options for attuning national policies in both regions and the overarching ASEAN and EU policy;
- how to assess the consequences for a new EU policy (e.g. dedicated programmes) towards SEA.

Several countries in SEA are currently undergoing a rapid transformation of their economies, reflected in the steady rise of investment in education and S&T. The common division in three levels of development (see Schüller et al 2008 and in chapter 7) is arguably still visible, yet according to a number of our workshop participants, countries at the lower level are catching up. This process catching up forms a major challenge, because SEA countries deal with the combination of a high population density and a relatively low education level. For S&T cooperation to have long term effect, to focus on higher education and training of young talented researchers, seems obligatory. This might be the appropriate time to support that development with an extra EU effort. The education of young researchers might be a central element in such specific EU incentives directed towards stimulating bi-regional cooperation.

In discussions about S&T cooperation between SEA and Europe, the dilemma of investing on the one hand in capacity building for countries or institutes that lag behind, and on the other hand in cooperating between excellent researchers, is a central theme. The problem arises because these two goals, which can be summarized as "top research versus capacity building", vary to a considerable degree and can even be mutually exclusive. The question, then, is how this dilemma can be avoided or be transformed into a productive element when setting up cooperation. While there are differences within SEA in stages of development and thus in needs and interest when it comes to S&T cooperation, new initiatives should be wary of the fact that neglecting these differences can have major drawbacks for regional cooperation, and in fact might increase the differences. It is obvious that in an open competition for EU funds, some countries will stand a much better chance than others, which not necessarily reflects wither quality or relevance of the research proposals.

5.5.1 Policy relations within and between both regions

Researchers from institutes in SEA consider sustainability (long term commitment) in international cooperation an important condition for re-enforcement of their infrastructure and human resources. European Framework Programmes generally fund projects or programs for a limited number of years (3–5). Together with the fact that open competition as a rule doesn't work evenly in the context of many SEA countries and institutions (given the uneven distribution of resources), this gives rise to at least two points. First, Framework Programmes are intended to stimulate new forms of cooperation, based on the assumption that after a period of several years many of these networks have proved to be self-sustaining enough for the participants to continue without further EU support, or are successful enough to actually compete for new funds. The question is then of course whether this is indeed the case. A critical analysis of whether or not this is actually the case is lacking at this moment. Secondly, many Europeans working with SEA emphasize the importance of building trust and overall good relations with the top of institutes and higher ranking officials. This can only be accomplished if longer term commitment is guaranteed.

5.5.2 Memoranda of Understanding (MOUs) and ASEAN policies

In most cases international cooperation entails that many different departments or national agencies work together. This usually leads to a rather intricate network of demands and interests that have to be mutually attuned, a very time consuming, process for which diplomatic skills are required. MOU's can be helpful in these situations.

While many researchers in Southeast Asia working in international networks stress the importance of MOUs, however, expectations of their impact and usefulness are easily overestimated. And precisely because of the politically sensitive nature of MOUs, some institutes prefer to work without MOUs and establish their contacts directly without ministerial interference.

Seen from the perspective of many SEA governments, ASEAN is important for the development of national S&T systems, not so much as an organisation that enforces particular policies, but as a framework in which comparison and learning is facilitated; specific improvements in the S&T system in one country has on several occasions stimulated policy makers in another SEA country to push for similar improvements.

Researchers and policy makers in SEA alike see the need for prioritising research in an ASEAN context. Countries try to influence ASEAN policy in the direction of their national priorities. If such a priority is adopted by ASEAN, this theme will in many cases receive even more emphasis in the national policy.

The ASEAN Flagship programs are seen as a good effort on the part of ASEAN to stimulate the regional R&D systems. These programs provide seed funding which allows for leveraging. Scientists are very much aware that working at a regional level instead of the national level may provide economies of scale if both financial means and physical infrastructures can be used more efficiently.

The ASEAN Science and Technology Fund (also known as ASEAN Science Fund, or ASF) was established in 1989 for the purpose of providing seed financing for the various programmes, projects and activities under ASEAN science and technology cooperation, as identified and approved by the ASEAN Committee on Science and Technology. At the moment, this source of funding is still very modest.

The ASEAN-European University Network (ASEAN Uninet) is a network of over 50 excellent universities, for which participants are selected. This network is currently at least as important as formal ASEAN S&T policy and initiatives.

Many Southeast Asian researchers need more information on international cooperation and more conferences to meet colleagues and define projects. Face-to-face meetings are still clearly preferred, as these are more successful in promoting a sense of mutual understanding and trust. Understanding and trust are pivotal for this kind of international cooperation.

5.5.3 Cooperation in national policies, some examples

Several countries consider international cooperation as a criterion in the internal quality control systems. International cooperation is thus in itself an indicator of success, i.e. as part of quality control and funding. In e.g. Vietnam internationally cooperation is clearly important for career advancement, and publications in English are worth ten times as much as publications in Vietnamese. Indonesia for instance provides more funding to institutes if they have international collaborations.

Laos seems to become more open to international cooperation, although no specific priorities are formulated by its national government. Laos is also an interesting example of the wider problem of the mismatch of national priorities and international priorities, as its government works with 5 and 10 year action plans. This makes it difficult to change national policies quickly in order to respond to outside changes.

In the Philippines, universities can cooperate with foreign universities directly, without the involvement of ministries. This is an advantage of institutes in the Philippines over many other SEA countries (however, the general problem of lack of contacts with foreign colleagues also applies to researchers from the Philippines).

Involving developing countries that have recently changed policies based on research outcomes could be a useful strategy for many SEA countries. Such South-South or North-South-South cooperation among research orientated policy makers have in several cases proved its use. ICT, a field in which many SEA institutes participate in Framework Programmes is a case in point. In this field Brazil is acting as an increasingly important partner in South-South cooperation. This is a clear example of a sector where research is only one element and has a clear relation with innovations in wider society. It is also a sector with possibilities for leapfrogging, i.e. skipping certain stages in technology development.

5.5.4 Wrap up

In general, a lack of coordination between university policies, national policies, and multilateral policies can be observed in the context of international S&T cooperation. This applies both to the European and to the Asian side, but the main difference is that the level of investment is much higher on the European side, and therefore the number options for setting up cooperative research endeavours are considerably larger. However, despite the abundance of funds and options, it appears to be difficult for SEA partners to become serious partners in cooperative initiatives. The lack of coordination between research and policy is not helpful in this situation. In particular, feedback from successful projects or programs into the S&T system is low. There exists a relative lack of reliable statistical information on the S&T systems of several countries in SEA compared to Europe. Nevertheless, based on the interviews and focus groups conducted for this study, a number of preliminary conclusion can be drawn.

ASEAN

- It would be beneficial to the region if ASEAN would define clearer S&T priorities and objectives. This could also be an incentive for the EU to develop specific instruments for cooperation in those priority areas;
- Most SEA countries require the involvement of different national bodies in international research projects. This is seen by many researchers as an unnecessary bureaucratic burden. To address this issue, one of the options would be to make one department or agency responsible for formal aspects of international research projects, thus creating a single contact point for research institutes. This process may be facilitated by a policy dialogue on this topic within ASEAN;
- The ASEAN Science Fund is a useful instrument to improve research in SEA. At the moment this fund is rather modest;
- In many countries it is necessary to create more awareness about the EU as an important partner on S&T issues and bring this to the attention of the Department of Foreign Affairs.

ASEAN and EU

- During the biannual meeting between the EU and ASEAN, it would be beneficial to allot more time for a S&T policy dialogue, and specifically on the topic of research priorities;
- In the future, the possibility could be explored to organise joint calls by EU and ASEAN together, to which both sides contribute;
- A clear action plan from both EU and ASEAN in which benefits to both EU and ASEAN are explained would be very helpful to inform policy makers.

EU

- A clearer strategy of the EU as a single unified region, as against the individual European countries acting in SEA, would be beneficial;
- Translating information about EU programs into the various national languages would be helpful;
- European and SEA researchers could find more useful matches with EU support if the EU were to differentiate and set up dedicated schemes accessible for institutes from countries at different levels of development.

5.6 International S&T cooperation: with Europe and other parts of the world

In a world of growing international cooperation but also of growing competition, SEA researchers and policy makers have to decide in what cooperative efforts they best invest their time. In this process many different considerations play a role. Content arguably comes first, but immediately following that policy considerations, cultural aspects and also rather practical issues come into play. Hence (perceptions of) the ease or difficulty in working with researchers from Europe in comparison with other regions or countries are of great importance. Whether Europe stands out in a positive or negative way depends to a large extent on what the EU has to offer: clarity about the options in Framework Programmes and other global initiatives.

What we have learned from our SEA interviewees and workshop participants is that most SEA researchers do not find it easy to obtain the relevant information about Framework Programmes, but once they have started up a project cooperation with EU they in general do feel working with EU to be very different form working with researchers in other parts of the world. They also find the final detailed reporting phase more difficult. In working with Japan, for example, the first start-up phase is often more demanding, and may take up to two or more years, but once funded, a much more liberal approach in project management and control is in place. This section discusses some of the differences, from a SEA perspective, between working with researchers from Europe and working with researchers from other regions.

5.6.1 Cooperation in the context of EU and other regions

In order to compare SEA-EU cooperation with cooperation with other regions, one first has to identify the goals of the EU with regard to cooperation with SEA. That, unfortunately, is not very clear. In comparison, Africa seems to be getting much more focussed attention from the EU, especially after the launch of the EU-Africa Strategic Partnership at Lisbon in 2007. For SEA, there are however various separate country-specific funds. Vietnam for example is setting up 17 key laboratories with EU aid. Part of the problem for the EU when dealing with SEA is the region's diversity, bringing with it tensions between capacity building and cooperation between more or less equal partners in science and technology. In Africa, similar tensions exist, but for the majority of African countries cooperation takes place as a more or less unified form of capacity building.

Another important factor when comparing cooperation between different regions in the world is the relative closeness in terms of culture and geography. It is in many ways easier to work with other SEA countries in the region, or with Japan, India, Australia or China: visiting research sites or meeting at a workshop is easier and even teleconferences are less difficult to arrange frequently if all participants work in nearby time zones.

Many Southeast Asian researchers in the Bali workshop mentioned that the success rate is low when competing for EU funding in comparison with funds from other countries outside the EU. Hard figures are lacking, but in general the success rate in EU funding is below 20 percent for Framework Programmes.

While many Southeast Asian researchers are interested in getting involved in international cooperation with European researchers, they often find it difficult to gain support from government officials and policy makers. A main reason is the lack of knowledge about the possibilities of EU framework programmes, sometimes simply because specific documentation is available in English only and not in the national languages. Clear guidelines on procedures from the EU for potential participants from SEA would clearly be helpful.

Another potential pitfall is the fact that researchers generally consider EU projects to be very large, and because of the number of partners too difficult to efficiently participate in. Researchers often prefer small-scale bilateral cooperation with European partners.

Overall, SEA countries do not perceive the EU as one unified body, but see the EU as an collection of heterogeneous individual countries. This perception is further enhanced by the existing long-term relations with particular countries, relations that do not as yet exist with the EU as a whole. Typically, national delegations of European countries in SEA are as a rule much larger than the EU delegations.

Many SEA researchers feel that Europeans use different approaches in their work than SEA researchers. Two examples of these differences between Europe and other regions are:

- Project management. In European projects, the work is structured in clearly defined work packages and outputs and expectations are clearly defined. This enables researchers to focus. It is useful for participants to have clearly defined deliverables, such as the European project managers have set out in their work plans. SEA researchers feel they can take certain aspects of planning and control by European colleagues as examples of good practice.
- A more straightforward European versus a more circumspect Asian approach. Some feel that Europeans lack what is called ´the Asian spirit´. Europeans in general tend to be more bluntly direct in their behaviour, while Asians on the whole lean to a more sensitive mode of behaviour. S&T relationships within SEA tend to have a long start-up phase because of this, but eventually are more long-lasting and robust.

Establishing relationships with Japanese institutes can thus be a lengthy process but once a relationship is established, it tends to be more firm and more sustainable in the long term. One example of a successful programme with long term planning is the Biomass Asia Research Consortium, with two institutes in Thailand, one in Vietnam, Indonesia and Malaysia and China, and five in Japan.

Some interviewees also indicated that Japan tends to have more interest in their country's national priorities than does Europe. Much emphasis is put on training young people and investing in stimulating S&T infrastructures.

There are many competitive initiatives in the region for S&T cooperation. Three examples:

- The Pacific Rim cooperation, via the Association of Pacific Rim Universities (APRU), is a network consisting of 36 selected research universities aiming at "fostering education, research and enterprise thereby contributing to the economic, scientific and cultural advancement in the Pacific Rim." APRU's activities include strategic initiatives to promote entrepreneurship amongst its membership and the use of advanced ICT in the delivery of education. Pacific Rim cooperation may very well become more important in the future and deserves further study in order to improve SEA-EU cooperation.
- Australia has started building up research links with SEA in the 1950s. In the 1970s Australia also became ASEAN's first dialogue partner, that is the first country ASEAN agreed to meet on a regular basis to discuss political, economic and functional cooperation. Part of the cooperation was set up via The ASEAN–Australia Development Cooperation Program (AADCP). In the 1990s an Australian-ASEAN project focused on advancement in biotechnology was set up. Australia is also an important factor in international training of SEA students. In 2007, over 65 000 students from ASEAN countries were studying at Australian educational institutions.[64]
- Cooperation between New Zealand and ASEAN started in 1975. This cooperation today incorporates S&T, and New Zealand has contributed to the ASEAN Science Fund. These S&T links between SEA and Australia and New Zealand, with often elements of mutual benefits, may be useful cases for further study.

5.6.2 Some country specific examples

Indonesian researchers would like to see more of a reciprocal relation in student exchange, by stimulating the number of EU graduate students coming to Indonesia. In recent years Japan and Korea have been raising the numbers of PhD students going to Indonesia through specific programmes. Over a longer period a shift can be seen; decades ago many Indonesian researchers who were trained abroad had done their PhD in Germany. This then shifted to the US, then to Japan. Nowadays India and China train a lot of Indonesian PhD students. These shifts are partly related to the higher living costs in the EU and the US.

In the case of LAPAN, the National Institute of Aeronautics and Space in Indonesia, recent international cooperation with Germany was primarily focussed on technology, whereas with Japan it was possible to set up cooperation with also invests in training of Indonesian researchers.

In Laos the need is felt for more information on opportunities for cooperation with the EU. Information on collaboration possibilities with Japan, Korea and China is readily available, whereas information on cooperation with EU is not. Korea and Japan also have experts in Laos, and their presence often leads to future research projects. Such experts also more frequently learn the national language.

The Philippines traditionally were strongly focussed on working with the US. A recent shift towards the UK has set in. There is not much cooperation with the rest of Europe, which could be changed once knowledge about potential partners is more widely disseminated, in both the Philippines and Europe.

64 http://www.dfat.gov.au/facts/asean.html

5.6.3 Wrap up

When building and maintaining successful S&T cooperation between Europe and SEA, one needs to consider a number of important issues. These issues can be divided into socio-cultural differences, geo-political aspects, content-oriented and practical points.

Socio-cultural differences between researchers do not seem to matter so much once a project is on its way, but can be a barrier before projects start. This might be caused by the way research topics are decided upon, or the overall approach towards research projects, or the issue of formal project-leadership.

Geo-political aspects are hard to overcome because they have their own dynamics. People often find it easier to interact with people in their own region, and the interests of one region is likely to differ from the interests of another. It might be more productive to focus on cooperation instead of competition. This is of course easier said than done in a world of growing global competitiveness, but since many problems in society are truly global, solutions need international cooperation. So it seems much more productive to see developments in the Pacific Rim or Australia or India in terms of cooperation than of competition.

Regarding the content of cooperative projects or programmes, there would ideally be a joint agenda between SEA and EU, like in the case of Africa. Such a framework could serve as an agenda for new cooperative projects. Failing that, the direction of new endeavours is up to individual participants. Not all SEA participants in projects with European partners, especially in larger projects, have the experience that they could provide a satisfying input in the beginning when project plans are formed. In the perception of SEA researchers, they have more influence in these import first steps of setting up a cooperative effort with Asian partners. Furthermore, SEA researchers feel that governments in the region, especially Japan, are paying more attention to national priorities of SEA countries than Europe does. Japan is also mentioned as a country that is more open to help build S&T infrastructures, and to train young researchers (capacity building). The image of EU researchers as simple sample gatherers in short-term projects is persistent.

Also, for less developed countries such as Laos or Cambodia, Japan and Korea seem to be more willing to provide local R&D experts, who often are willing to learn the national language.

As a final remark, we would like to emphasize the importance of efforts to stimulate the education and training of the next generation of researchers. The importance of this cannot be overestimated, especially with the growing level of education in many SEA countries. Informants from most countries stressed the importance of this point, and with countries like Japan, Korea and China being very active in this field, and raising their investment off late, there is a world to lose for Europe.

5.7 List of opportunities and pitfalls

This chapter lists the opportunities and pitfalls that were brought up during the various focus groups and interviews. We have refrained from giving specific recommendations in this analysis of opportunities and pitfalls. In 2010, the SEA-EU-NET project will publish short- and long-term recommendations linked to a foresight on SEA-EU cooperation in 2020, after consulting high-level political stakeholders and programme owners.

5.7.1 International S&T cooperation

Opportunities

"Global problems need global solutions." Global solutions can only be realized by building international networks of researchers and their institutes and establishing appropriate S&T policies. In order to obtain better opportunities for successful international cooperation most of our respondents listed the following opportunities:

- Involve researchers, policy makers, and other relevant stakeholders in priority setting decisions for collaborative programmes as early as possible;
- Involve SEA partners in priority setting and in the planning and design phase of the project from the outset;
- Fully engage all project partners in the research and project itself, and ensure that every project partner is a fully committed stakeholder;
- Research should, to a large extent, be driven by local, regional, and national problems. Collaborative programmes should consider the potential befits to the economy and society SEA, and not primarily driven by a European perspective;
- Attention should be paid to the follow-up of temporary projects: establish scientific tools and infrastructure, implement policy changes that extend beyond the scope of a particular project;
- Take into account the different perspectives and interests regarding the goals of international S&T cooperation of researchers on the one hand, and policy makers and other stakeholders on the other;
- Give due consideration to cultural differences and differing socio-economic needs;
- Encourage full participation of the private sector in collaborative research projects to foster better connections between academia and industry, and to enhance opportunities to finance projects. IPR issues should be covered in the project terms of reference.

Pitfalls

- Overlap between bilateral and bi-regional schemes should be avoided by building on (the experience obtained in) existing bilateral programmes;
- A lot of opportunities are missed by a sheer lack of knowledge about relevant potential partners, in both regions. Initiatives should be taken to help providing such knowledge;
- During meetings at the highest political level between the EU and ASEAN, a more developed and strategic dialogue should be cultivated to address key S&T related issues.

Whilst these points might seem fairly obvious, most of our respondents strongly felt that EU funding mechanisms do not seem to recognize them, and that EU civil servants often are not familiar enough with these issues.

5.7.2 S&T funding instruments

Opportunities

- Establish long-term research centres where scientific tools can be implemented, and new knowledge can be developed. These centres of excellence would help to turn short-term results from temporary projects into long-term benefits for science and society.
- Establish research schools adjacent to research centres to offer returning students and scholars an attractive environment, so as to handle brain drain problems, and educate new generations of scientists;
- SEA's S&T systems would benefit from having more strong and recognisable research centres, especially focussed on themes that are directly relevant to the region, like e.g. marine biology, coastal zone research, fishery, forestry.
- Attract more foreign researchers by research centres, possibly organised at the regional ASEAN level, thus stimulating interaction with local researchers, and providing a stepping stone for researchers to find their way in the region.

Pitfalls

- The ASEAN Science fund for improvement of research is unfortunately very modest;
- Administrative burden and tight and restrictive rules make it more difficult for SEA to become fully engaged in the research, and fully responsible for the project in bilateral and EU projects.

5.7.3 EU Framework Programmes

Opportunities

- Make available easy-to-read information about the FP programmes and the opportunities it creates for SEA;
- Improve information dissemination (by National Contact Points) prior to the opening of a call, as is the case within Europe, and provide information on potential partners;
- Provide experienced and knowledgeable project managers and EU project officers;
- Launch joint calls by EU and ASEAN, and organise network and relationship building activities between researchers in SEA and Europe.

Pitfalls

- Insufficient time following the release of calls for proposals is allowed for the drafting and submission of proposals. Current time frames are too tight, especially for many SEA scientists;
- There is a mismatch between EU funding cycles (grants for several years) and the required matching funds from SEA, often governed by yearly national funding cycles;
- Discouraging organisations from third countries to act as a project leader in a FP project is not an incentive for possible SEA partners to join projects, and is generally regarded as a sign of distrust. Discouraging SEA partners to act as project leaders, regardless of the ambitions of a potential SEA partner, is a sensitive issue;
- Continuity and sustainability of S&T cooperation with European collaborative project is a problem, especially when compared to Asian partners such as institutes in Japan and Korea. Links with these institutes tend to be more firm and have a more long-term character than with European partners;
- Framework programmes are considered to be very competitive in a way that does not take into account the various levels of development in ASEAN member states;
- Framework programmes do not offer earmarked funds for specific regions. European and SEA researchers could find more useful matches with EU support if the EU were to differentiate and set up different schemes accessible for institutes from countries at different levels of development. This could be translated into a specific funding calls targeted at cooperation with SEA;
- In general cooperating in Framework programmes carries a large administrative burden, also when compared to working with individual European countries. Clear and easy to follow guidelines as to reporting and project management are lacking.

5.7.4 Capacity building schemes as pre-requisite for S&T development

Opportunities

- Training schemes for young researchers should be setup to create a strong base of national scientist in SEA;
- Focus on helping to build long-lasting soft and hard S&T infrastructures. Projects should be formulated with that goal in mind;

- Attractive positions should be created within the knowledge system for excellent young students;
- Promote a more equal exchange of scientists between SEA and Europe, and create mechanisms that redress the imbalance between the number of SEA researchers going to Europe and European scientists going to SEA.

Pitfalls

- Southeast Asian infrastructural weaknesses;
- Low overall national budgets for S&T;

Focus on other than S&T priorities reduces the (financial) incentives for S&T cooperation.

6 Scientific cooperation between Southeast Asia and Europe in 2020. Driving factors as assessed by scientists and policy-makers

Alexander Degelsegger, Florian Gruber[65]

The European Commission tasked the project SEA-EU-NET to conduct a foresight exercise on determinants of future scientific and technological (S&T) cooperation between Southeast Asia and Europe.

This International S&T Cooperation Foresight study, conducted in 2009 and 2010, has been based on a driver-identification scenario workshop in Indonesia with policy-makers from both regions and on a survey of scientist's opinions using open email consultations and Delphi methodology.

The results of the exercise are a reliable and comprehensive set of drivers perceived by key stakeholders as influencing the 2020 future of S&T cooperation between Southeast Asia and Europe. Identifying these drivers not only helps to structure future policy-discussions, but they can in themselves be expressed in terms of recommendations and ideas for possible instruments to increase S&T cooperation levels. Furthermore, the drivers have been combined, also within this chapter, to the logic of a possible success scenario for S&T cooperation between Southeast Asia and Europe in 2020. This proposed scenario logic can inspire continued discussions on how a successful future scenario might look like and, accordingly, what drivers have to be addressed to move towards it.

Based on the unusually high response rate that we could achieve in the scientists consultations and Delphi survey, we cannot only conclude that our results are solid, but also that there is a real interest in S&T cooperation between Southeast Asia and Europe on the side of the scientific community.

Key recommendations for policy-makers

On a general level:

- This study should be further discussed among the stakeholders involved and could be taken as a stepping stone within the process of policy development.
- The dialogue on and planning of S&T cooperation should keep engaging scientists.
- The time-related windows of opportunity in the planning horizons of the cooperating regions' policy-making should be made clear and considered.
- Coherence between STI policy and other policy areas concerned by S&T cooperation should be continuously aimed at.
- It should be taken into account that both regions are internally highly diverse, with resulting region-internal differences in the needs and customs of the scientific communities.

And as identified by the consulted stakeholder communities:

- It should be taken into account that the most important motivation for scientists to cooperate is the goal of doing state-of-the-art science on a topic of mutual interest and relevance. The feeling to contribute to the development of a country or the solving of global challenges, the access to a field, expertise and equipment, friendship or reputation are other important motivations.
- S&T cooperation should be sustained on a long-term basis.
- A suitable balance should be found between the flexible funding of cooperation activities in research projects defined bottom-up and the dedicated funding of S&T cooperation with a thematic focus.
- A suitable balance should be found between supporting cooperation in basic and applied research.
- Personal contacts are more relevant than institutional agreements. Therefore, supporting mobility is crucial.
- Measures should be adopted to enhance equilibrated mobility in both directions as, currently, there is a bias towards Southeast Asian scientists coming to Europe.
- Existing human and network resources should creatively be harnessed. Among the many options, established scientific conferences could be invited to convene in Southeast Asia; retired scientists could

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be offered part-time positions, senior scientists could be willing to engage in cooperation and exchange in the framework of sabbatical themes.
- PhD student exchange, joint PhD programmes and particularly co-supervision of PhD students should be supported to a higher degree.
- Southeast Asian Diaspora academics in Europe should be addressed as possible facilitators of S&T cooperation.
- Return and reintegration support schemes should be considered, especially for Southeast Asian scientists who have spent longer periods of time in Europe.
- Reward schemes for successful cooperation should be considered as potentially increasing the motivation to cooperate.
- Quality metrics for assessing the success of international S&T cooperation projects have to be further developed.
- Regional training networks, joint research centres and other joint research infrastructure can help to increase cooperation intensity.
- Bridging institutions offering administrative, research management and partnering support should be considered as a means to increase cooperation levels.
- Administrative burdens hampering S&T cooperation like visa issues, material exchange and field access clearance procedures should be simplified.
- Open access to literature and sample databases should be supported.
- The results of joint research should be made available in the respective regions, not only in international journals.

The second group of policy recommendations emanates directly from the concerned stakeholder groups. The authors have coded and structured the empirical data.

6.1 Introduction

As part of its analytical activities, SEA-EU-NET was tasked to conduct a foresight study on the future of science and technology (S&T) cooperation between Southeast Asia and Europe. The aim of this future looking activity was to open up and structure as well as subsequently inform the discussion on the potential future cooperation between the two regions.

This deliverable is the output of activities undertaken towards this aim between October 2009 and December 2010. Concretely, after substantive preparatory work consisting in desk research and consultations with foresight experts, a scenario workshop with a group of policy-makers from both regions was held in November 2009 in Bogor, Indonesia. The goal was to gather and assess driving factors of S&T cooperation between Southeast Asia and Europe relevant over the period of the next 10 years. Results of this part of the foresight exercise were then analysed for project-internal purposes and published[66] as a case study in a paper discussing methodological specificities of what is best called 'International S&T Cooperation Foresight', a rather recent type of foresight activities. Concrete recommendations coming out of the policy-makers' assessment have been included in a project deliverable (first version of deliverable 4.1, "Policy Recommendations for enhancing Science and Technology cooperation between the European Union and Southeast Asia") that has been distributed during the meeting of the Association for Southeast Asian Nation's (ASEAN) Committee for Science and Technology (COST) in May 2010 in Vientiane, Laos. Furthermore, aspects of this first part of the foresight exercise were discussed in expert interviews conducted with relevant Southeast Asian stakeholders in the context of the ASEAN COST meeting.

While it is the policy-makers who frame and set more or less favourable conditions for S&T cooperation between the two regions, it is the scientists who are actually cooperating and invited by the recent political agenda to do so to a higher degree. In order to access the knowledge of those who already have palpable experience in science cooperation between Southeast Asia and Europe, we approached all scientists from Southeast Asia and Europe who have published together with one or several colleagues from the respective other region and engaged them in an open email consultation and a subsequent two-stage Delphi survey in order to find out what they consider potentially increasing cooperation levels. Our expectations that this stakeholder group would be able to offer very concrete and sometimes unusual ideas of instruments and framework conditions have been confirmed.

In a final phase of desk research, policy-makers' and scientists' assessments of driving factors behind Southeast Asia-Europe S&T cooperation have been combined and distilled into a set of policy recommendations and of dimensions along which concrete scenarios for planning purposes can be developed. Interest from the side of our project partners as well as available resources within the project have led us to consider driving the foresight task further than originally planned by implementing a scenario discussion workshop with Southeast Asian stakeholders that took place in May 2011 in Chiang Mai/Thailand as a key element of a three-day SEA-EU-NET event. Apart from continuing discussion and deepening analysis, the workshop aimed at ensuring that the outputs of the task prove useful for actual decision-making and joint planning.

In the following chapters, after a detailed account of the study's underlying methodology (chapter 6.2), the intelligence produced by the SEA-EU-NET International S&T Cooperation Foresight is presented chronologically along the lines of its production that also follows a logic of combining expertise on framework conditions (from the policy-makers) with practitioners' (scientists') inside knowledge and, put differently, top-down with bottom-up approaches. This series of chapters (6.3–6) is followed by a synthesis comparing the results of the policy-makers and scientists consultations (6.7), thus breaking the chronological and logical order with the aim of comparing the policy-maker and scientist levels. A concluding chapter summarising the foresight task's findings in a set of policy recommendations and ideas for future instruments (6.8) is followed by an outline of the basic logic and a draft of a possible success scenario (6.9) as well as the draft success scenario and an outlook (6.10).

66 Gruber, Florian / Degelsegger, Alexander (2010): S&T Cooperation Foresight Europe-Southeast Asia, in: Форсайт (Foresight), 4(3), pp. 56–68

6.2 The methodology

6.2.1 General considerations

Foresight is a tool to engage relevant stakeholders and experts in a structured way of thinking about and exploring possible futures of shared interest in order to create awareness for possible future developments, act upon these futures or react in face of foreseen or unforeseen changes.

In this foresight on the future of S&T cooperation and, more concretely, on driving factors of importance for scientific cooperation between Europe and Southeast Asia, we decided to use the year 2020 as a horizon and to adopt a two-stage approach in carrying out the analysis. The decision to invite the stakeholder groups to look at a 2020 perspective is motivated both by the current policy framework and by methodological considerations. Following the Lisbon Strategy, the Europe 2020 Strategy[67] and more specifically the Innovation Union flagship initiative[68] are the most relevant guiding framework for European-level S&T policy and explicitly focus on international S&T cooperation as relevant for Europe's smart, sustainable and inclusive growth. Moreover, the 8th Framework Programme for Research and Technological Development, currently being in its early preparatory phase, will cover the period from 2013 to 2020. Besides the policy framework pointing to the 2020 horizon, 10 years is also a time span that can reasonably be reflected upon in a foresight exercise without a need to include big systemic change, usually occurring over longer periods of time. To look at Europe's S&T cooperation in 2030 or even 2050 would have been both a much more difficult endeavour and would require a different methodology, taking broader and more long-term trends into account in a discussion of visions rather than concrete intelligence for present action. Finally, the policy-makers (whom we were able to address and whose opinions we aimed to include in our study) are currently at a level in the hierarchy that allows them to have in-depth knowledge of S&T cooperation matters, but they are not tasked to stir Europe's longer term future beyond the mentioned policy framework set by their highest-level superiors.

As regards the two-stage approach, we assumed that two major groups are instrumental in developing and sustaining scientific cooperation: The policy-makers and programme owners that set the frame for S&T cooperation and develop and fund specific programmes for cooperation, and the scientists that actually live and conduct the cooperation, resorting or not to the funds provided by science policy-makers.

In order to gather data and opinions from both of these groups as well as to include and engage them in the process of thinking about the future S&T cooperation between the two regions, we decided to approach the stakeholder groups in different ways: in one case by means of a physical workshop, in the other case via an online Delphi survey with a preceding open email consultation.

The main reason behind this different ways of approaching the stakeholder groups is the fact that policy-makers concretely concerned with (and thus knowledgeable about) this form of cooperation are few in number. These few, however, seemed to have a good overview on the current state of programmes and on the future plans, according to our preparatory analyses and project experience. Thus, it makes sense to try to investigate their expertise in more depth and engage them personally, not least because they have a major stake in designing the political framework conditions for the future they are reflecting upon with us in the foresight analysis.

The scientists, however, are a much larger stakeholder group. We decided not to randomly approach large groups of European or Southeast Asian scientists, nor to invite small groups to give us their individual and, given the large size of the population, unrepresentative views. Instead, we considered it most reasonable to approach those scientists who already have cooperated. We decided to revert to co-publications as a proxy for cooperation experience, i.e. we looked for scientists from each of the regions who have already published with scientists from the respective other region, and engaged them via an online consultation and Delphi survey.

The whole exercise has been dealing with the constraints proper to International S&T Cooperation Foresight[69] exercises: increased complexity due to the bi-regional perspective (set however within a global network

67 http://ec.europa.eu/eu2020/
68 http://ec.europa.eu/research/innovation-union/

69 Foresight has recently emerged in several EC funded projects as an important tool in structuring the thinking and discussion about future S&T cooperation and related activities. Due to several methodological issues that set this kind of foresight apart form, for instance, national technology foresight exercises (see reflections in our methodological chapter) the authors of this report decided to coin this new appellation „International S&T Cooperation Foresight".

of cooperation relations) with, at the same time, very limited time resources of and difficult access to policy-making stakeholders. Moreover, members of this stakeholder group are in positions not only to assess, but to significantly shape the future the exercise is dealing with, which again adds complexity to the process as few relevant variables can be considered totally external. Regarding the scientific community, it is not easy (due to time constraints on their side, negative experiences with policy consultation processes or simply disinterest) to attract those scientists to the foresight exercise, who are actually cooperating and, at the same time, knowledgeable about science cooperation.

6.2.2 A success scenario based foresight process

Over the years, social scientists and policy-makers have used several methodologies to gain insights into the future and develop action-orienting conclusions according to a desired version of the future. When it comes to international S&T cooperation policy, however, the approach of scenario building based foresight has shown to be popular[70]. An exemplary effort in this direction can be seen in the SCOPE2015 foresight project conducted for the INCO[71] directorate of the European Commission's Research Directorate General by PREST/Manchester[72]. Currently, several INCO projects[73] or, for example, the International Council for Science (ICSU)[74] are using or planning to use scenario techniques for S&T cooperation relevant foresight exercises.

It is not surprising that in the pre-foresight phase of this exercise, desk research and consultations with project partners in Southeast Asia and Europe have equally shown that scenario techniques seem most appropriate for the data generating, networking and strategy development[75] part of the foresight process. It became also clear, however, that S&T cooperation foresight has characteristics and needs that are different from national technology foresight or scenario planning in corporate strategic thinking.

Scenarios are built up from collective visions of the future by a group of experts and should help decision-makers and other stakeholder groups to simplify "the avalanche of data into a limited number of possible states"[76]. Scenario building efforts often start with the clarification of the setting, the identification and analysis of driving forces ('drivers') that are considered to influence how the present will be transformed in the future in specific areas of interest, and a subsequent importance ranking of the identified drivers as well as of uncertainties that become apparent during the process. Then, the scenario logics are defined, scenarios fleshed out and their implications discussed[77]. Thus, generic scenario building exercises comprise an exploratory elaboration of several futures that range from desired developments to undesired futures that are better avoided.

In addition to exploratory scenario building processes resulting in multiple scenarios, another approach is outlined in literature, namely the "success scenario" method[78]. Therein, an effort is made to present an image of a desirable condition in form of one single scenario in order to help decision-makers reflect the current situation and identify crucial steps in view of a favourable future. A related scenario building exercise can then be used by decision makers to streamline their approach to the topic in question. As Vincent-Lancrin has put it: "Future scenarios do not aim to predict the future […] but merely aim to provide stakeholders with tools for thinking strategically about the uncertain future before them, which will be partly shaped by their actions and partly by factors beyond their control"[79]. This "singular scenario" approach is also useful when it comes to structuring and guiding discussions so that underlying assumptions become clear and can be explicated[80]. Moreover, from our perspective and mandate we could expect that, by assigning importance to cooperation between specific regions, the consulted stakeholders from both sides, when answering our requests and offering their views and strategic thinking on a successful region-to-region S&T cooperation, would be induced to at least think about and maybe give importance to this specific kind of cooperation.

The SEA-EU-NET Foresight endeavour aims at involving S&T policy-makers and the scientific community in a dialogue reflecting upon the future of S&T cooperation between Europe and Southeast Asia in a year 2020 perspective. The project addresses Southeast Asia as a research area as well as the European Research Area – thus, the bi-regional perspective is inherently part of the project's analytical focus. Nevertheless, bilateral S&T cooperation or constellations bringing together one region and single countries are also within its reach. Thus, we could anticipate that the regional-country dichotomy appears as an axis for our scenario logics, resulting in 4 possible base scenarios (region-region cooperation, region-country, country-region and country-country), three of which seem principally relevant. However, given the severe time and resource constraints on the side of this exercise and the stakeholders as well as the mandate of the SEA-EU-NET project, we decided to focus first and foremost on the region-region multilateral cooperation setting.

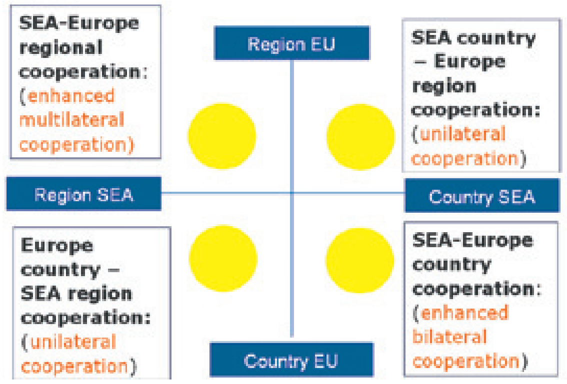

Figure 62: Possible cooperation structures as a basis for scenarios

Going one step further in the anticipation of scenario logics, S&T cooperation intensity appeared as a natural additional axis in the deductively developed basic scenario matrix[81]. The most basic description of the success scenario we have been looking at would then be: In 2020, S&T cooperation between Southeast Asia and Europe has become more intense in view of a higher number of collaborations and in-depth forms of cooperation on a region-to-region level (i.e. not only as regards, for instance, Vietnam and Germany, Indonesia and the EU or France and Southeast Asia) in comparison to 2010.

6.2.3 Driver identification by policy-makers

One of the benefits of conducting this foresight exercise in the frame of the inter-regional cooperation project SEA-EU-NET was that the steering board that convenes once a year comprises most of the policy-makers that we wanted to include in our study. The success scenario oriented driver identification workshop, key to the policy-maker oriented part of this foresight exercise, was conducted in 2009 in Bogor, Indonesia as part of the steering board meeting during the annual week of cooperation.

The Bogor 'drivers workshop' offered the possibility to gather policy-makers and programme owners from different countries in both regions within a joint bi-regional event. The fact that the policy-makers knew they would attend a bi-regional event, facilitated focussing the drivers discussions to a region-to-region level (rather than a country-to-region or country-to-country level). Resource constraints (i.e. mostly time constraints) are always a pressing issue in high-level foresight processes, aiming not only at stakeholder participation, but also at creating commitment among the stakeholders to the discussions. While preparing the workshop, we realised that focusing on one perspective, namely the region-to-region level, was the most that could be managed with the allotted time. The region-to-region perspective on S&T cooperation seemed to be not only the most pressing one, but is also the one closest to SEA-EU-NET's mandate. Actually, while it might be easier for single countries to arrange meetings with single other countries or join meetings of a regional party, SEA-EU-NET particularly has the role and potential to bring together S&T stakeholders from both regions to discuss the topic of cooperation. In addition, preparations showed that the question of the feasibility and necessary framework conditions of a dense and intensive cooperation scenario between both regions raises a high degree of interest among stakeholders. Another feature of the workshop setup was coming from cultural considerations: in the Southeast Asian context taking contrary positions within a group is sometimes thought of as impolite. However, by asking the experts to consider the region rather than the country perspective and by offering the possibility to anonymously opine for the region (e.g. by using flip charts and regional groups rather than single-country groups and/or verbal input), we could ignite motivated discussion and received a high degree of feedback from the group.

Given the above reasons, we opted for an extended single success scenario method engaging an expert panel[82] with a pre-defined desired "summer" scenario (based on desk research) applying an inward bound perspective[83]. This means that we combined the scenario discussion with a backcasting[84] element looking at the driving and shaping factors[85] for the scenario starting from the desired future going backwards towards present times. Thereby, the procedure facilitates the translation of the scenario building effort into valid policy recommendations.

70 Scenario techniques are also used in thematically much broader foresight exercises as the recent European Commission (2009) report "The World in 2025. Rising Asia and Socio-Ecological Transition" shows.
71 International Cooperation
72 For the final report see: European Commission (2006): Scenarios for future scientific and technological developments in developing countries 2005–2015, EC DG Research: Brussels
73 Next to SEA-EU-NET: EULAKS, New INDIGO and ERA-Net RUS to name but a few
74 ICSU Foresight Analysis on the potential development of international science, online at: http://www.icsu.org/1_icsuinscience/PDF/ICSU_Foresight_summary.pdf, most recent access date: 3 March 2010
75 Van der Meulen, Barend (2007): Looking Beyond the Endless Frontier. ESF Forward Looks Scheme: Analysis and Recommendations, European Science Foundation: Strasbourg, p. 10
76 Schoemaker, Paul J.H. (1995): Scenario Planning: A Tool for Strategic Thinking, in: Sloan Management Review, 36(2), p. 27
77 ipts/Joint Research Center of the European Commission (2007): Online Foresight Guide. Scenario Building, online at: http://forlearn.jrc.ec.europa.eu/guide/3_scoping/meth_scenario.htm, most recent access date: 3 March 2010
78 Miles, Ian (2005): Scenario Planning, in: UNIDO Technology Foresight Manual. Volume 1 – Organization and Methods, pp. 168–193
79 Vincent-Lancrin, Stéphan (2009): What is Changing in Academic Research? Trends and Prospects, in: OECD (ed.): Higher Education to 2030. Volume 2. Globalisation, OECD: Paris, p. 173
80 Miles, Ian / Green, Lawrence / Popper, Rafael (2004): FISTERA WP4 Futures Forum. D4.2 Scenario Methodology for Foresight in the European Research Area, European Communities: Brussels
81 Schwartz, Peter / Ogilvy, James A. (1998): Plotting Your Scenarios, in: Fahey, Liam / Randall, Robert M. (eds.): Learning From the Future. Competitive Foresight Scenarios, New York: John Wiley, p. 64
82 Expert panels are sometimes considered a technique separate from scenario workshops, but equally valuable for strategy development (cf. Van der Meulen 2007, p. 10).
83 Miles, Ian (2005), p. 169
84 Popper, Rafael (2008): Foresight Methodology, in: Georghiou et al. (eds.): The Handbook of Technology Foresight. Concepts and Practice, Edward Elgar: Cheltenham, p. 54
85 For a definition and indicative listing of possible drivers and shapers, please refer to Miles (2005), pp. 190ff. Our experience has shown that the concept of 'drivers' was much easier to explain to participants than the differentiation between drivers and shapers.

Besides the advantage to capitalise as much as possible from the available resources in terms of participating experts, this scenario planning design also offered the possibility to evaluate the "desirability" and "credibility" of the basic scenario which, according to Miles[86], are considered important elements of a success scenario.

This workshop design has proven a successful adaption of standard scenario methods for

- a setting involving mid-to high-level participants,
- facing time constraints,
- when discussing the viability and surrounding of a specific and possibly successful scenario[87] with the aim to sensitise for this possible future, create commitment for it and trigger a joint planning process.

The participants of the scenario workshop were the members of the SEA-EU-NET Steering Committee, as we assumed that the body (installed because of their bird's eye view of EU-SEA scientific relations in order to steer the project) would also be the most suited one to take a look and think about future bi-regional cooperation. 16 experts from policy-making and programme-owner institutions actively participated in the scenario workshop, 7 of them speaking for Southeast Asia and 9 for Europe.

As a starting point, the participants were introduced to and confronted with the following basic "summer" success scenario that was deliberately limited in length and detail in order to allow participants to quickly and easily align to the envisaged perspective:

Basic scenario: In the year 2020 the cooperation in S&T between the EU and ASEAN had reached a level of importance that some years before was hardly to be expected. Major development was the rise of ASEAN as a regional power, as the countries in the region decided to put importance to and budget into this umbrella organisation. In this way, ASEAN could initiate symmetric cooperation partnerships with the other major global players, the EU, the USA, and major S&T powers consisting also of countries that differ quite a lot in their economic development, the European Union was considered an important cooperation partner, and with dedicated programmes including joint programming and funding from both sides, the cooperation in the area of S&T grew ever more intense.

We asked the participants of the workshop to project themselves 10 years into the future and "inside" a scenario where regional scientific cooperation between Europe and Southeast Asia has come to be very active, very successful and intense.

Then we asked the participants to identify the drivers that would have led to such a scenario (backcasting), i.e. forces that would have to be identified and taken into account 10 years before (i.e. now, in the present) in view of the scenario. Due to the interaction dynamics in the brainstorming character of this session, we applied a rather broad definition of drivers. Sticking to a stricter definition would imply to interrupt and correct the flow of ideas at certain points, which we wanted to avoid as it could stop the creative process.

The drivers were structured along 5 policy areas[88]:

- Higher Education Policy,
- Science and Research Policy
- Industry, Trade and Economic Policy
- Development Policy, Global Challenges,
- Diplomacy, Foreign Policy, Security Policy

In a second stage of the workshop we asked the experts to take a regional view depending on their origin, and to rate the importance of the drivers using a grade-like rating in relation to either Europe or Southeast Asia (after re-coding for visualisation reasons: 5 points express highest importance and 1 least relevance). It is important to point out that not all experts had to rate the drivers. The number of experts assigning grades to the drivers, thus, is an additional measure for the perceived prominence of this driver (in addition to the average grade, for sure). Section 6.3 will analyse the outcomes of this exercise.

Then the experts were asked to identify, which would be the most important shaping factors[89] for the desired scenario. In another subsequent step, the experts were asked to comment the proposed shapers (which are basically names without descriptions), so that everybody would know what is meant by a particular shaping factor. And then, thirdly, the experts were asked to once again rate the importance of the shapers in relation to their region by awarding "points". Here, no grades from 1-5 were asked, but each participant had a maximum of 10 points to assign to all mentioned shapers. The experts were also invited to comment on the presented shapers.

Finally, it is important to highlight that in both parts of the workshop, participants were invited to consider and rate[90] a number of pre-given, indicatory drivers and shapers (given to orient and stimulate the discussion by giving concrete examples), but then to go beyond and to add other drivers and shapers considered to be important. Experts have made extensive use of this possibility.

86 Miles, Ian (2005), p. 184
87 Indirectly, the desirability of the scenario can be deduced from the reactions of the experts.

88 Based on the simplification of a compilation of policy areas from a ppt-presentation by Callum Searle, DG RTD D2 International Co-operation, "Forward Looking Activities and International S&T Co-operation", 2 June 2009
89 Environmental conditions that are relevant, but cannot be influenced (in contrast to drivers that are also relevant and can more readily be influenced)
90 Again, not all experts had to rate all shapers. They could select freely. As in the case of the drivers, this offered additional information for the interpretation and analysis of the importance of the shapers.

Methodologically speaking, we would avoid differentiating drivers and shaping factors if we were to do the exercise again. The added value that is gained by separating drivers from shapers is not substantial enough compared to the effort involved in clarifying the differences between the two concepts, not entirely clarified in literature, yet.

As indicated above, the results of the drivers workshop have subsequently been analysed by the authors (see chapter 6.3) and have been translated into a series of policy recommendations (see chapter 6.8). During the ASEAN COST meeting in May 2010 in Vientiane/Laos, they have also been parts of the discussions in a series of expert interviews held with key stakeholders from, among others, the Philippines and Laos. However, it has become clear during these interviews, that there is an inherent difficulty in approaching Southeast Asian policy stakeholders with questions on region-to-region S&T cooperation with Europe, while they are participating at an ASEAN COST meeting in a particular country-related role and following a particular country-related agenda. In most of the cases, the interviews offered very relevant background insights for the SEA-EU-NET project as a whole, but time was too short to present findings from the drivers workshop to additional stakeholders and subsequently focus on their comments regarding these results.

In terms of an overall methodological assessment of the first stage of the foresight process focusing on policy-makers, and from the very positive feedback we could collect subsequently to this workshop, we can state that the interactive workshop with at least half a day reserved explicitly for this purpose was a great success. The atmosphere has been open and productive, contributions were equally distributed among regions and the policy-makers reported that they gained some insights in the course of the workshop. Apart from the substantial results presented in chapter 6.3, the workshop was an important starting point for the methodological professionalisation of "International S&T Cooperation Foresight". As a next step in the foresight exercise's logics, it was necessary to tap into the knowledge, experience and needs of those actually involved in S&T cooperation, the actual target group of cooperation support.

6.2.4 Accessing scientists' views and experience

For gathering information from the scientific community, we decided to follow a different strategy: We assumed that these scientist that had already cooperated through publishing would be the best suited sample group from the scientific community to provide us with answers to our query on how to step up S&T cooperation levels between the two regions in the future (thus, co-publication was used as a proxy for cooperation). Moreover, we reasoned that scientists active in the day-to-day practice of international collaboration would be able to come forward with very concrete bottom-up inputs probably interesting for our study's target audience: S&T policy-makers in Southeast Asia as well as at European and European Member State/Associate Country level.

From an analysis of Europe-Southeast Asian co-publications in ISI Web of Science, we derived a list of all scientists from both regions that have published articles at least with one author from the respective other region. Given that we wanted to reach out to researchers currently active in S&T cooperation between the two regions, we limited the data set to the period from 2005 to (May) 2010. Email contact addresses of authors from both regions publishing articles together with one or several authors from the respective other region could be extracted from the data set.

Because of the big number of contacts (around 12.000) we decided to use an online survey in two phases: In a first phase, we asked the scientists in an open question via email which driving factors for Europe-Southeast Asian scientific cooperation they deem most important and determining for future success. Around 300 partly extensive (up to 2 pages) and mostly relevant email responses could be gathered in this first phase. Apart from the content feedback we also got additional contacts to authors with co-publication experience. This was achieved by asking those authors, who were indexed in Web of Science as co-publishing with the other region, but without listing the emails of their coauthors, if they could provide us with further infos on their colleagues.

The second phase was a Delphi survey where we asked the same group of respondents (initial group plus additional contacts from the open consultation) for their views on the most important, most often mentioned and most interesting driving factors that were provided in the first round. These driving factors have been isolated by us in desk research in a bottom-up interpretation of the email texts, taking into account the frequency of occurrence in the open consultation or the novelty of the opinion. Due to the high number of drivers derived, the variables have been condensed to 39 drivers (a significantly higher number cannot be managed by respondents in an online survey) presented in the wording of the scientists' responses (leaving the scientists' original phrasings, though sometimes slightly shortened or amended to make them understandable out of the context of the full answers).

The scientists presented the drivers usually in form of concrete recommendations of instruments or activities. The advantage of keeping this framing was twofold: first, the drivers pointing towards a future success scenario were presented in a way that was accessible even when quickly going through the questionnaire; secondly, we used the opportunity to gain feedback on a series of hands-on recommendations on how to step up cooperation coming out of the scientific community itself.

The Delphi method

Delphi involves an iterative survey of experts. Each participant completes a questionnaire and is then given feedback on the whole set of responses. With this information in hand, (s)he then fills in the questionnaire again, this time providing explanations for any views they hold that were significantly divergent from the viewpoints of the others participants. The explanations serve as useful intelligence for others. In addition, (s)he may change his/her opinion, based upon his/her evaluation of new information provided by other participants. This process is repeated as many times as is useful. The idea is that the entire group can weigh dissenting views that are based on privileged or rare information. Thus, in most Delphi processes the mount of consensus increases from round to round.[91]

In order to get the feedback we were looking for, we decided to use (two-stage[92]) Delphi methodology because of two issues.

- First, the idea behind Delphi is rather straightforward and easy to understand: In a first round, a questionnaire is sent out containing question types that allow for easy statistical analysis (in our case, we asked for an estimation of the relevance of each of the drivers on a four-point scale). The easy-to-handle question type is important not only in view of the large amount of data and time constraints in the analysis, but also to feed back the answers from the first round to the same respondents in a second round. In this second round, the same questions as before are presented again, but allowing the respondents of the survey to see their original answers compared to the global averages of answers from the scientific community and to re-assess their original answers in light of their peers' opinions. This will give more reliability to the (after the second round usually more consensual) answers.
- Secondly, the methodological approach of using Delphi style survey allows us to ask for answers from the whole scientific community as derived from the co-publication analysis. Therefore, by not selecting a part of a whole based on some indicators of relevance, but asking the whole concerned population, we assume that the results of our survey will have more relevance in terms of representing a good overview of the actual opinions of the respondents.

As already said, the goal of the Delphi analysis was to let the whole group of scientists already engaged in co-publication activity decide upon which statements from the open email consultation were relevant. After the first Delphi round, we had not only a look at the overall results, but also tried to group answers by a procedure minimising variances within the respective group (i.e. deviations from the means of a specific subgroup must be smaller within the group than between the group and other cases or other possible groupings). By this means, we found out that scientists from Europe, from Singapore and from Southeast Asia excluding Singapore were the three most suitable groupings (we did not want to have more than three groups). To give an example: The difference in relevance ratings (of all drivers) between Indonesian scientists and Thai scientists was smaller than between Indonesian and Singaporean or Indonesian and European scientists.

The motivation for using an inductive grouping for the respondent's group in the second stage of the process, which is not utilized in "normal" Delphi queries, was that we assumed that scientists from Europe and Southeast Asia would not necessarily share the same motivations (drivers) for starting and continuing the cooperation.

Given the difference between the regions and the fact that Singapore is materially the wealthiest country in the ASEAN region, the groupings seem quite natural. This being true, as we shall see in chapter 6.5, the grouping still gives interesting and in some cases unexpected insights.

We have already seen that the first stage of the scientist consultation by email has gathered significant feedback. The response rates in the second stage, i.e. the Delphi, have also been very impressive: Out of the 12,000 email addresses initially gathered, slightly less than 10,000 were actually active and functioning. Around 1,200 scientists have completed the online survey in the first Delphi round. The second Delphi round, presenting the average relevancies assigned to the identified instruments in the first round and offering each participant the possibility to adapt one's initial answers or comment upon them, has been completed by 48 % of the respondents from the first round. The overall response rate throughout the whole Delphi process is around 5.7 % (very high according to independent experts; similar exercises normally attract answers from only 2–3 % of the persons contacted), which turns the set of concrete instruments identified into a reliable source of bottom-up recommendations. Moreover, answers were equally distributed among the two target regions[93] (for the second round: 254 complete answers from Southeast Asia and 301 from Europe).

91 Slocum, Nikki (2003): Participatory Methods Toolkit. A practitioner's manual, Brussels: viWTA/UNU-CRIS/King Baudouin Foundation, p. 75

92 A Delphi-style survey is normally done with the same respondents group in the two or more rounds (more than 3 rounds are usually not considered as fruitful).

93 Respondents were asked to state for which region (Southeast Asia or Europe) they feel most suited to answer. We did not decide regional affiliation ourselves based on the Web of Science data because we thought that in case of double affiliations or mobility (e.g. a Southeast Asian scientist currently affiliated in Europe or the US), it's best to let the respondents decide on what their perspective is.

The goal of using the open email scientist consultation process before starting the Delphi was to ensure that the driving factors that we would later ask the scientists to evaluate in order of relevance would come directly from the concerned scientific community and would not be "invented" by us. A nice side-effect was that we got very positive feedback from scientists that mention explicitly their approval of this approach, and that the incoming completed surveys were more numerous than usual in comparable exercises. Moreover, the results gained display both the scientists' ideas regarding relevant drivers of future S&T cooperation between Southeast Asia and Europe and concrete recommendations on how to achieve an increased cooperation intensity. Critical remarks within the consultation process concerned mainly the transparency of the follow-up process (which we will tackle by sending this report to all contacted scientists) and the question of science policy to take and implement advice derived in the process. In this regard, the authors of this study can only recommend strengthening the link between science policy and science by acknowledging the importance of scientists' advice in the development of science policy. Taken together, the respondents for our queries have invested a huge amount of working time and they would probably appreciate if this contribution could be made explicit in the further development of science policy.

6.2.5 Towards a success scenario of 2020 EU-ASEAN S&T cooperation

As explained above, after the drivers identification, scenario building typically starts with defining the scenario logics, followed by a fleshing out of the draft scenario, before this is put up for discussion. The SEA-EU-NET Foresight team used the results of the driver identification and assessment process for the desk research based development of a core scenario logics and a draft success scenario. We followed the single success scenario method introduced above. Given the resource constraints in view of the discussions of the scenario, this was the most promising method for the goals of triggering debate and creating a jointly owned vision of the future.

The success scenario drafted in the narrative form of a fictive news clipping, was put up for discussion (in a Knowledge Café format[94]) during a SEA-EU-NET event in Chiang Mai / Thailand. A high-level policy-maker and research funder audience (around 30 people from 8 ASEAN countries) discussed the future of EU-ASEAN S&T Cooperation in the light of the necessary future paradigm shifts defined in the Krabi Initiative 2010[95].

After this detailed account of the methodology forming the basis of this foresight study, we can now focus on the results, starting with the policy-makers and then moving on to the scientists' views before finally contrasting and combining both with the goal to generating a set of fruitful insights on how to go for a 2020 S&T cooperation success scenario for Southeast Asia and Europe.

6.3 Policy-makers' views

As said before, at the beginning of the foresight process in November 2009, policy-makers from Southeast Asia and Europe were invited to consider driving forces for an increased S&T cooperation between the two regions in five policy areas. For each of these areas, we will highlight the major driving forces that were identified in the workshop. Subsequently, we will point out interesting differences between the regions before, finally, moving on to the results of the identification of environmental factors that are considered relevant for the future of S&T cooperation, but cannot or hardly be influenced ('shapers').

6.3.1 Higher education policy

In the field of higher education policy, facilitation of mobility and achieving science excellence in a globalised world were identified by experts from both regions as the most important driving forces for achieving a high level of region-region cooperation between Europe and Southeast Asia. The far-ranging driver favourable policy background was slightly more important for the SEA experts, whereas internationalization of education was highlighted mainly by Europeans. SEA experts take very different stances towards this issue among them.

Discrepancies between the two regions are most prominent, however, in the rating of the importance of drivers like funding and donor availability (more important for SEA experts), research management (more important for European experts) and, most notably, humanities and letters, with good support from the European side and none from Southeast Asia. The following diagram shows a selection of drivers that were estimated as highly important by both regions (right part of the diagram) and where views differed significantly (left part of the diagram).

94 A variation of the World Café method; cf.: Hage-Malsch, Sabine (2007): Personalisiertes Wissensmanagement: Knowledge Cafés – ein Tool mit Potenzial, in: wissensmanagement, Heft 5

95 A strategic regional policy initiative to raise competitiveness for a sustainable and inclusive ASEAN using science, technology and innovation, which was endorsed by the 6th Informal ASEAN Ministerial Meeting on Science and Technology (IAMMST) on 17 December 2010. See: http://www.aseansti.net/index.php

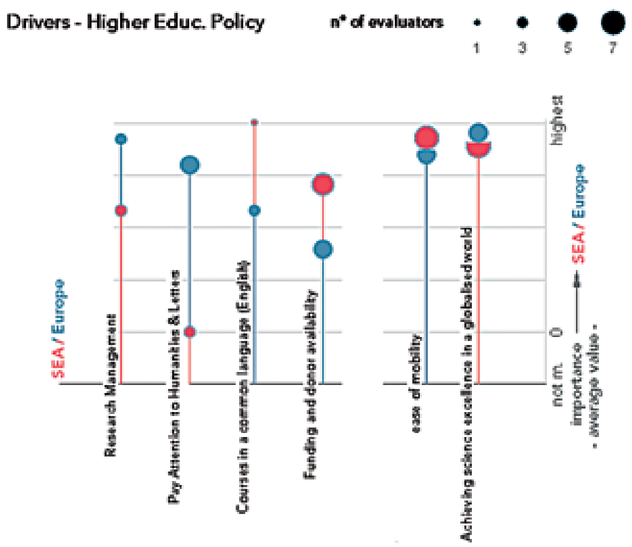

Figure 63: Drivers in higher education policy

6.3.2 Science and research policy

In this policy area we have one driver that experts from both regions consider outstandingly important, which is Joint Agendas for common challenges (schemes such as ERA-NETs). Participants from both regions, furthermore, agreed upon the relevance of maintaining a competitive edge in global innovation, tackling global challenges and support for research infrastructure as factors that can drive (or hinder) the development of a successful bi-regional high intensity S&T cooperation scenario. One additional driver should be highlighted as it complements the last-mentioned support for research infrastructure: Schemes for joint usage of infrastructure, such as 'Centres of Excellence' were also perceived as quite relevant by the whole group of experts.

As can be seen in the following diagram, less consensus prevailed regarding a set of five other drivers: European experts emphasized Achieving science excellence in a globalised world[96], while SEA experts assigned more prominence to Leveraging Research Funding, Funding and donor availability and SEA Integration.

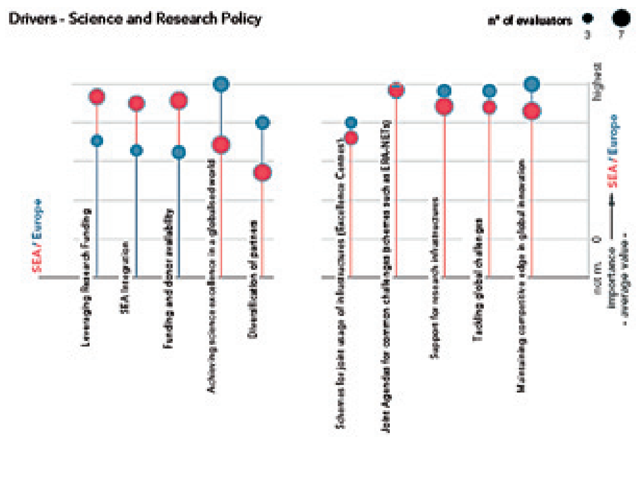

Figure 64: Drivers in science and research policy

6.3.3 Industry, trade and economic policy

The discussions around the policy fields of Industry, Trade and Economy resulted in the most diverse workshop results. The participants from Southeast Asia and Europe agreed in assigning outstanding importance to maintaining a competitive edge in global innovation and, to a lesser extent (less experts giving a grade, however with a similarly high average grade) to the free movement of people and capital between regions.

Regarding a set of other drivers that were proposed for considerations or that popped up during the discussion, considerably discrepant views prevailed, most notably when it comes to trade and economic factors. Getting more SMEs into RTD cooperation, supply chain integration/efficiency (average of 5 points from SEA against 3.5 points from Europe in both cases) and reducing/removing trade barriers (4.75 against 3.33 points average) were all regarded as much more important by SEA experts than by European experts.

An additional fact can be seen as enclosing the aforementioned list at a superordinate level: A favourable policy background in this policy area was considered absolutely crucial (average of 5 out of 5 points) by the SEA experts participating (with 5 out of 7 giving grades). Two thirds of the European experts considered the issue an important, but no crucial driver (3.83 points out of 5). One third of the European experts did not vote on this aspect. While not all SEA experts considered these issues worth expressing their opinion on, those who did (between 2/7 and 5/7) underlined the importance of the trade and economic policy background drivers.

Apart from these, as mentioned already, science excellence, here, is seen as a most important driver by European participants, while a "pro poor" approach and questions of funding and donor availability are considered important drivers by Southeast Asian experts rather than by Europeans.

96 As we have seen, in the field of Higher Education Policy, experts from both regions agreed to science excellence as a crucial driver. In the field of Industry, Trade and Economic Policy, it is rather like in the case of Science Policy: European experts emphasize this point more than SEA experts do.

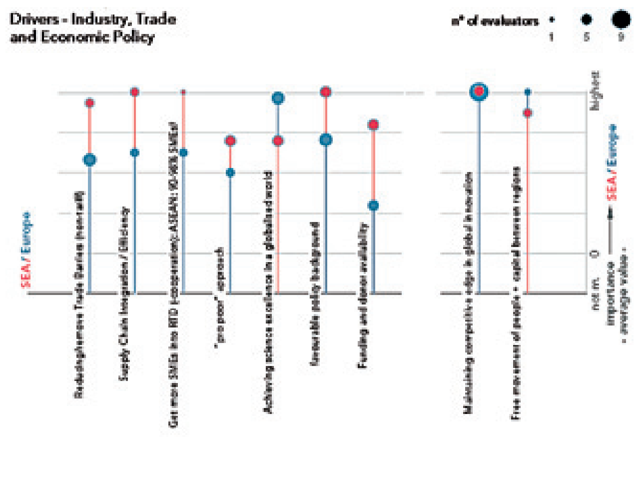

Figure 65: Drivers in industry, trade and economic policy

6.3.4 Development policy and global challenges

In contrast to Trade and Economic Policy, Southeast Asian and European experts showed rather similar views on the important drivers for bi-regional S&T cooperation between the two regions in 2020 in view of Development Policy.

Only with regard to mutual respect as a driving force and the tackling of global challenges, the assessments differed, with European experts assigning more importance to both of these drivers.

A series of related drivers like supporting less developed countries, identifying specific common problems of EU-SEA S&T cooperation, jointly formulate calls, jointly identify key research areas and trust aspects ("Address issues which are of interest to ASEAN and not just of relevance to EU. Only then trust will be built"), are considered equally important by participants from both regions.

Figure 66: Drivers in development policy

6.3.5 Diplomacy, foreign and security policy

Finally, in the area of Diplomacy, Foreign and Security Policy, creating good/stable diplomatic relationships and a joint responsibility on climate change/global issues were regarded as highly relevant drivers for a successful future S&T cooperation scenario by experts from both regions.

Interestingly, particularly regarding the above mentioned views in Economic Policy, in the context of Foreign Policy, Southeast Asian experts considered improving the competitiveness of national firms a moderately relevant driver, while Europeans considered this aspect quite central. Southeast Asian participants, however, in contrast to their European colleagues, perceived the lifting of trade barriers a highly relevant driver, which is consistent with the results in the field of Trade and Economic Policy.

Considerable differences exist in the views on Human Rights and the fight against human trafficking as a relevant driver: 7 out of 9 European experts saw it as a totally crucial aspect (4.85 out of 5 points) while 5 out of 7 SEA experts assigned moderate relevance (2.8 out of 5 points). An agreement on intellectual property issues was considered slightly more important by European participants.

As in the field of Science and Research Policy, SEA integration is seen as an important driver by SEA experts and as a moderately relevant one by Europeans. The question of scientists' mobility and, more concretely, the abolishment of visas shows similar results: Southeast Asian experts consider it a more important driver.

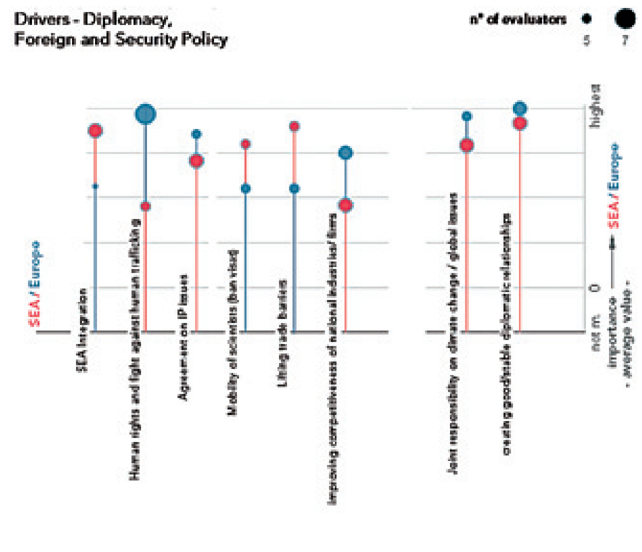

Figure 67: Drivers in diplomacy, foreign and security policy

6.3.6 Diverging views within regions

Besides examining consensus and diverging views on the importance of certain drivers between the two groups of regional experts, taking a look into the difference of views expressed within each region also promises to disclose meaningful insights.

In the case of Southeast Asian experts' answers, a series of driving forces was considered by some as crucially important and by others as rather irrelevant. This is shown in the following table using each of the experts' grades given to the specific driver as well as the variance and average of the given points (answers with a variance of more than 1 are highlighted).

Table 11: Diverging driver relevance assessments – high variance in Southeast Asian answers

Policy area	Driver*					
	Estimated relevance Europe			Estimated relevance for SEA		
Higher education policy	Support for co-authored papers (co-funding schemes)					
	4, 4, 4, 3	s^2 = 0.25	∅ 3.75	5, 3, 3, 2, 4	s^2 = 1.3	∅ 3.4
	Internationalisation of education					
	5, 5, 4, 4, 5	s^2 = 0.3	∅ 4.6	1, 4, 4, 5, 4, 5	s^2 = 2.2	∅ 3.83
Science and research policy	Diversification of partners					
	5, 5, 4, 3, 3	s^2 = 1	∅ 4	5, 2, 1, 3, 2, 3, 3	s^2 = 1.6	∅ 2.71
Industry, trade and economic policy	Achieving science excellence in a globalised world					
	5, 5, 5, 5, 4, 5	s^2 = 0.17	∅ 4.83	4, 4, 5, 2, 4	s^2 = 1.2	∅ 3.8
Development policy/global challenges	Link DEV-Programmes stronger with S&T programmes					
	3, 4, 4, 4, 4	s^2 = 0.2	∅ 3.8	4, 5, 2, 2, 4	s^2 = 1.8	∅ 3.4
	SEA integration					
	3, 2, 2, 4	s^2 = 0.92	∅ 2.75	3, 4, 5, 2, 3	s^2 = 1.3	∅ 3.4
Diplomacy, foreign policy, security policy	Improving competitiveness of national industries/firms					
	5, 4, 5, 3, 4, 3	s^2 = 0.8	∅ 4	1, 2, 2, 4, 5, 3	s^2 = 2.2	∅ 2.8
	Supporting less developed countries					
	3, 3, 3, 5, 2, 5	s^2 = 1.5	∅ 3.5	1, 3, 3, 3, 5, 4	s^2 = 1.8	∅ 3.2

*Most important = 5; least important = 1
s^2 variance
∅ average

Southeast Asian experts, for example, had no corresponding views among themselves to the question whether the support for co-authored papers would be relevant as a driving force for S&T cooperation between Southeast Asia and Europe.

In the area of Higher Education Policy they disagreed even more about the possible role of an internationalising education for boosting bi-regional S&T cooperation. EU policy-makers decided to address the goal of an intense bi-regional science and technology cooperation through enhanced higher education internationalisation. This aspect, for instance, might need clarification and further consultation with the Southeast Asian partners.

In Science and Research Policy, there was no consensus among Southeast Asian experts regarding the question whether a diversification of partners drives bi-regional S&T cooperation between Southeast Asia and the EU forward or not. As seen above, this point is in average considered less important by the Southeast Asian attendees. The opinion of the participants regarding the possible driver science excellence also varies strongly within the group of Southeast Asian participants and among the regions.

By contrast, as regards the role of support to less developed countries, the rating was moderately positive on both sides, while answers vary significantly within each group of attendees.

These aspects exemplify the diversity of the Southeast Asian region, which will have to be taken into account in any effort to strengthen bi-regional S&T cooperation. This was also expressed by workshop participants from both sides in the final discussion round.

In addition, views on the significance of integration processes within Southeast Asia for S&T cooperation with Europe also differed, although not as strongly as other issues. It might be appropriate to keep these different estimations of the role of SEA integration in mind when approaching the goal of a strengthened bi-regional S&T cooperation at the political level. When there is no consensus among Southeast Asian stakeholders that SEA integration is helpful in this account, it might be difficult to get substantial political support at regional Southeast Asian level.

The issue of the driver supporting national industries was already discussed above. Southeast Asian experts offered different opinions and valued this driver less than other economy-related issues. This might be explained by either a trust of Southeast Asian stakeholders in their economic landscape, the experience that national industries are not that important for S&T endeavours or the perception that national industries are central for competitiveness and thus too critical to be subsumed under shared regional responsibilities.

In the case of the European group of experts[97], there was diversity with regard to a greater number of possible drivers (answers with a variance of more than 1 are highlighted):

97 Which was slightly bigger – 9 participants compared to the 7 SEA participants

Table 12: Diverging driver relevance assessments – high variance in European answers

Policy area	Driver*					
	Estimated relevance Europe			Estimated relevance for SEA		
Higher education policy	Competition for scarce (human) resources					
	5, 3, 5, 1, 4	s^2 = 2.8	∅ 3.6	3, 3, 4, 4, 4, 3, 4	s^2 = 0.3	∅ 3.57
	Diversification of partners					
	2, 4, 3, 5, 3, 3	s^2 = 1.1	∅ 3.33	2, 3, 4, 4, 3, 3, 4	s^2 = 0.6	∅ 3.29
	Brain gain					
	5, 4, 4, 1, 3	s^2 = 2.3	∅ 3.4	3, 3, 2, 5	s^2 = 1.6	∅ 3.25
Science and research policy	Competition for scarce (human) resources					
	1, 5, 3, 4, 4	s^2 = 2.3	∅ 3.4	5, 4, 3, 3, 3, 4, 4	s^2 = 0.6	∅ 3.71
	Bi-regional "Science Days" (events)					
	5, 3, 2, 4, 4	s^2 = 1.3	∅ 3.6	4, 3, 2, 2, 2, 2	s^2 = 0.7	∅ 2.5
Industry, trade and economic policy	Competition for scarce (human) resources					
	3, 1, 5, 4, 5	s^2 = 2.8	∅ 3.6	4, 3, 4, 4, 4	s^2 = 0.2	∅ 3.8
	Favourable policy background					
	2, 4, 3, 5, 4, 5	s^2 = 1.4	∅ 3.83	5, 5, 5, 5, 5	s^2 = 0	∅ 5
	"Pro poor" approach					
	1, 5, 3, 3	s^2 = 2.7	∅ 3	3, 5, 5, 3, 3	s^2 = 1.2	∅ 3.8
Development policy/global challenges	Support for research infrastructures					
	3, 5, 5, 1, 4	s^2 = 2.8	∅ 3.6	4, 4, 3, 3, 2	s^2 = 0.7	∅ 3.2
Diplomacy, foreign policy, security policy	Supporting less developed countries					
	3, 3, 3, 5, 2, 5	s^2 = 1.5	∅ 3.5	1, 3, 3, 3, 5, 4	s^2 = 1.8	∅ 3.2
	Mobility of scientists (ban visas)					
	3, 1, 4, 5, 3	s^2 = 2.2	∅ 3.2	4, 3, 4, 5, 5	s^2 = 0.7	∅ 4.2

*Most important = 5; least important = 1
s^2 variance
∅ average

We do not want to pick out each single item here, but extract some of the most interesting findings relevant for policy recommendations.

As can be seen, the competition for scarce (human) resources as a possible driver for bi-regional S&T cooperation provoked strongly different reactions among European experts in all three policy areas in which this driver was indicatively raised for discussion. European workshop participants disagreed about possible brain gain as a driver in the scenario.

Whether or not the organisation of bi-regional science days can advance S&T cooperation, was also an ambiguously evaluated issue. Accordingly, if such events should take place in the future, policy-makers, programme-owners and organisers cannot expect unanimous support from stakeholders.

Supporting less developed countries, supporting research infrastructures and adopting a "pro poor" approach are possible drivers that are very diversely reflected upon by the European participants. Likewise, European experts did not agree upon the importance of mobility with the explicit hint to possibly banning visas for scientists. Further research in form of follow-up and additional interviews is needed in order to give valid interpretations of these findings.

6.3.7 Shapers and additional drivers for SEA-EU S&T cooperation 2020

In this section, we shortly highlight the most important shapers of the future of bi-regional S&T cooperation between Southeast Asia and Europe that were identified by the scenario workshop participants.

In methodological terms, as described above, participants were asked to consider a list of indicative shapers and add new ones. Subsequently, every expert could both vote the relevance of each of the shapers by distributing 10 relevance points over the whole set of shapers and add qualitative comments and further explanations.

As will be seen, while in theory and definition it might be possible to draw a line between driving and shaping forces as directly influencing or indirectly conditioning factors, in a dynamic workshop setting, it might not always be easy to maintain this separation proposed by the UNIDO foresight manual[98]. Several of the shapers that will be presented here, can or even must actually be interpreted as drivers.

The shaper that by far raised the biggest interest among experts in both regions was focusing common R&D areas on Food, Energy and Water. While this can also be understood as a driver, here it is also to be interpreted in terms of the general relevance of food, energy and water issues in the region in the not-so-near future. A corresponding commentary of an expert justifying the impact of this shaper on Southeast Asia: "F, E, W are the main issues in ASEAN countries. Although there have been a lot of approaches and achievements […] still in the upcoming years (up to 2020), people in ASEAN […] are very concerned on these three issues". Similarly another expert: "It is important for ASEAN countries to have a regional food product or a regional proven technology for ensuring energy resources".

Another expert addressing the impact of this shaper on the EU recurs to a different reading: "[C]ommon R&D programmes will have an effect on the future EU scientific programmes". He/She means that, as more money will be allocated to research activities focusing on these issues, this will shape the bi-regional S&T cooperation.

98 UNIDO (2005): Technology Foresight Manual. Volume 1 – Organization and Methods

It becomes clear that the differentiation between drivers and shapers is not intuitive and not easy to maintain in our scenario workshop setting with policy-makers and programme-owners.

The external influences of global issues as well as financial and environmental crises are related to the driving and shaping focus on common R&D areas are. Here, the experts agreed that global challenges "will affect [the] amount of R&D funding to support international collaboration". Moreover, it was highlighted on both sides that these challenges could lead to competition for resources and conflicts. "CO_2 will decide upon the 'language' of S&T cooperation". However, it is also highlighted that global challenges might turn into an opportunity for cooperation in a focused thematic approach – this reading suggests that if there is a pressing need, bi-regional cooperation will function well.

According to the participants' views, intellectual property issues will shape the form of future bi-regional S&T cooperation between Southeast Asia and Europe. Weak IPR regimes could discourage international collaboration. IPR are said to be especially important for the EU – the reason for this appraisal might be that the workshop participants doubt that the European scientific community will share significant research efforts and outcomes without having the property rights clarified. Southeast Asian experts share the view of the opportunities included in IPR systems and state that the countries in the region will further develop the IPR culture. However, they also point to the adverse effects of an IPR system: these could lead to competition and impose barriers. As the IPR system can actively be influenced by policy making, it can also be a driving force.

The availability of technical and scientific skills as well as existing management capacities are also mentioned as relevant context factors for bi-regional S&T cooperation. The latter are considered essential for participation in EU-funded schemes. An expert opined that increased management capacities in Southeast Asia will lead to an increase in S&T absorption capacity which, in turn, increases cooperation with Europe. The former point of technical and scientific skills also has to be seen as relevant for S&T absorption capacity.

Interestingly, the support to regional S&T institutions in Southeast Asia is not considered to have a significant impact on SEA in terms of bi-regional S&T cooperation with Europe. On the other hand, European experts expressed the need for regional centres of excellence. We discuss this point in more detail in the recommendations section. The development of common and harmonised planning, monitoring, evaluation and impact assessment methodologies was determined to be a crucial shaper for bi-regional S&T cooperation, specifically as regards Europe. Southeast Asian experts assign much less impact to this point and, thus, less relevance in the SEA case.

Before turning to the policy recommendations that can be extracted out of the aforementioned views on drivers and shapers of a high-intensity bi-regional S&T cooperation between Southeast Asia and Europe, we will give a brief overview of the factors directly and indirectly influencing the future scenario.

The following points call our attention:

- There is a common concern for global challenges among both groups of experts which becomes apparent both in the identification of drivers and shapers.
- The needs for supporting research infrastructure and for technical and scientific skills were nominated important factors in terms of drivers and shapers. We observe a diverse picture regarding possible ways to address this issue (development assistance for S&T capacity-building, "pro poor" approach in S&T cooperation programmes, etc.). Further discussion and consultation processes are needed, which would contribute to networking and trust-building goals among the regions and stakeholder communities.
- Southeast Asian experts consider economic and trade factors as important drivers, while they do not insist on the improvement of national firms' competitiveness as a central driving force. Their European peers assigned opposite relevancies to these two drivers.
- European participants, by comparison, were more concerned about the protection of intellectual property rights as a necessary precept for successful and far-reaching S&T cooperation.
- In the context of S&T, Southeast Asian experts are less concerned about the relevance of human rights and are less convinced of the usefulness of taking into account subject areas like humanities in the bi-regional cooperation.

After having presented the policy-makers' views on important driving factors of the future of S&T cooperation between Southeast Asia and Europe, we will now turn towards the insights of those involved in actual scientific collaborations. The simple idea behind approaching a broad segment of the scientific community was that scientists would know both what their reasons are for collaborating and what they would need in order to collaborate more.

6.4 Driving factors – perspectives from an open email consultation

As indicated in the chapter on methodology above, we started to reach out to a part of the scientific community that has already been co-publishing in a Southeast Asia-Europe setting with the respective other region. Concretely, we started addressing scientific authors who have cupublished in the course of the last five years with a simple and open email consultation. The scientists were asked the following:

Dear […]

The European Union aims to intensify S&T networking with the countries of Southeast Asia and tasked our project SEA-EU-NET with identifying the most important driving factors for science cooperation between the two regions.

We have already asked for the opinions of science policy-makers, but we think that the views of scientists from both regions are an at least equally important factor when planning for future actions.

As you have already published in this bi-regional setting (we made an ISI Web of Science search for co-published papers with authors from both Europe and Southeast Asia) we kindly ask you

- *to reply to this email with your view of important driving factors that support the build-up and strengthening of scientific relations between the two regions from the scientists' perspective (post-doc; working scientist; science manager). We kindly ask you to reply within one week.*
- *to participate in a two-stage rating process of these drivers (using the Delphi methodology; 10min for each stage) to assess the importance that the targeted scientific community as a whole poses on those driving factors (for this we will contact you via email, as soon as we have analyzed the proposed drivers).*

At the end of the deadline, after sending out the email consultation question to additional contacts indicated by the respondents, and after several reminders, we have received the considerable amount of 280 qualitative answers of a length between several lines up to two pages. In some cases, short discussions evolved on the basis of our responses to requests for clarification or opinion from the respondent scientists.

In the following analysis of the data gathered in the course of this open email consultation, we do not discriminate between responses from Southeast Asia and responses from Europe. Given that especially in the case of co-publishing scientists multiple affiliations and bi-regional biographies are common, we have to leave the decision, out of which regional perspective they are talking, to the scientists. The discrimination between the regions can only be done in the subsequent step of the Delphi survey. Hence, the following are the driving factors for S&T cooperation as identified by scientists with recent co-publication experience from both regions[99].

We will start with looking at what tools and support mechanism can, if available, drive international cooperation before having a look at the scientists' personal and institutional motivations for international cooperation that can also be considered as drivers.

Naturally, financial resources to support international S&T cooperation (in dedicated programmes, but also bottom-up as top-ups to existing research funding schemes) have been highlighted as a basic prerequisite for stepping up international cooperation. Analysing the qualitative material, one gets the impression that scientists are keen on international cooperation as soon as they discover joint interest in a common research topic or other mutual benefits like laboratory access, technology transfer and access to the field. If they do not come across possibilities to identify joint topic interest or mutual benefits (at conferences and other workshops, field visits, but also dedicated international cooperation support programmes), then they will not look after cooperation just for the sake of cooperating, unless they follow other related goals (like technology transfer for humanitarian reasons). In some cases, personal interest (ranging from friendship to touristic interest, concern for global challenges and ideals of supporting countries in their economic development) might push scientists to look for cooperation actions (with varying sustainability). However, in both cases (personal interest or joint topic interest and expectations of mutual benefits), cooperation is not likely to happen if specific resources (ranging from money for proper S&T cooperation projects to small add-ons to existing projects in terms of travel money and equipment support) are not available either in the form of dedicated international cooperation support programmes or as part of regular research budgets.

A task for science policy, thus, might be to "anticipate development", as a scientist respondent called it, make scientists aware of possible joint interests and offer the right amount of appropriate resources while at the same time "mak[ing] sure to effectively support actual cooperation in training and research and not only external appearances" (another scientist respondent).

One scientist put the issue of funding as follows:

"The funding of research projects is not organised for collaboration, and one project is usually built on at least 4 research programmes: to finance research in both laboratories, to finance students (grants) in both laboratories, and mission/travel funding. Moreover […] it is usually difficult to obtain money to buy research equipment and without equipment, this can not be a real collaboration"

The wider problem of lacking research infrastructure has been voiced by a number of respondents.

As resources are limited, some balance will have to be found between explicitly supporting international cooperation for specific groups of researchers or specific thematics and supporting collaboration as soon as it appears as a beneficial option in ongoing nationally or regionally funded research.

International S&T cooperation is still often not rewarded by the scientists' university or wider academic environments in terms of scientific career development. Thus, resources could not only be used to support international cooperation activities ex ante, but some funds could be employed to establish reward structures for successful cooperation between Southeast Asia and Europe. Interestingly, a respondent has also pointed

99 Methodologically speaking, these are the codes inductively identified in the open email consultation answers.

to possibly rewarding scientists willing to engage with their community through international peer reviews. While this debate sounds slightly misplaced at first sight, in view of the fact that a number of co-publications and subsequent cooperations originate from authors' including their reviewers as co-authors, it is reasonable to discuss reward structures for high-quality reviewing supporting international cooperation.

The financial and reward aspects bring us to one of the specific driving factors of international cooperation that are related to, but not only determined by the availability of financial resources (the empirical material gathered throughout our email consultation pinpoints a rich range of modalities, going far beyond simply stating that money is needed): the question who decides in which thematic areas S&T cooperation takes place, i.e. is supported and rewarded. Respondents identified a combination of bottom-up and limited joint top-down priority setting as necessary in the context of international cooperation. While most of the respondents highlighted that it is indispensable to have thematically open support for international S&T cooperation in order to make it function (the argument being that scientists just will not search for partners as long as they do not feel that it adds to the content of their research), a few respondents also opined that top-down priority setting would in general help to drive cooperation levels. For them, top-down thematics indicate political backing for this kind of research, a frame that has been mentioned by several Southeast Asian scientists as a pre-requisite for successful cooperation. Assessments have not been univocal in this regard. However, a solution to possible resource dilemmas has been mentioned by the scientists themselves several times: Support for cooperation on jointly defined subject areas relating to global challenges or other areas of common interest could be combined with thematically open bottom-up support.

Regardless of the thematic focus, respondents unambiguously voiced that international S&T cooperation can only function over a longer term[100]. When long-term support for exchange and subsequent cooperation is available without too quickly looking at quantifiable results (or looking at them with suitable metrics), trust and personal relations can grow, which in turn help develop a joint understanding of research problems and the development of joint research interest.

Relatedly, exchange of researchers[101] was also among the most frequently highlighted driving factors. Most respondents underlined that exchange of personnel is a very efficient and indispensable driver of long lasting collaborations. Regarding the details, most scientists propose long-term exchange themes for PhD-students and short-term exchange schemes (visits) for Post-Docs and senior scientists. Rather few respondents proposed undergraduate exchange as driving S&T cooperation levels.

It was mentioned that for PhD-exchange to function efficiently and to the benefit of both sides, the selection process has to be fair, open and has to offer exit strategies in case the collaboration does not prove to make sense (e.g. because of differences in thematic interest or research excellence not discovered before, or because of insufficient graduate education levels). As a participant in our email consultation said, in Asia

"it is equally or even more difficult than in Europe to get good PhD students. The best graduates immediately get lucrative positions in industry. That's why the applicants [for university PhD positions] are often not the best in their year".

One possibility that was mentioned to mitigate damage of unsuccessful exchange agreements was to have a six-month introductory stage with the PhD candidate. In case both sides agree and consider ongoing cooperation fruitful, the exchange can then be extended to the full length of a PhD programme. Another option for overcoming uncertainties was to combine prior senior scientist short-term exchange with personal meetings with PhD candidates and a joint selection process. In both cases, combining exchange and visits with training (might be language, but also subject area specific scientific training) was also identified as probably beneficial to sustainable cooperation via exchange. Additional training, for instance at the beginning of a long-term stay, could in general be wise in order to integrate foreign PhD students or Post-Docs into new university and lab environments. Regional training networks could be set up build research capacity, to develop and implement joint curricula and to ensure comparability of degrees and education.

Respondents also mentioned the improvement of quality control metrics as essential, both in view of selecting candidates for exchange schemes and collaboration, and in view of evaluating the success of S&T cooperation.

In terms of the PhD projects and their subject areas, most respondents emphasised that these issues should be defined bottom-up.

An interesting related driving factor was pointed out in several email responses: co-supervision of PhD students. This is normally combined with some exchange schemes of a longer or shorter length and formalised joint PhD programmes, joint projects involving a PhD or rather informal agreements with PhD students admitted to regular national PhD programmes of the target country.

In any case, the core idea is that co-supervision drives collaboration between senior scientists from two regions via the intermediary of the young research with all sides benefitting. The PhD student gets to know different research and lab cultures, benefits from higher exposure to his/her research field and from complementing the knowledge base of both of his/her supervisors. The supervisors can meet irregularly on short-term basis, e.g. during the usual conferences of their scientific field, but are connected during a longer time-period via their joint PhD student. The returning PhDs bring along with them networks, expertise and fresh ideas to his/her original working environment.

Above, we mentioned that most scientists do not share the conviction that international S&T cooperation is beneficial merely for political reasons, long-term economic prospects or for the sake of cooperation itself. In this regard, exchange and co-supervision can prove very helpful, as well, as people are brought together over longer periods of time, thus enabling them to identify and develop joint research interests.

Notwithstanding the possibilities of long-term exchange of junior scientists, most respondents also mentioned that the classical fora for scientific exchange, namely the disciplinary and interdisciplinary conferences, are highly relevant drivers for international S&T cooperation, at least for those scientists that are not already connected extensively on a global scale. In addition to usual support schemes like reduced fees for younger researchers or scientists from developing country, support schemes might be envisaged to support the disciplinary associations in case they want to hold a conference in a Southeast Asian country.

Several respondents agreed that, in addition to scientific conferences, other types of meetings like dedicated matchmaking events or smaller problem-centred scientist meetings are also greatly helpful to generate cooperation possibilities.

The following more specific, but very relevant innovative exchange-related tools and driving forces for S&T cooperation have also been identified by the scientists responding to our open email consultation. Some of them point towards innovative approaches of nurturing and benefitting from exchange for cooperation:

Some respondents observed that it is relatively easy to convince Southeast Asian scientists to visit European labs for short or long-term research stays. Mobility in the other direction is less frequent, but would be particularly important in view of above mentioned aspects like PhD exchange, training, but also in view of technology transfer. Outgoing funds for European scientists willing to go to Southeast Asia might be helpful, here. These can address European PhDs and long-term stays as well as the short-term exchange of senior scientists already mentioned. Another very concrete proposal made by the respondents was to offer sabbatical schemes for senior scientist's long-term exchange. Such a measure can, for sure, work both ways for mobility from Southeast Asia to Europe and vice-versa, but might especially be attractive for established European scientists whose institutions often offer sabbatical schemes (but often without related mobility support). Alternatively, retired senior scientists willing to take part-time positions at partner universities in third countries could be approached. Even if they might (for good reasons) not be any longer at the cutting-edge of scientific development, younger generations of scientists could greatly benefit from their accumulated networks and expertise, which they, in turn, can more easily share as they are no longer part of the everyday routines of their universities and disciplines. Research institutions and the local private sector could benefit from contacts, training, technology transfer, etc.

As important as it is to leverage senior scientists' knowledge and networks, once exchange schemes have been used at whatever level, it is also very important to keep the contacts alive, possibly also to advance them on an institutional level. Programme owners of exchange programmes might consider the idea of reserving some funds for this.

Not only in order to maintain contacts, but also in view of the goal of establishing new contacts and future cooperation, Southeast Asian diaspora communities in Europe (or Southeast Asian scientists with European PhDs) might be helpful. A lot of especially second generation migrants in European countries have studied, and still have contacts in Southeast Asia, know the languages and sciences cultures of both regions.

Most of these exchange-related aspects focus on personal contacts. However, they can receive significant support from institutional contacts, e.g. university collaboration agreements involving joint university campuses, third country campuses, exchange schemes or joint events. Several respondents indicated institutional contacts as being particularly relevant for international cooperation. However, the majority rather underlined single personal contacts as relevant. Given the variety of answers, we conclude that the scientific community acknowledges both personal and institutional contacts as supportive for S&T cooperation.

Institutional contacts might be relevant for another driver identified by the respondents: partner identification must be easy, if it is not "just happening" at conferences or during exchange schemes. Institutional contacts might help as well as virtual databases of institutions and researchers.

Information and Communication Technologies (ICTs) also help in identifying topic interest and keeping contact: While practically all scientists insist on the importance of regular physical meetings,

"international cooperation can [also] be done in a virtual manner [as] current information and communications technologies allow for high levels of interaction and cooperation".

Given that an internet connection is provided, ICTs can also greatly help in providing access to literature or sample databases or by allowing joint and cloud computing. This access is a precondition for participating in global state-of-the-art science. The more familiar scientists from both regions are with the literature bodies the

100 Maybe the only exception have been some scientists from Singapore. The lower relevance these scientists assigned to long-term cooperation might be explained by the fact that the Singaporean research community is highly internationalised and mobile.

101 Not surprisingly, respondents exclusively referred to scientist exchange as driving S&T cooperation. Programme owner exchange was not considered relevant. As a respondent put it: "[T]hey lack scientists, not managers".

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respective other region is referring to the easier will be the identification of joint interests, topics and approaches. This facilitates cooperation.

It might also lead to a standardisation of the pool of knowledge, research questions and research designs applied, which could be critically acclaimed. However, it is indispensable for cooperation to unite two or more parties working on a joint research problem. In order to avoid turning regional science traditions into abstract international elite discourse without impact, another driver for international cooperation identified by the respondents could be of use: Results of joint research should be made available within the regions, not just in international journals. By this means, it can be linked back to the regional and local sets of problems the research is aimed at addressing.

Bridging institutions to support international S&T cooperation (by linking partners through organising events, making knowledge available, etc.) have been recommended in a series of answers to our email consultation. They could also serve the goal of linking joint international research with regionally relevant issues. In addition, regional, supranational research institutions (like the International Rice Research Institute) or long-term international research centres could excel in this function. They have the mandate to bring together researchers from different regions of the world, usually in order to engage them in work towards the solution of a global problem or the investigation of a phenomenon or resource of joint interest.

Red-tape and bureaucracy has been highlighted by several respondents as hindering cooperation efforts. They referred to different kinds of bureaucratic obstacles, though. Concretely, the avoidance of administrative difficulties in view of (according to the scientists)

- Material exchange (plant material, human tissue, etc.)
- Field access
- Visa issues
- Financial accounting

was identified as driving cooperation between the two regions. Science cooperation management guidance (financial aspects, visa support, etc.) has been considered potentially useful by the respondents, in this context.

Some respondents pointed to industry involvement and technology transfer from (applied) science to the private sector as "cementing" cooperation. In order to make that happen, another factor has to be taken into account: intellectual property rights (IPR). Clear IPR guidance was mentioned by some participating scientists as helping S&T cooperation to grow into concrete results with local impact.

Finally, soft factors like mutual respect, openness to differences among cultures, a non-arrogant attitude, but also language skills, communication skills (e.g. in order to clarify what can reasonably be expected from the cooperation), etc. have been considered as relevant for the facilitation of S&T cooperation between Southeast Asia and Europe.

Regarding the personal or institutional motivations that drive international S&T cooperation, respondents mentioned the following drivers (no ranking of importance):

- the goal of doing good state-of-the-art science
- reputation
- the feeling to be able to contribute (to the development of a country or a scientific discipline)
- the ideal of helping to solve of global challenges; while this appears first and foremost to be a personal or institutional motivation, if one considers that cooperation in the fight against global challenges produce cooperation patterns, it also is a tool
- getting field access; here, some kind of international cooperation is quickly established given the interest and needs of one party. The relevant question, then, is not so much how to establish S&T cooperation, but how to establish it on an equal footing.
- exchanging empirical data and materials
- getting access to expertise and knowledge pools
- getting access to human resources (e.g. motivated PhD students)
- getting access to an economically important or increasingly important region
- tapping into potential for joint development of technologies; For sure, this driving factor appears as more or less relevant according to the research subject area and mode of investigation
- love for the culture(s)
- tourism
- keeping friendship alive

As international cooperation activity is increasingly becoming an important performance indicator for individual scientists and scientific institutions, the quest for international projects and publications will have to be added to the above list as an increasingly relevant institutional motivation for S&T cooperation.

This driver becomes particularly relevant as it might come into conflict with personal needs and motivations: For instance, while one might expect that a mobile research career in Europe or Southeast Asia might be interesting not only in terms of intellectual, but also financial reward, some negative aspects of researcher mobility (as a tool for and itself a form of international cooperation) have to be kept in mind. Working abroad for a while could cause problems when the positions at the home institution cannot be kept meanwhile (reintegration grants and/or-assurances could prove useful, here) or when a return is difficult or unattractive for other reasons. While abroad, the family is either left behind or brought along, which causes considerable financial strain, especially when one partner has to leave his or her job in order to be able to follow.

"Supporting exchange between scientists [...] requires good funding to also support family travel […]. The cost of this is difficult to compensate, especially when one partner has to stop working for that period. For the own work and career planning such a stay might be good but financially it can be a disaster."

Conditions might also not be that favourable at all:

"I have looked into coming to Europe but the labor market conditions in research and academia are too bad for me to do so, relative to the US market."

Naturally, scientists will have potential trade-offs in mind when considering to engage in international cooperation.

These personal and institutional motivations are inherently driving international cooperation to a certain extent, whatever the framework conditions are. However, as mentioned at the beginning of this overview of participants' responses, motivations can (to a higher or lower degree) be transformed into action by the availability of tools driving international S&T cooperation between Southeast Asia and Europe. As to policy-makers' scope of action, personal and institutional motivations can and should be addressed, but can hardly be changed. Policy-making can make sure, however, that the tools for transforming motivation into action are suitably available.

Specifically with regard to the tools that might drive international S&T cooperation, we wanted to make sure that we did not only gather individuals' opinions, which would be worthwhile but not representative. This is why we fed back the qualitative material from this open email consultation to the entire target respondent group of approximately 10,500 scientists with Southeast Asia-Europe co-publishing experience in form of a two-stage Delphi survey.

6.5 Global assessment of important driving factors – Delphi survey results

In order to let the entire target group evaluate the individual assessments of driving forces of international S&T cooperation between Southeast Asia and Europe, the set of "drivers" (tools and personal motivations) was presented to the group of 10,500 scientists in the form of the following 39 statements:

Motivations – general

- From an academic viewpoint, the possibility of interacting with people coming from a culture so different, yet sharing the same scientific interest and working in similar topics is stimulating.
- If we do not act immediately, we will be soon lagging behind. Strong and early partnerships might help Europe keep up with the tumultuous growth of the S&T potential of the SEA countries.
- Driving factors for cooperation are mainly to share our knowledge with a developing country
- In order to engage in S&T cooperation, a love for Southeast Asia/Europe and its people and cultures is necessary.

Motivations – scientific

- The motive for cooperation is a shared interest and expected mutual benefits among all partners.
- The motive for cooperation is the global scholarly reputation of the institutions within which cooperative activities are housed.
- The motive for cooperation is to get access to high-tech labs.
- I cooperate because I think my partners can benefit from my institutions' excellence.
- Working together promotes not only scientific results, but friendship that is likely to lead to further joint studies.

Information

- Scientists in each region must be familiar with the other region's scientific institutions, science policies, and scientists.
- A permanent bridging institution should be established to accelerate knowledge exchange between the two regions (e.g. by helping with partner search, mastering administrative burdens, helping with proposal writing,…).
- Networking events should be available (separate from or in addition to thematic academic conferences) where scientists from both regions can meet, discuss and build networks.

Policy framework

- It is breaking through the political barriers that is most important.
- Thematic priorities for cooperation should be clearly pre-defined by policy-makers and funding assigned accordingly.
- Research grants should be awarded independent of governments' thematic priorities.
- The EU should reach out to facilitate the inclusion of Southeast Asian scientists in FP7.
- Joint programs should be set up, where each party can leverage funding from their own country to address an issue of direct concern to both.

- Thematic priorites and joint programs should be established with a long-term perspective.

Programme setup

- At the end of each project cycle, separate funding should be allocated for publications and dissemination work.
- It would be good if EU encouraged the Southeast Asian countries to be the coordinators, and not just members of FP7-consortia.
- Industry and leading companies should be involved across various disciplines to work with and sponsor academic institutions in both EU and SEA.
- S&T activities should be supported by training the persons involved in "soft skills", mediating cultural differences (on top of the usual funding schemes).
- The countries should encourage their scientists working abroad to collaborate with scientists at home.
- The financial and auditing aspects of the EU grants are extremely confusing.
- Some incentives could be offered to scientists who work for the scientific community (e.g. offer support to conferences organised by scientists who review papers for international peer reviewed scientific journals).
- In cooperation, people should be of comparable rank within their organisations.
- Most of the SEA Countries are 'developing' ones with few (if any!) facilities to do scientific research. Therefore, in this kind of cooperation human resources are the key factor.
- One of the keys of success is technology transfer to our hosts.

Programme components

- It would be beneficial to start some of the interactions at a lower level by providing internship opportunities to undergraduate students to foster a better exchange.
- Personal contacts of the supervisors are essential before PhD student exchange, to ensure the good quality of students.
- Support long-term exchange of doctoral students/pre-doctoral students and short-term visits of post-doc or working scientists.
- It should be considered to fund PhD students first for a period of 6 months; in case that they are excellent a prolongation to 3 years as recommended by the professor could be envisaged.
- The main driver is PhD scholarships awarded to graduates already employed for several years in scientific institutions, not to people who have just completed a degree.
- Training grants should be provided to young investigators – going in both directions, while travel grants should be offered to other investigators.
- Support should be given to post-docs to re-visit foreign host institutions to keep contacts alive.
- PhDs returning to developing countries should be given funds to set up their own lab in order to be able to continue their work.
- Cooperation can be very successful if you place motivated and highly trained foreign scientists in a country's laboratories for long term stays.
- I would advise to offer professors still active in research sabbatical-like periods and subsidies in exchange for this additional work as they are already overwhelmed with all kinds of duties so that very few can accept.
- Retired scientists should get a better funding to go to developing countries for mentoring their former students.

In the first round of the Delphi survey, around 1,050 scientists have estimated the relevancies of each of these statements (scale: strongly agree – agree – disagree – strongly disagree; not applicable) and around half of them have accepted the offer of having a second look at the overall relevance ratings in view of possible modifications and justifications of individual positions.

The answers of the first round have shown that it makes sense to discriminate "Europe", "Southeast Asia excl. Singapore" and "Singapore". Answers in the first round within each of these regions were more similar than answers between the region itself and the two other groupings.

6.5.1 Overall assessment

Regarding the following group of driving factors, there has been extremely high agreement[102] in all three regions:

- "From an academic viewpoint, the possibility of interacting with people coming from a culture so different, yet sharing the same scientific interest and working in similar topics is stimulating".
- "The motive for cooperation is a shared interest and expected mutual benefits among all partners".

102 The percentages of „strongly agree" and „agree" answers in the three regions in sum could theoretically reach 300 percentage points. "Extremely high agreement" refers to more than 290 percentage points.

- "Working together promotes not only scientific results, but friendship that is likely to lead to further joint studies".
- "Support long-term exchange of doctoral students/pre-doctoral students and short-term visits of post-doc or working scientists".

We see here that the whole group of scientists with co-publishing experience agrees on a series of "soft" factors that are key to cooperation as well as on a specific instrument of cooperation: the centrality of (short and long-term) exchange of senior scientists and PhD (or even undergrad) students.

Very high agreement[103] has been provoked by the following statements:

- "Joint programs […], where each party can leverage funding from their own country to address an issue of direct concern to both".
- "Thematic priorities and joint programs should be established with a long-term perspective".
- "The countries should encourage their scientists working abroad to collaborate with scientists at home".
- "Personal contacts of the supervisors are essential before PhD student exchange, to ensure the good quality of students".
- "Support should be given to post-docs to re-visit foreign host institutions to keep contacts alive".

Here, the scientists refer to the importance of joint programmes (based upon national funds, but with dedicated cooperation support), a long-term perspective and the inclusion of the diaspora communities. Moreover, it is indicated that personal senior scientist exchange can assist the task of ensuring exchange of suitable PhD candidates. Interestingly as well, the whole group agrees that it would contribute to ongoing cooperation to help scientists that have spent some time abroad to keep their contacts alive.

Most of the other drivers have raised moderate agreement levels. The statements with which scientists of all regions mostly disagreed were:

- "In cooperation, people should be of comparable rank within their organisations".
- "The main driver is PhD scholarships awarded to graduates already employed for several years in scientific institutions, not to people who have just completed a degree".

However, for our analysis we believe that a look at the regional and hierarchical differences in the answers proves more interesting than going into more detail at the level of overall averages.

6.5.2 Regional differences

When looking at the answers from scientists speaking from a Southeast Asian point of view and comparing them with those answers made from a European perspective, some interesting and some less surprising differences catch one's eye.

According to a t-test comparison of the sample means from the first round[104], Southeast Asian scientists showed significantly[105] higher agreement rates to the statement that "a love" for the respective other region and its cultures and people is necessary. The situation is similar with the statement that "driving factors for cooperation are mainly to share our knowledge with a developing country". This means that more scientists considering themselves as talking from a Southeast Asian perspective (which does not mean that they are currently based in Southeast Asia!) are motivated by the goal of supporting developing countries than people with a European perspective.

Agreement rates for the following statements are also significantly higher in Southeast Asia than in Europe (but European scientists still agreed to these statements):

- The motive for cooperation is the global scholarly reputation of the institutions within which cooperative activities are housed.
- The motive for cooperation is to get access to high-tech labs.

Both issues are yet more relevant for Southeast Asian scientists than for Europeans.

- I cooperate because I think my partners can benefit from my institutions' excellence.

It is noteworthy that compared to answers from a European perspective, a larger number of scientists from Southeast Asia consider their institutions' excellence as motivating their partners to cooperate with them.

- A permanent bridging institution should be established to accelerate knowledge exchange between the two regions (e.g. by helping with partner search, mastering administrative burdens, helping with proposal writing,…).

While scientists in both regional groups agree that such a bridging institution would be useful, Southeast Asian scientists consider it even more relevant.

- Networking events should be available (separate from or in addition to thematic academic conferences) where scientists from both regions can meet, discuss and build networks.
- The EU should reach out to facilitate the inclusion of Southeast Asian scientists in FP7.
- It would be good if EU encouraged the Southeast Asian countries to be the coordinators, and not just members of FP7-consortia.

While agreement levels with regard to the inclusion of Southeast Asian scientists in FP7 are very high in both regions, less Europeans (62 % compared to 87 % Southeast Asians) tended to agree that Southeast Asian part-

103 > 275 percentage points

104 We have chosen the first round, here, for two reasons: First, the geographic grouping in the second round was based on this analysis of the first round. Secondly, the sample sizes are bigger in the first round, results thus more reliable.

105 „Significantly" refers to an α-level of 0.01.

ners should be encouraged to coordinate FP7 proposals.

- Thematic priorities and joint programs should be established with a long-term perspective.

Practically all (>95 %) Southeast Asian respondents agreed that this is an important issue. In the case of the Europeans, agreement was lower, but still considerably high (87 %).

- At the end of each project cycle, separate funding should be allocated for publications and dissemination work.
- Industry and leading companies should be involved across various disciplines to work with and sponsor academic institutions in both EU and SEA.

Scientists from Southeast Asia agree at a significantly higher degree to the involvement of industry. Between 90 and 100 % of the responding scientists in Southeast Asia agreed to this statement, whereas in Europe "only" 75 % did so.

- One of the keys of success is technology transfer to our hosts.
- S&T activities should be supported by training the persons involved in "soft skills", mediating cultural differences (on top of the usual funding schemes).
- Some incentives could be offered to scientists who work for the scientific community (e.g. offer support to conferences organised by scientists who review papers for international peer reviewed scientific journals).
- Most of the SEA Countries are 'developing' ones with few (if any!) facilities to do scientific research. Therefore, in this kind of cooperation human resources are the key factor
- Training grants should be provided to young investigators – going in both directions, while travel grants should be offered to other investigators
- I would advise to offer professors still active in research sabbatical-like periods and subsidies in exchange for this additional work as they are already overwhelmed with all kinds of duties so that very few can accept.
- PhDs returning to developing countries should be given funds to set up their own lab in order to be able to continue their work

Regarding the funds for returning PhDs, 75 % of European respondents agreed, while in the case of Southeast Asian respondents, the overall average agreement rate was more than 90 %.

European scientists did not agree to these statements that have nevertheless been agreed upon among Southeast Asian scientists:

- It is breaking through the political barriers that is most important[106]
- Thematic priorities for cooperation should be clearly pre-defined by policy-makers and funding assigned accordingly.

Interestingly, the only driver where Southeast Asian scientists agree to a significantly smaller degree (they still agree, however) is reflected in the statement that "the financial and auditing aspects of the EU grants are extremely confusing". It might be that there is a bias because Southeast Asian respondents wanted to be polite in front of us (and we are and have been perceived as a European project). Otherwise, Southeast Asian scientists could simply be happier with FP7 also in terms of accounting and auditing or they are not so familiar with FP7 yet, as to have a critical opinion. In-depth qualitative analysis would be needed to present a definite answer, here.

6.5.3 Developed countries – developing countries?

As we hear, interestingly, respondents answering from a Southeast Asian perspective are more concerned about supporting developing countries than their European counterparts. What are the differences, now, within the extremely diverse ASEAN region, and between this group of countries that could be considered (more or less) consisting of developing countries and Europe or countries like Singapore?

As said, Southeast Asia is not only culturally, but also in terms of economic development a highly diverse region. Each clear differentiation of ASEAN countries into developed and developing ones is impossible.

What can be said, however, and what also has been shown by the comparison of answers from the first round (concretely, between which groupings differences has been biggest compared to the inner differences of each of the groups), is that Singapore is a separate case. We will, thus, now give some comparison between Europe, Singapore and the group of ASEAN countries excluding Singapore.

In almost all cases, comparing Southeast Asia excluding Singapore with Europe results in similar, but stronger differences than the ones mentioned under b. between Southeast Asia including Singapore and Europe. The only thing we want to explicitly mention, in view of this comparison, is that awareness regarding the following statement is higher among Southeast Asian (excl. Singapore) scientists than among European scientists: "[i]f we do not act immediately, we will be soon lagging behind. Strong and early partnerships might help Europe keep up with the tumultuous growth of the S&T potential of the SEA countries". Nevertheless, also around 85 % of European scientists would agree to that statement.

When comparing agreement rates in Singapore with Southeast Asia excl. Singapore, differences appear again regarding almost the same set of drivers as mentioned above in b. when comparing Europe and Southeast Asia in general – with Singapore replacing Europe, here. Concretely, agreement on the following driving forces for future S&T cooperation has been significantly higher in Southeast Asia excl. Singapore than in Singapore (however, most Singaporeans still agree):

- Driving factors for cooperation are mainly to share our knowledge with a developing country.

While only 58 % of respondents answering from a Singaporean perspective agree to this statement, 84 % from the other Southeast Asian countries do so.

- In order to engage in S&T cooperation, a love for Southeast Asia/Europe and its people and cultures is necessary.
- The motive for cooperation is to get access to high-tech labs.
- Working together promotes not only scientific results, but friendship that is likely to lead to further joint studies.
- It is breaking through the political barriers that is most important.

Singapore does not seem to suffer from any political barriers impeding cooperation: a majority of Singaporean respondents disagrees with the statement or considers it not applicable to their situation. In the other Southeast Asian countries, 70 % of the respondents agree with the statement.

- At the end of each project cycle, separate funding should be allocated for publications and dissemination work.
- S&T activities should be supported by training the persons involved in "soft skills", mediating cultural differences (on top of the usual funding schemes).
- In cooperation, people should be of comparable rank within their organisations.

Engaging people of comparable hierarchical rank is even less important in Singapore than in the other Southeast Asian countries. The majority (56 %) of people answering from a Singapore perspective disagree that this is of any relevance.

- Most of the SEA Countries are 'developing' ones with few (if any!) facilities to do scientific research. Therefore, in this kind of cooperation human resources are the key factor.

Interestingly, around 40 % of Singaporeans disagree with that statement and 15 % consider it not applicable to their situation. Regarding the other Southeast Asian countries, 88 % of the respondents agree to this statement.

- One of the keys of success is technology transfer to our hosts.

Agreement rates in Singapore are 15 % less than in the other Southeast Asian countries (70 % agreement vs 85 % agreement).

- Support should be given to post-docs to re-visit foreign host institutions to keep contacts alive.
- PhDs returning to developing countries should be given funds to set up their own lab in order to be able to continue their work.

Regarding one driver, agreement in Singapore has been similar to agreement in Southeast Asia excl. Singapore, but with much higher abstention in the case of respondents answering for Singapore: "The financial and auditing aspects of the EU grants are extremely confusing". However, 50 % of Singaporean respondents do not consider this question applicable, according to repeated qualitative comments because Singapore is not allowed to receive FP7 funds[107].

The following table summarises the above discussion:

Table 13: Regional specificities in driver relevance assessments

Agreement / region	Southeast Asia (excl. Singapore)	Singapore	Europe
Strong agreement in all regions regarding the following drivers	– Interaction is stimulating – Shared interest and mutual benefits as motive – Friendship – Long-term exchange for PhDs, short-term for seniors – Joint programs based on national funds – Long-term perspective – Personal contacts of supervisors – Support to post-docs for revisiting		
	Southeast Asia (excl. Singapore)		**Europe**
Higher agreement rates in: … regarding the following drivers in	– Reputation – Access to high-tech labs – Partners benefit from my institution's excellence – Bridging institution – Networking events – FP7 outreach – SEA coordinators in FP – Separate funding for dissemination – Involve industries – Technology transfer – Soft skills training – Incentives for working for the scientific community – SEA countries are developing countries – human resources important – Training grants – Sabbaticals – Funds for returning PhDs to set up labs – Breaking through political barriers – Policy-makers could pre-define thematic priorities – Act, otherwise Europe will lag behind		– Confusing FP7 financial auditing aspects

T-tests comparing samples based on different sets of Southeast Asian countries (e.g. ASENA excl. Singapore, Malaysia and Thailand) have shown that the results are very similar: The differences in agreement occur in relation to precisely the group of drivers where differences in agreement also occur when comparing Southeast Asia as a whole or without Singapore and Europe or Southeast Asia excl. Singapore and Singapore.

106 However, in the open email consultation several scientists experienced in prolonged S&T cooperation also consider this a very important driver.

107 Which is, strictly speaking, not true. It has only to be justified why the inclusion of a partner from Singapore is necessary for the success of the project.

6.6 The different views from hierarchy

In the Delphi survey, we have also asked the respondents to specify at which hierarchical/career level they currently are (PhD, Post-Doc, Senior Scientist, Emeritus or Other). The complete answers in the first Delphi round came from 50 PhDs, 96 Post-Docs, 674 senior scientists and 42 Emeriti[108]. As can be seen, the overall answers in our survey can be interpreted as reflecting the opinion of senior scientists.

In order to find out whether scientists of different career levels assess driving forces for S&T cooperation differently, we have compared the means of the most relevant subsamples. The results have been as follows:

There have been no significant differences (neither at 0.01 nor at 0.05 level) between the agreement rates of PhDs and Post-Docs. Regarding differences between the answers of senior scientists and emeriti, only one driver was agreed upon by significantly more emerit than senior scientists:

- Retired scientists should get a better funding to go to developing countries for mentoring their former students.

It seems quite understandable that retired scientists have an interest in the availability of such funds. Nevertheless, it is also a good sign that senior scientists would be interested in such schemes.

Significant differences can be recorded, thus, only between the younger and more senior cohorts of the scientific community. We have compared the answers of PhDs and Post-Docs together with those from senior scientists.

Regarding the following statements, agreement among senior scientists is significantly (at 0.01 level) higher than among their younger peers:

- From an academic viewpoint, the possibility of interacting with people coming from a culture so different, yet sharing the same scientific interest and working in similar topics is stimulating
- The financial and auditing aspects of the EU grants are extremely confusing.

In the case of the following drivers, it is the opposite case, i.e. younger scientists consider them more relevant:

- A permanent bridging institution should be established to accelerate knowledge exchange between the two regions (e.g. by helping with partner search, mastering administrative burdens, helping with proposal writing,...).

It would be an interesting question to follow up if this newer generation of scientists argues in favour of such a bridging institution also when they are already more established or whether this appraisal of such an institution is linked to their not yet fully developed academic networks.

- Networking events should be available (separate from or in addition to thematic academic conferences) where scientists from both regions can meet, discuss and build networks.

Younger scientists feel that networking events would help them in view of supporting their international cooperation activity. Their networks are still not as developed as those of their elder peers.

- It is breaking through the political barriers that is most important.

We assume that younger scientists with less visa and project acquisition, accounting and auditing practice still struggle more with political barriers.

- Thematic priorities for cooperation should be clearly pre-defined by policy-makers and funding assigned accordingly.

This might be the case because younger scientists are not yet so confident in deciding which topics could best be dealt with in an international cooperation mode.

- At the end of each project cycle, separate funding should be allocated for publications and dissemination work.
- Industry and leading companies should be involved across various disciplines to work with and sponsor academic institutions in both EU and SEA.
- S&T activities should be supported by training the persons involved in “soft skills”, mediating cultural differences (on top of the usual funding schemes).
- One of the keys of success is technology transfer to our hosts.
- It would be beneficial to start some of the interactions at a lower level by providing internship opportunities to undergraduate students to foster a better exchange.
- PhDs returning to developing countries should be given funds to set up their own lab in order to be able to continue their work.

The latter two items are not surprising given that PhDs are not far away from their undergraduate past and given that the last driver proposes direct benefits for this group.

Having in mind these and related contextualisations of the data presented here, in view of trying to shape the 2020 future of S&T cooperation between Southeast Asia and Europe, it is sensible to take into account the specific needs and thought patterns of younger generations of scientists, even as these might change with increasing seniority.

Besides the career level, we have also asked the respondents to specify whether they currently are in an administrative position or not. 438 first-round respondents answered with “yes”, 590 with “no”, which allows us, again, to look at significant differences in the agreement rates between two groups.

Agreement rates among researchers in administrative positions has been significantly (at 0.01 level) higher than among other researchers regarding the following six drivers:

- The motive for cooperation is the global scholarly reputation of the institutions within which cooperative activities are housed.
- The motive for cooperation is to get access to high-tech labs.
- I cooperate because I think my partners can benefit from my institutions’ excellence.
- Working together promotes not only scientific results, but friendship that is likely to lead to further joint studies.
- Cooperation can be very successful if you place motivated and highly trained foreign scientists in a country’s laboratories for long term stays.
- I would advise to offer professors still active in research sabbatical-like periods and subsidies in exchange for this additional work as they are already overwhelmed with all kinds of duties so that very few can accept.

Agreement rates among researchers in administrative positions have in addition been significantly (at 0,05 level) higher with regard to the following three additional drivers:

- If we do not act immediately, we will be soon lagging behind. Strong and early partnerships might help Europe keep up with the tumultuous growth of the S&T potential of the SEA countries.
- Networking events should be available (separate from or in addition to thematic academic conferences) where scientists from both regions can meet, discuss and build networks.
- Thematic priorities for cooperation should be clearly pre-defined by policy-makers and funding assigned accordingly.

For most of these bullet points the (necessary) management orientation of people active in science management and science administration positions helps to interpret the differences in agreement levels. The group of senior scientists in administrative positions is at the core of our target group for the scientist foresight – these respondents unite a scientist perspective with a more performance-oriented view on the practice of international S&T cooperation. Thus, they (together with programme owners with a scientist background) can probably best bridge science and science policy. As the resources of this SEA-EU-NET study have been limited both as regards time and finances, it was not possible to bring these two parts of the target group around one table in a physical meeting.

Rather, we have by desk research compared the results of the scientist email consultation and Delphi survey with those of the policy maker workshop. The next chapter presents some of the outcomes of this endeavour.

6.7 The views from the scientific community contrasted by views from policy-makers

In the preceding chapters, we have first presented the results of a scenario-based drivers workshop where policy-makers and programme owners from Southeast Asia and Europe have identified and discussed driving forces for the future of bi-regional S&T cooperation. Then, the results of an open email consultation and Delphi survey with a relevant part of the scientific community (namely the part that has recently engaged in joint publication activity) have been presented. In the consultation and Delphi survey, scientists have also identified a series of driving forces for the 2020 future of S&T cooperation between Southeast Asia and Europe.

We will now compare the results of both exercises in order to see where policy-makers’ and scientists’ opinions were similar, where they could complement and where they contradict each other.

Several supposed driving forces for S&T cooperation between Southeast Asia and Europe have been identified in both the policy-maker scenario workshop and the scientist consultation. However, in these cases, the scientists’ assessments tend to go into more detail as to what concrete operationalisation of the driver could actually support cooperation. This could be expected, given that in the policy-maker workshop we aimed at a broader discussion (stirred by listing five different policy areas) making use of the audience’s wider expertise, while the scientist consultation was trimmed towards dipping into the experience of those that are actually doing science cooperation.

To illustrate the difference of broadness and depth to which we here refer to: Funding and donor availability, for instance, as well as leveraging research funding, two drivers identified by the policy-makers, clearly refer to the scientists’ conviction that dedicated funds for cooperation activities have to be available (either in specific programmes or as add-ons to usual funding schemes). Policy-makers voice with another driver that the free movement of capital has to be guaranteed. They do not specify, however, whether funding of cooperation should be linked to dedicated international cooperation programmes or whether specific mobility, conference/workshop outgoing, return, sabbatical or retirement schemes should be financed. Regarding the question whether funds should be thematically focussed or bottom-up, the drivers of joint agendas for common challenges, jointly formulate calls, jointly identify key research areas and tackling global challenges suggest that a top-down priority setting combined with the instruction to cooperate is considered a viable option. As we have seen, most scientists rather think of international cooperation support of bottom-up initiatives as the most relevant driver. This driver is absent in the policy-makers’ debate.

108 We have not discriminated regional perspective and career level at the same time as sample sizes would have become too small.

Similarly, where the policy-makers rather vaguely pointed to facilitation of mobility as a relevant driver, scientists underlined the importance of the availability of exchange support schemes (with tailor-made time frames and modalities of exchange, quality criteria, etc.) or support for international conference visits and organisation. The driver of facilitated visa procedures and conditions identified by scientists can also be grouped under this heading (or under the policy-makers' driver of the favourable policy background). Policy-makers have additionally considered the free movement of people and capital a moderately important driving force.

However, policy-makers did not share the concern of scientists in view of bureaucratic obstacles impeding mobility, the exchange of empirical material (biomaterials, etc.) and field access. Instead, trade liberation and free movement of capital have been identified by them (policy-makers from both regions) as facilitating S&T cooperation. This is a driver that has not been present in the opinions of the scientists.

The driver of internationalisation of education, identified by policy-makers, can be referred to scientists' hints to the relevance of joint PhD programmes, PhD and undergraduate mobility and exchange as well as regional training networks in order to ensure the quality of education and the comparability of degrees.

The driver of schemes for joint usage of infrastructure, such as Centres of Excellence appears in the scientists' assessments at three different occasions: once where they propose support to research infrastructure; secondly, where they pose the question of regional and/or supranational research institutes and/or bridging institutions; and finally, where the topics of joint databases and computing are raised.

One of the "soft" factors identified by the scientists as relevant drivers also has been highlighted by policy-makers: mutual respect. Others like a communicative, open and non-discriminatory attitude towards the other region have not been raised by policy-makers.

Apart from these corresponding drivers (or possible connections between more general and more specific, but related drivers), a series of factors brought forward by the scientists do not at all or not prominently appear in the policy-maker workshop material: The possibilities of co-supervision of PhDs discussed above have not been considered by the policy-makers. Similarly, the involvement of scientific diasporas has not been discussed in the workshop, nor have favourable or unfavourable labour market conditions (co-determining, for instance, the possibilities of recurring to mobility schemes) been mentioned. Policy-makers from neither region insisted upon the relevance of long-term commitment as a driver for cooperation or upon the driver of connecting the research work with the local contexts. They did not come forward with an estimate whether personal or institutional contacts are more relevant.

Policy-makers seemed more reluctant to assign regional and supranational research and bridging bodies a role in stepping up international cooperation. At the same time, the integration of Southeast Asia has not been considered a driver for S&T cooperation by parts of the policy-makers, but not by the responding scientists. Scientists seem to think either in local/national or global networks. Correspondingly, the proposed bridging institution and research centres, in their view, are not explicitly linked to a regional ASEAN level. Rather, respondents seemed to suppose that these bodies will either be international or bi- or multilateral with involvement of Europe.

Similarly, the platforms providing access to data and literature, considered relevant among scientists, are not envisaged as region-specific, but global.

We have said above that the scientists' driver estimates go into depth in the area of scientific practice and that the policy-makers' proposals of drivers cover a broader range of areas. Among the drivers that have not been mentioned by scientists are, in addition to SEA integration, the trade barrier abolition and supply chain integration that policy-makers considered relevant for facilitating cooperation and linking S&T to innovation. Economic and trade factors are not considered by the scientists. A firm's or a country's competitiveness is not driving S&T cooperation, according to them. For scientists, the inclusion of industry and SMEs is rather relevant as a driver in that it can harness scientific results, link it back to a field of application and not let the impact stop at citation indexes in international journals. Moreover, scientists did not consider topics like human rights and the fight against human trafficking as a relevant driver for the future of S&T cooperation.

Regarding the question of personal and institutional motivation: So far, we have compared the sort of drivers of S&T cooperation that present themselves as supportive tools rather than motivations. In terms of personal and institutional motivations also being possible drivers of international S&T cooperation, policy-makers' assessments are again less detailed than scientists' accounts and reflect the formers' national economic perspective. Achieving science excellence might be translated into the scientists' personal motivation of doing good research in the preferred subject area. However, maintaining a competitive edge in global innovation is of no general concern to scientists. Some of them have pinpointed at industry and SME involvement as "cementing" cooperation and proving its success, but the scientists' approach is on a case-by-case basis related to scientific content (e.g. determining whether or not some sort of new knowledge in a specific field is to be commercialised and how), not to a country's overall innovation performance. Policy-makers should bear in mind that those actually conducting S&T cooperation might not share this preoccupation for an economy's innovation performance. Competitiveness and innovation performance might thus be an indirect or second-level driver: namely a motivation of those trying to motivate scientists to cooperate. It can be deduced that in case the policy-makers want scientists to engage more intensely in innovation practices, some specific funding programmes would probably be necessary. However, we might also have a small bias towards public research oriented scientists, as scientists related to or engaged with industry might not appear in databases of scientific publications.

Tackling global challenges, pro-poor approach or supporting less developed countries, by comparison, can be motivational drivers for both scientists themselves as well as science managers and policy-makers. Moreover, it is a motivation that can become a tool-like driver of S&T cooperation given that jointly working towards the solution of global challenges (e.g. in the framework of dedicated calls) or towards a country's future can establish long-term cooperation partnerships reaching out to other subject areas and partners.

In concluding this chapter, we can summarise that a series of drivers identified by the policy-makers can reasonably be further specified with the data from the scientist consultation and Delphi. Both sets of drivers can be combined and, thus, result in a broader and, regarding the proper science cooperation activity (as done by scientists), more in-depth account of relevant variables or drivers influencing the future S&T cooperation between Southeast Asia and Europe.

6.8 Conclusions and recommendations

The preceding pages have shown that the SEA-EU-NET Foresight exercise has created extensive strategic intelligence on the question which variables influence the future of S&T cooperation between Southeast Asia and Europe according to key stakeholder groups. We believe that the findings can best be summarised in the form of policy recommendations resulting from the different components of the analyses. These are not to be understood as recommendations developed by and extensively discussed within the SEA-EU-NET consortium, but rather are summarised results of the foresight consultation phases presented above. These results and insights come from the policy-makers and scientists involved. Our role has been to structure them and pass them on, which we do in this chapter, after some general recommendations coming from the authors and foresight process designers rather than directly from the respondents.

In this understanding, the following general, but also drivers and instruments-related recommendations are addressed to policy-makers wishing to adopt possible action lines towards a 2020 success scenario whose possible core structure is outlined in the next chapter as a future-oriented planning tool.

We would like to advert, once more, that the recommendations refer to and address region-to-region cooperation. They do not take into account specifics of a country-region or country-country perspective. Due to the nature of this document, the recommendations are trimmed towards possible application by EU regional policy-makers. It is obvious that close cooperation with European and ASEAN policy-makers is necessary in order to achieve a successful bi-regional cooperation scenario.

General/process recommendations

- This study should be taken as a stepping stone within the process of policy development. With the current study, an in-depth assessment of drivers of international S&T cooperation is presented. In order to harness the material's potential, this document should be discussed in the context of S&T cooperation planning exercises, further scientists consultations, etc.
- Keep engaging scientists in the dialogue on and planning of S&T cooperation. We have seen in this exercise how rich the scientists' cooperation experience is and how insightful scientists' attempts to dissect their own motivations behind cooperation can be.
- It would be useful for any attempt aiming at increasing S&T cooperation to know when the windows of opportunity in the planning horizons of the cooperating regions' policy-making lie. For instance, if university laws contain regulations on the formalities behind university's international institutional partnerships or when a third country is interested in project twinning, joint programming, etc., then it would be good to have a clear picture when a discussion would have to touch ground in order to be on time.
- Strive for policy coherence, especially between S&T and innovation policy (harnessing the results of joint research), trade (free exchange of goods, but specifically of samples, biomaterials, etc.), visa policy (easy-to-obtain long-term visas for collaborating scientists), development policy (possibility of using ODA money for the support for basic research infrastructure, global challenge related research and human resource development)

Drivers and support instruments for SEA-Europe S&T cooperation

In order to concretely step up S&T cooperation levels between Southeast Asia and Europe, providing resources for some or all of the subsequent instruments is recommended by a majority of the group of scientists we have approached and/or by the group of policy-makers and programme owners that have joined the process:

- Efforts towards S&T cooperation should be sustained over a longer-term basis. Cooperative research needs time to grow (the scientists estimated between 3 and 5 years) until it can bring quantifiable results. S&T cooperation support must, thus, be stable (in order to be trusted and to "survive" financial crises) and flexible (in order to react to new subject areas or forms of cooperation) at the same time.

- In terms of thematic areas of joint research, define a suitable balance between flexible funding of international cooperation components of bottom-up defined research and dedicated calls and programmes for international cooperation in areas of joint interest. It would have to be discussed in a separate occasion with the scientists to what extent the openness of the entire FP7 to third country participation meets the need for bottom-up priority setting.
- Define a suitable balance between basic blue-sky research and applied research, possibly even with industry participation. The outstanding prominence assigned by the policy-making stakeholders to the goal of maintaining a competitive edge in global innovation as a driver for bi-regional S&T cooperation (in view of Science and Rearch Policy, Industry, Trade and Economic Policy) might advise to thematically focus S&T cooperation efforts, at least in a short-term perspective, to innovation-relevant applied and basic research. However, the scientific community gave ambiguous answers: Some would like to see the early and tight cooperation with industry and SMEs, that possibly makes cooperation sustainable, others prefer research collaboration in the form of blue-sky projects.
- Regarding dedicated international cooperation calls and joint calls, make sure that the priority-setting is organised as an open non-discriminatory process with scientist involvement. Joint calls and joint programming have been highlighted as relevant drivers especially by policy-makers. They could be dedicated to address global challenges in order to suitably complement rather than counteract thematically open bottom-up support for cooperation. Throughout the scenario workshop, European experts have pressed much more for common and harmonised planning, monitoring, evaluation and impact assessment standards. If the EU wishes to get more active in standard setting in Southeast Asia, much lobbying and awareness raising would be needed, particularly of the latent and sometimes apparent perception that e.g. the Framework Programme is "complicated". The opposite option would be to develop standards that are more flexible for cooperation with "third regions". The development of joint calls could help a good deal in this dilemma, as it brings programme owners from both sides together with the concrete goal of setting up and committing to common standards. The idea of joint calls would also have to take into account the following to sets of recommendations.
- Consider mobility and exchange of personnel a positive value, not only looking at it as increasing brain drain. Interestingly, SEA experts were not so much concerned for brain drain/gain and brain circulation as drivers. Both were considered important, but less so than by European experts. In the scientists' answers, neither brain drain nor brain gain have appeared as relevant concepts. For scientists, mobility and exchange are the relevant concept, instead.
- Adopt measures to enhance mobility in both-directions (and circularly) promises to contribute to scientific excellence. Apparently, it is not self-evident that scientist-driven mobility is symmetrical. It is harder to find a European scientist going to Southeast Asia than vice-versa – support European scientists going abroad.
- Make use of existing human and network resources. The scientists engaged in the foresight process came forward with a set of specific ideas on how to capitalise on existing structures and human resources for increasing S&T cooperation. For instance, it was mentioned that long-established regular scientific conferences could be supported in their possible attempts of holding sessions or entire conferences in third countries. In terms of human resources, offering part-time positions to retired excellent scientists to spend time in a cooperation partner's country can prove rewarding for them, personally, as well as for cooperation levels. Their networks can be kept alive and passed on. They can support their home institutions while abroad, etc. In the case of senior scientists who are still active, sabbatical themes with related exchange to partner countries might yield similar services to cooperation levels.
- When it comes to exchange and mobility of junior scientists, support PhD exchange, joint PhD programmes and co-supervision of PhDs. Particularly co-supervision can increase cooperation levels on a sustainable basis as the candidate produces cooperative output and, what is more, as he or she personally links two senior scientists over a considerable period of time.
- Ensure that junior and senior scientists spending time abroad find an easy way to return and reintegrate to their personal and professional surrounding in their countries of origin. Offering seed money for some lab equipment in order to keep working in a similar environment on the subject of interest has been considered an option, here, as has been the idea of including Post-Doc travel money in PhD grants to allow the PhDs to return to their partner institutes from time to time.
- Engage diasporas: Diaspora communities of Southeast Asian scientists and non-scientists exist in Europe in different sizes at different locations. These communities' scientists often speak both regions' languages, equally often have studied in both regions and know both scientific cultures. These contacts can be highly valuable for establishing and maintaining contact with S&T cooperation target countries. Groups of Southeast Asian Post-Docs and senior scientists having completed their PhDs in Europe should also be understood and approached as diaspora communities, in this context. Possible forms of inclusion could be: support the establishment of scientist diaspora organisations; invite representatives to key events; support visits of delegations, etc.
- In order to motivate scientists not currently engaged in (or willing to engage) in mobility schemes to cooperate, reward successful cooperation. Scientists will not think about cooperation unless thematically absolutely necessary (or interested in cooperation for personal reasons) if they are not able to get any reward for their careers out of it.
- The following recommendation is still related to the aspects of selecting cooperation candidates and rewarding cooperation, while not only human resource related: Keep developing quality metrics assessing cooperative research. The long-term perspective, the type of previous contact, the level of the researchers involved, the country context, etc. should be taken into account when selecting candidates or projects for cooperation support or when evaluating cooperation activities. Scientists insisted that it is key to make sure by appropriate metrics that actual research is supported.
- Regional training networks can help to ensure that (measurable) standards are met and that comparability is given.
- Such regional training networks are one example of what was also recommended to be supported: joint research infrastructures. In this context, for instance, labs participating in joint or cloud computing, offering ICT infrastructure to other labs could be supported. Also the more traditional approach of actual joint supranational bi-regional or regional research centres has been mentioned. The role and importance of regional S&T institutes with a mandate of bringing together researchers from different geographic backgrounds, has been highlighted in several of the scientists' email responses to our consultation request. The existence of regional centres of excellence and other regional S&T institutions in Southeast Asia was also considered important for S&T cooperation between the regions by European experts, but not that much by Southeast Asian participants. This is interesting, as it suggests that SEA experts at policy-maker and scientist level do not consider formalised/institutionalised inner-regional cooperation as a precondition for inter-regional cooperation. Nevertheless, support for research infrastructures and schemes for inter-regional joint usage of these infrastructures were highlighted as very important drivers by both sides. From a European Union point of view, we can thus deduce the recommendation to consider inter-regional institutions rather than press for inner-regional S&T institution-building and afterwards connect inner-European with inner-Southeast Asian regional institutions. Establishing awards for bi-regional S&T cooperation could be a first step towards bi-regional research centres.
- Some scientists recommending the support for joint infrastructures referred to joint bridging institutions rather then actual research centres. These bridging institutions could offer management support for international S&T cooperation projects, give administrative advice to scientists willing to cooperate or offer partner search tools.
- Finally, particularly the scientists consulted virtually by us, recommended to work towards the abolishment of administrative burdens (in view of visa issues, material exchange and field access) and, in parallel, to work towards open source access to literature and sample databases. Open source access has not only been considered relevant for the act of doing research, but also for the dissemination and usability of results: The related recommendation is to make results of joint research available in the regions, not only in international journals.

In this chapter, we have compiled variables and driving factors (expressed in the form of recommendations and recommended possible instruments) that policy-makers and members of the scientific community consider as possibly increasing the intensity of S&T cooperation between Southeast Asia and Europe in the future. Now, we will approach the set of variables and driving factors identified by stakeholders slightly differently, namely in view of a 2020 success scenario for bi-regional S&T cooperation.

6.9 The core logic of a success scenario

As presented above in chapter 6.2 on methodology, a basic success scenario[109] served as an initiating and inspiring input for our policy-maker workshop and as an underlying future scenario for the scientist consultation and Delphi survey. We will now revisit this success scenario and extend it by applying the foresight exercise's results to its inherent structure. Methodologically

109 In the year 2020 the cooperation in S&T between the EU and ASEAN had reached a level of importance that some years before was hardly to be expected. Major development was the rise of ASEAN as a regional power, as the countries in the region decided to put importance to and budget into this umbrella organisation. In this way, ASEAN could initiate symmetric cooperation partnerships with the other major global players, the EU, the USA, and major S&T powers Consisting also of countries that differ quite a lot in their economic development, the European Union was considered an important cooperation partner, and with dedicated programmes including joint programming and funding from both sides, the cooperation in the area of S&T grew ever more intense.

6 DRIVING FACTORS

following the considerations of Ian Miles[110] and Bonnett/Olson[111], by taking into account and combining the most important variables and drivers identified, we will be able to sketch what the core scenario logic could be, i.e. the main axes to act upon and interdependencies to consider, of a possible 2020 success scenario of S&T cooperation between Southeast Asia and Europe.

We do not aim at fleshing out the success scenario in any more detail as this would impose a reductionist approach using desk research instead of a scenario elaboration with the stakeholders in the process, as usual. Hence, instead of extensively describing a possible success scenario, we will combine those variables that, on the basis of the results generated so far, seem to be particularly relevant for the 2020 future of S&T cooperation between the two regions. Some of these variables are linked by synchronous interdependencies or a certain value of one (e.g. number of cooperation projects) is needed before another value of a second variable can be reached (e.g. high trust among the scientific communities). The variables, their interdependencies and related pathways are all relevant when trying to act upon the variables in order to reach a certain success scenario.

The following outline of the scenario logic is not to be considered final. It is one among a series of ways of approaching the interdependencies and pathways involved in a possible 2020 success scenario of S&T cooperation between Southeast Asia and Europe. The visualisations should inspire and help to structure the thinking about the future, not present ready-made and definite models.

First of all, the amount of funding explicitly available in both regions for S&T cooperation between the regions can be assumed as a highly relevant variable. A related variable is the amount of funding involved in actual cooperation (that might also stem from activities not dedicated to cooperation (e.g. usual FP7 projects), but still implemented in a cooperative manner).

A second highly relevant variable is the level of availability of funds: is a bi-lateral, country-region or bi-regional cooperation setting favoured in terms of available funds.

A first relevant interdependency appears, here: Funds and level of availability are related insofar as the bi-regional level can be relevant and substantially funded even when the bi-lateral funding is high given that the overall funding is sufficient (which, in turn, is strongly related with external variables like the worldwide economic situation).

Both variables are strongly linked to a third one: cooperation intensity. The availability of funds does not automatically lead to interest in cooperation, but will still be strongly related. The availability of FP7-type bi-regional support will increase the amount of bi-regional S&T cooperation.

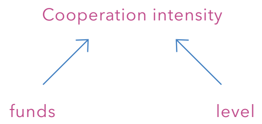

Figure 68: Success scenario logics: cooperation intensity – funds – level

Particularly the scientist participants in the foresight process emphasised that personal contacts (leading to joint understanding, development of joint interests, friendship, etc.) are a crucial driving factor for S&T cooperation. This factor is related to the ones already presented in an asynchronous way: Higher cooperation intensity leads to the establishment of a higher amount of personal contacts, deepened over time. This higher amount of personal contacts, in turn, is likely to further increase cooperation intensity (given the availability of funds).

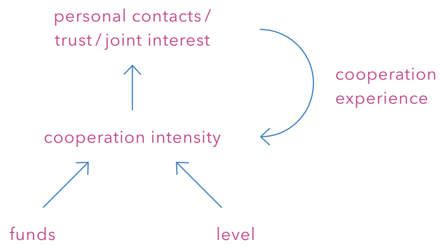

Figure 69: Success scenario logics: cooperation experience

Moving beyond this very basic first component of the core success scenario logic, we would like to remember that particularly policy-makers in the foresight workshop at the beginning of this exercise have underlined that policy coherence is a relevant driving factor of S&T cooperation. Not only science and higher education policy have to be aligned towards reaching the goal of increasing S&T cooperation between Southeast Asia and Europe, but aspects of trade, economic, foreign or development policy are equally concerned. Relating this to the variable of available funding, given a specific limited amount of financial resources for Southeast Asia–Europe S&T cooperation, policy coherence is relevant to allow for a functional distribution of funds. This, in turn, leads to a third driving factor identified as highly relevant for S&T cooperation: the goal of tackling global challenges. Here, the link between S&T and development policy and the available funds becomes clear. Acting upon on of the following three variables will affect the other two.

Figure 70: Success scenario logics: policy coherence – global challenges – funds

110 Miles (2005), op. cit.
111 Bonnett, Thomas W. / Olson, Robert L. (1998): How Scenarios Enrich Public Policy Decisions, in: Fahey, Liam / Randall, Robert M. (Eds.): Learning from the Future. Competitive Foresight Scenarios, New York: John Wiley

Considering this set of drivers, there is a related series of interdependencies with the variables of the favourability of the overall political environment (of Southeast Asia–Europe relations, the global situation, etc.) and the role of avoiding administrative burdens of different type (personal mobility, material exchange, etc.). In order to achieve policy coherence and keep the administrative burdens for bi-regional S&T cooperation low, the political climate has to be good.

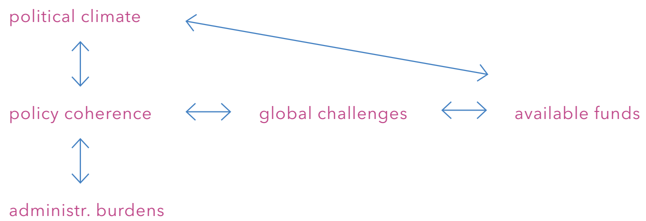

Figure 71: Success scenario logics: policy coherence – global challenges – funds extended

In order for the political climate to be good, despite favourable environmental conditions, discussion fora (for joint S&T agendas, etc.) are needed. The two variables are thus linked in our scenario logics. Having the possibility that policy-makers regularly meet at joint fora also allows to develop joint planning horizons, better tackle global challenges and give top-down incentives for related cooperative S&T (obviously, not all global challenge related research is motivated top-down).

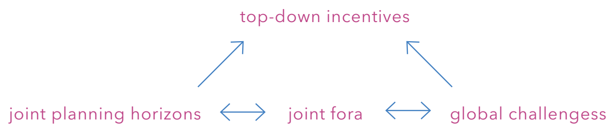

Figure 72: Success scenario logics: top-down – joint planning – joint fora – global challenges

By involving the variable of available funding and limited resources, we see that there might be a trade-off between funds available for top-down inspired and bottom-up inspired global challenge related (or other) research. The variable of the balance between top-down support with given thematic priorities and thematically open support for bottom-up initiatives might best be separated into two variables, here.

It is similar with the variable of the balance between resources for applied and for basic cooperative research.

Joint fora involving or dedicated to scientists link the variable of the importance of personal contacts with the most important personal motivations of scientists for embarking upon S&T cooperation: working together on research problems considered relevant and interesting by both parties, doing state-of-the-art science; reputation; the feeling of being able to contribute. Cooperation intensity would, in this case, be increased via bottom-up initiatives in the case of unstructured scientist fora (e.g. scientific conferences, random meetings) and via top-down initiatives in case scientists are invited to an event for the explicit purpose of discussing cooperation on specific topics. In view of the funds and possible support, it is a strategic decision to take with what balance open scientist fora like the usual scientific conferences (maybe to be realised in new places) or dedicated subject-oriented matchmaking events are supported.

The important driver of the availability of mobility schemes is, according to our scientist respondents, intrinsically linked with the cooperation intensity. The form of this link might be different depending on whether resources are concentrated on long-term (e.g. PhD) or short-term (e.g. senior scientists) exchange. Long-term exchange has to rely on a stable political climate.

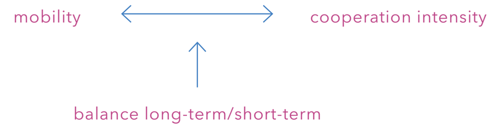

Figure 73: Success scenario logics: mobility – cooperation intensity – long-term/short-term

A better equilibrium between Southeast Asia-to-Europe and Europe-to-Southeast Asia mobility was mentioned by the scientist stakeholders as a relevant driving factor for future S&T cooperation. More precisely, scientists referred to the fact that while a considerable number of Southeast Asian scientists do their PhD in Europe, take part in mobility schemes, etc., a lower number of Europeans is involved in long- and short-term exchange and mobility with Southeast Asia. In order to act upon this driver, some incentive structures (money, prestige) might be needed. A more equilibrated scientist exchange pattern between the regions is said to increase cooperation intensity (as expressed in joint publications, technological development, etc.). There is also a relation with the driver of quality assurance and metrics and with the factor of brain drain/brain gain (not mentioned by the scientists, but by the policy-makers).

The aspect of brain drain or brain gain points to another interdependence of the core variables already introduced: If policy-makers and/or scientists determine that scientists' mobility proves to have either positive or negative outcomes on the long run, administrative burdens might be adjusted, which, in turn, would lead to more or less cooperation. Minor-level variables like the idea of the availability of reintegration schemes and some funds for returning PhDs would also be affected.

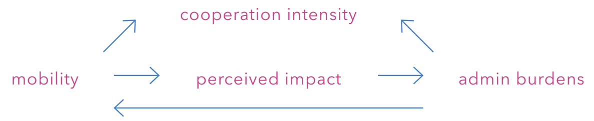

Figure 74: Success scenario logics: cooperation intensity – perceived impact

Mobility and its impact are furthermore related to the driver of open access to literature and sample databases as well as to a series of environmental factors, namely the availability of a common language and broadband internet access. While a common language is positively related with an increase of mobility-based and non-mobility based cooperation levels, broadband access and open access policies favour cooperation that does not necessarily rely on physical mobility.

Successful mobility schemes, together with increasing cooperation experience, can over time also be linked with, among others, the variable of the availability of suitable discussion fora for joint planning, priority-setting, etc. With a larger pool of scientists experienced in and committed to cooperation, the scientist stakeholder group is more readily available for participating in related policy-making discussions.

As said, this selection of key variables and driving forces as well as their integration is not meant to present a definite model of any sort. It is a proposal for structuring the most relevant variables influencing the future for thinking about a successful future scenario.

We propose to use this core logic of a 2020 success scenario in re-entering discussions with policy-making and programme-owning stakeholders. Related events could be used both for presenting to stakeholders the results of the foresight exercise, for continuing discussions and, thus, for activating commitment shown and inviting to make use of the foresight results.

Within the SEA-EU-NET project, there was the opportunity to organise one half-day scenario discussion event as one of three parts of a three-day project event series that was hosted by the Thai Science, Technology and Innovation Policy Office (STI) and took place in Chiang Mai in May 2011. In the following, the input and some highlights of the outputs of this event are presented.

6.10 A draft success scenario of future EU-ASEAN S&T cooperation

The SEA-EU-NET Foresight draft success scenario has been prepared by the SEA-EU-NET Foresight Team with the set of concrete and general driving forces behind S&T cooperation (identified and assessed along the SEA-EU-NET Foresight process) as well as with the success scenario logic at hand. Given the severe time constraints on the side of the policy makers, we have chosen to work with a single success scenario. These constraints were also the reason why we considered it unfeasible to conduct the task of scenario drafting within the workshop. Instead of presenting and discussing the scenario logic, we have chosen to prepare a ready-to-use draft version of a success scenario in the narrative of an imaginary news article looking back towards the current decade from 2020.

We want to explicitly underline that this draft success scenario is not to be considered the project's or certain partner's desired view. It is just one possible future scenario drafted with the above material in mind for the purpose of motivating debate. For this very reason, it had to be short, thus grossly but deliberately simplifying a complex picture into a one-page scenario.

Scenario title: Europe and Southeast Asia as preferential partners in STI

Goal: a dense network of STI working relations with adequate funding and political backing

Narrative form: fictitious news editorial in year 2020

Narrative text:
Southeast Asia and Europe celebrate 5 years of bi-regional STI cooperation Agency

Science ministers from countries of Southeast Asia and Europe met today in the Peninsula Bangkok Hotel in Thailand to celebrate the 5-year anniversary of the ASEAN-EU STI Cooperation Agency (ASEUSTICA), a body offering joint funding opportunities as well as administrative, legal and networking support to both scientific communities.

Even though cooperation in STI between Europe and Southeast Asia was already happening on a nation-to-nation basis for decades, the founding of the bi-regional policy-networking project SEA-EU-NET by the European Commission in 2008 was a milestone for an enhanced bi-regional cooperation. Three years after the SEA-EU Year of S&T in 2012 and the subsequent signature of an SEA-EU S&T Cooperation Agreement, the project has been remodelled into a permanent agency with funds from both regions in 2015, the year of the establishment of the ASEAN Community, and now celebrates its fifth anniversary. S&T cooperation levels have ever since continued to rise with significant spill-overs to collaborative innovation. The density of the partnership distinguishes it from both Southeast Asia's and Europe's STI cooperation with other regions.

Reasons for the success of this equal-term intra-regional partnership can be found on several levels, but the close trade relations and the strong interest in economic cooperation from both sides is seen by experts as one of the most relevant forces for the seeking of synergies within other fields, such as STI.

With a growing awareness of "Europe" as a partner within Southeast Asia, the already existing bilateral cooperation on national level slowly moved towards a multilateral context. Cooperation with countries such as Germany was increasingly seen as cooperation with Europe, a view that was lacking before and that could unlock cooperation with other European MS.

A similar process went on in Europe, as Southeast Asia was increasingly seen as a region that is very diverse, but economically converging and increasingly integrated, and that could offer a wide range of cooperation opportunities in science, technology and innovation.

We can discern several turning points that led to this close cooperation: on a political level, the signature of the S&T Agreement has been a clear impulse to strengthen the bi-regional cooperation. This was increasingly backed by administrative support such as visa and biomaterials exchange facilitation for scientists and long-term multilateral programmes with dedicated funding. These programmes always had mobility as one cornerstone, as face-to-face contacts with the possibility of developing long-term working relations or even friendships were seen as beneficial. Retired scientists and members of scientific Diaspora populations have volunteered as focal points providing information on exchange possibilities and formalities as well as access to their networks. Social and material costs of exchange and mobility could be reduced by offering re-integration schemes. Today, a Southeast Asian scientist who has spent half of his career at a European university can move back on a temporary part-time and, if the cooperation proves successful for both sides, permanent basis.

The professor-student-professor relationships stemming from support to joint PhD supervision were seen as one of the major confidence building measures, establishing at the same time career-spanning inter-regional linkages with a frequent manifestation of the cooperation in joint publications and patenting. While researcher mobility in 2010 was mostly directed from Southeast Asia to Europe, European PhDs and senior scientists are now as motivated to join faculties in Southeast Asia as their peers are to come to Europe.

Besides the attractiveness of working with another culture, the reason for success of these programmes, as can now be seen, had a lot to do with the fine-tuning processes initiated on a regular basis jointly from both regions. Feedback and outlook mechanisms for joint instruments were backed by policy makers and programme owners. They have benefited from regular input from the concerned scientific community. The analytical work being done by the cooperation agency with its annual collection of quality metrics for success of cooperation was also of use to stir the process underway.

Another reason for the intense STI cooperation between Southeast Asia and Europe can be seen in the close cooperation of STI-related networks, initially supported by projects like SEA-EU-NET, then self-sustained. Many of these networks, be it alumni, technicians, universities, scientific Diaspora or thematic networks, met continuously over the last 10 years to create synergies at stakeholder events of an annually changing thematic focus.

Both scientists and politicians stressed in interviews the importance of these annual bi-regional conferences. Their outstanding feature was that they could (and did) lead to the subsequent foundation of a bi-regional research institute in the hosting country in the thematic area focused by the event. This possibility ensured high-quality attendance of scientists and politicians as well as good media coverage. Over the last few years, the private sector innovation actors got increasingly involved in these conferences, providing funding in order to benefit from idea and talent exchange at dedicated conference sessions on innovation. In addition, the Agency presents each year the most relevant scientific outputs produced in programmes under its umbrella as well as the most promising patents filed.

By 2020, the Agency itself is financed through country-specific fixed and voluntary contributions from the ASEAN and EU Member States, from business sponsors as well as from fixed shares of the revenues of patents which have been filed with the Agency's support or which came out of Agency-supported R&D. At the same time, the Agency keeps up ASEAN's commitment to open access policies and awards research relevant for improving the quality of life.

It can be expected that the share of the Agency's budget coming from Member States will continue to decrease.

Jakarta/Brussels, 30 May 2020

As explained above, the draft success scenario has been discussed during a half-day workshop in a Knowledge Café format: discussion tables with one Southeast Asian and one European moderator each where participants could freely choose to attend and change table whenever they want. In this setting, we have been successfully trying to link the SEA-EU-NET Foresight S&T cooperation success scenario to existing future thinking in the region. The ASEAN Krabi Initiative 2010[112] outlines five paradigm shifts that are considered necessary in order to bring about the benefits of science to the ASEAN citizens (STI Enculturation; Bottom-of-the-Pyramid Focus; Youth-Focused Innovation; STI for Green Society; Public-Private Partnership Platform). The moderated discussions started on five tables (one for each of the five paradigm shifts) with the invitation to deliberate what ASEAN-EU S&T Cooperation could contribute to each of these paradigm shifts and how, consequently, a successful future S&T cooperation between these two regions would look like in 2020.

The main results of the five round tables on the five paradigm shifts have been:

- STI Enculturation (that is the growing consciousness about the relevance of S&T among the Southeast Asian population)
  - Early education and media should be used for STI Enculturation
  - ASEAN-EU exchange on experiences in science education is relevant in order to avoid mistakes
  - Reviewing education systems is crucial as is investing more
  - A leading agency should be responsible for the process
  - More integrated policies among the governments are needed to foster STI Enculturation
- Bottom-of-the-Pyramid Focus (BOP)
  - A gap of interest between EU and ASEAN with regard to the BOP focus; FP7 does not address BOP – a respective platform is needed under Horizon 2020
  - New business models and new social STI entrepreneurs can have impact at the bottom of the pyramid and can initiate collaborations between Southeast Asia and Europe; these new business models include social innovation models that are bottom-up
  - Need to communicate (to EU etc) that BOP is a new market opportunity
- Youth-focused innovation
  - Very young populations in Southeast Asia
  - Increasing international mobility: international dialogue on brain drain/gain is needed
  - Sub-national migration movements from rural to urban areas: creation of local wealth
  - STI student exchange programmes within ASEAN and with the EU
- STI for Green Society
  - Joint technology development, not merely technology transfer
  - Harmonized standards
  - Sharing of best practices
  - Educational programmes
- Public-Private Partnership Platform
  - Advantages of PPP with international collaboration: invigoration of the education sector; co-funding between public and private actors; improvement of research systems; facilitation of research in areas of mutual interest
  - Incentives for foreign and domestic companies to get involved in PPP: companies may receive R&D grants, tax incentives, loans, finances for infrastructure
  - EU-ASEAN PPP collaboration agency to: provide STI research and training, platform for information exchange on PPP issues for companies and governments
  - Technology transfer from the EU to ASEAN should provide support to technology transfer of private EU companies by EU and SEA public funding; it should focus on green products; and it should help to overcome non-tariff barriers such as health regulations, food safety, etc.

These results can now be applied to revise and further specify the draft success scenario. The following aspects catch our attention:

- The STI Cooperation Agency that has been presented as a key player in the success scenario, could additionally (or exclusively) act as a bi-regional public-private-partnership facilitator, bringing together Southeast Asian firms with European public research and viceversa. Another possible additional focus of such an agency would be the support of experiences and best practices in science education
- Relatedly, the policy-maker participants called for publicly supported (from both sides) technology transfer, but also for actual joint technology development (based on harmonized standards, best practice sharing and joint educational programmes) in order to advance a Green Society. This would indicate that a 2020 S&T cooperation success scenario would also consist in closely cooperating technology development partners, not only public research. Parts of the joint technology development might be carried out in actual joint R&D centres, possibly co-funded by private and public actors.
- As does the draft success scenario, the knowledge café discussions pointed out mobility, more concretely international student exchange, as crucial for S&T cooperation, given that it does not merely lead to brain drain. One aspect the discussions underlined that was not covered in the success scenario yet: the currently very young ASEAN population will still be young in 2020, but large cohorts will have grown into well educated knowledge workers if the paradigm shift towards STI Enculturation and the reform of the education systems succeed.
- Finally, the discussions made clear that a 'successful' EU-ASEAN S&T Cooperation necessarily has to do justice to the bottom-of-the-pyramid focus called for in and relevant for ASEAN. Despite possible gaps of interest, a dedicated platform is needed for supporting joint research relevant for the bottom-of-the-pyramid parts of society. Bottom-up business models and social innovation will play a major role, in this regard, not least in collaborative efforts.

While we do not consider it necessary to include these four aspects into the above draft success scenario in a narrative form, printing a similar second fictive news text, we do want to highlight that such an updated narrative form is available for further discussions within and outside of the SEA-EU-NET consortium

In addition to disseminating this study (in print and via the SEA-EU-NET website www.sea-eu.net) and making it available to relevant stakeholders for further use, future activities not in the original scope of the SEA-EU-NET exercise could take up the current state of scenario discussions and carry them further.

The draft success scenario or scenario logics can be presented to and discussed with concerned policy-makers for instance on the European side, refining the scenario or adding alternative scenarios. Another option would be to take this or additional success scenarios as the basis for a backcasting exercise answering the question how to reach the identified scenario. Actions could be discussed that would have to be taken in the present and the near-future to stir bi-regional cooperation towards the success scenario (a second round of joint backcasting). Such an exercise not only inspires the policy-makers' structured thinking about the future, but again creates commitment and ensures the usefulness of the Foresight exercise.

112 http://www.aseansti.net/index.php

7 Southeast Asia's international S&T cooperation policy

Margot Schüller, Rudie Trienes, Alexander Degelsegger, Ludwig Kammesheidt, Florian Gruber[113]

7.1 Introduction[114]

Southeast Asian economies have weathered the global crisis relatively well and have rebounded in 2010. They are now searching for ways to sustain economic growth beyond their recovery. More than ever, the pursuit of an innovation-based development path is of crucial importance to the achievement of this objective. Recent studies have shown that technological processes and technical efficiency – the two components of total factor productivity that drive economic growth – have been major sources of growth in many of the Southeast Asian countries[115]. For the development of the national innovation system (NIS), international science and technology (S&T) cooperation plays a critical role. Within the ASEAN (Association of Southeast Asian Nations) region all of the member states have designed policies that foster innovation and international S&T cooperation, although on a different scale and scope depending on their own overall development level and priorities. In line with the ambitious goal of establishing an 'ASEAN Community' by 2015, the ASEAN S&T ministries decided at the informal S&T meeting (IAMMST) in December 2010 to intensify their regional cooperation in order to achieve a 'competitive, sustainable and inclusive ASEAN'.[116] In addition to closer regional S&T cooperation, collaboration with international dialogue partners is likely to have a significant impact on the transition to an innovation-driven 'ASEAN Economic Community'.

Compared to other regions in the world, the EU is one of the most attractive partners for international research collaboration, but itself also needs global connectivity and S&T dialogue partners to stay competitive. The ASEAN has become such a partner, who actively supports closer S&T cooperation within the region as well as on the international level. While bilateral cooperation in science, technology and innovation (STI) between countries in Europe and Southeast Asia has a long tradition, biregional collaboration between the ASEAN and EU is a rather new phenomenon. It is based on the idea of cooperation in fields of mutual interest and benefit and is characterized by an increasing institutionalization of the biregional S&T dialogue that was launched in 2008.

This contribution analyzes the international S&T cooperation policies of the Southeast Asian countries, focusing on the collaboration with the EU. The authors are interested in understanding the drivers of both the S&T policy of the ASEAN as a regional grouping as well as the national S&T policies of the member states. The study concentrates on the international S&T collaboration policy in general, fields of research and the type of collaboration. In order to structure our analysis we put the questions of preferences for specific partners for S&T cooperation and specific research fields into a broader theoretical discussion. This allows us to differentiate between the national S&T policy level on the one hand, and the level of the individual scientists in research institutes and universities who have a different perspective on S&T cooperation on the other. Applying the concept of push and pull factors helps to structure both the argument and our findings.

In Section 7.2 of this chapter we discuss the question of why scientists and countries are engaged in international S&T cooperation and what role the state plays in fostering an innovation-driven catch-up process. Section 7.3 provides an overview of the ASEAN's interregional and extraregional S&T policies. Section 7.4 studies the international S&T policies of individual ASEAN member states. Due to country-specific circumstances, there are variations in the orientation of each member state's international S&T collaboration. In Section 7.5 the push and pull factors of S&T collaboration between the ASEAN and the EU are summarized, conclusions are drawn and policy recommendations offered.

The findings and data we present in this article come from different sources. In addition to the presentation of data and insights from the study of the literature on Southeast Asian countries' S&T collaboration we have collected country-specific data for ASEAN and its member states through online questionnaires, face-to-face interviews, and discussions with European and Southeast Asian experts. Thanks to the Southeast Asian members' organizations that participate in the SEA-EU-NET project, the authors were able to conduct interviews with scientists and S&T administrators during the first study visit to Malaysia, Indonesia, Singapore, Thailand and Vietnam in 2008 and in the course of a second study visit to the Philippines and Laos in 2011. The contribution concentrates on the international S&T cooperation policies of these seven ASEAN member countries, while general data on the remaining countries (Brunei, Cambodia and Myanmar) are also presented.

Although our study visits to the ASEAN member states brought to light new perspectives on these countries' international S&T cooperation preferences, we were not in a position to study all policy aspects systematically and in a thorough way. Time constraints while visiting each country limited the achievement of a comprehensive picture of these countries' international S&T policies. There are, however, several studies conducted by our colleagues within this project since 2008 that complement our findings.

One impression that stands out is that some government research institutes (GRIs), universities and scientists in the region have already achieved global research standards and can be treated as equal partners in joint research projects. S&T cooperation with most ASEAN member states can thus be of mutual interest to the EU and the ASEAN. With other S&T actors in SEA who are still in the stage of developing their innovation system and need support for capacity building, cooperation in their country-specific research niches offers attractive joint collaboration opportunities. The EU's main challenge in successful long-term cooperation with SEA countries seems to be finding an appropriate policy design that can take into account the various S&T development levels and country-specific conditions. This would contribute to a better positioning of the EU in this Asian region, and hopefully lead to an increase in the rate of application in the EU Framework Programmes.

7.2 What drives international S&T collaboration and networks?

Science-based innovation enables companies and countries to be internationally competitive and achieve long-term economic growth. All science-related indicators demonstrate that the importance of science has dramatically increased on the global scale. The total spending on research and development (R&D) and the output of publications grew each by 45 per cent, and the number of researchers rose by 25 per cent, between 2002 and 2007. International research collaboration – defined as information exchange predominantly between researchers from various countries with the purpose of creating new knowledge[117] – has contributed to this development. This collaboration is most commonly reflected in co-authorship of academic papers. In 2008, the share of co-authored papers amounted to 35 per cent, compared to about 30 per cent in 2002 and 25 per cent in 1996.[118] Bibliometric analysis allows us to map the pattern of international scientific collaboration between countries and regions. It demonstrates that geographical proximity is one of the important rationales for collaboration, although not the only one.[119] In the discussion of what drives international S&T collaboration, a distinction between factors internal to science, relating mostly to individuals and networks, and factors external to science is usually made. The latter includes policy motivations and financial support incentives from governments and funding agencies for scientists.

Many authors have emphasized the role of the individual scientist and his/her motivation to cooperate

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114 We would like to express our gratitude to our SEA-EU-NET project partners in Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam. Without their support this study would not have been possible. Special acknowledgement goes also to all the representatives from governmental institutions as well as our colleagues from research institutes and universities in the ASEAN region for their time and effort in answering both our online questionnaires and our questions during the study visits in their countries. We also thank Christopher Tan, Sam Myers and Johan Stapel, who took part in the fact-finding mission in August/September 2008 and Jari John, Research Assistant at GIGA, for his support in the update of the consultation paper.

115 Park, Donghyun / Park, Jungsoo (2010): Drivers of Developing Asia's Growth: Past and Future, ADB Economics Working Paper Series No. 235, November 2010, online at: http://www.adb.org/documents/working-papers/2010/Economics-WP235.pdf, pp. 21f

116 The IAMMST adopted the so-called Krabi Initiative theme 'Science, Technology and Innovation (STI) for a Competitive, Sustainable and Inclusive ASEAN' (ASEAN 2010).

117 Hennemann, S. / Rybski, D. / Liefner I. (2010): The Myth of Global Science Collaboration. Draft, Justus-Liebig University, Institute of Geography, Gießen, online at: http://www.ihs.ac.at/vienna/resources/Economics/Papers/Paper%20Hennemann.pdf, pp.1–2

118 The Royal Society (2011): Knowledge, Networks and Nations. Global Scientific Collaboration in the 21st Century, RS Policy Document 03/11, London, online at: http://royalsociety.org/uploadedFiles/Royal_Society_Content/Influencing_Policy/Reports/2011-03-28-Knowledge-networks-nations.pdf, most recent access date: 13 September 2011, pp. 16, 46

119 Henneman et al. (2010), p. 1

with the best scientists in other parts of the world 'in order to access complementary skills and knowledge, with a view of stimulating new ideas'.[120] Based on their research of scientific networks, Wagner and Leydesdorff[121] also stress the importance of the individual and argue that international research collaboration is more due to 'the dynamics at the subfield level created by individual scientists linking together for enhanced recognition and rewards than to other structural or policy-related factors'. They emphasize factors internal to science – more precisely, internal to the intellectual and social organization of science – which offer incentives for individual scientists to cooperate within their own countries as well as across countries. For Suttmeier[122] the disciplinary differentiation of science on the one hand and the field-specific characteristics of mega-science on the other are factors that require closer cooperation between specialized scientists at the international level.

Based on this discussion and the analysis by Edler[123] and Bukvova[124] of various motivations that scientists have to pursue research collaboration, the following list of drivers for international research collaboration can be compiled:

- Access to expertise, leading edge and complementary know-how
- Access to funding from foreign institutions/programmes
- Access to natural or social phenomena, which are limited geographically
- Sharing of costs and risks in projects that require large infrastructure equipment
- Increase of academic prestige
- Capacity building; learning of new skills

In the collaboration between developed and developing countries there is the challenge of how to best reduce the negative effects of an asymmetry of partners with distinct and complementary strengths. Moreover, scientists in developing countries entering international research collaboration may not only expect an increase in their scientific skills, but also care about the impact of the collaborative research on local development and whether scientific and non-scientific capacity improvement contribute to future research.[125] Here, the individual motivation of scientists overlaps with the expectations of policy-makers that S&T collaboration serves economic and social development.

In sum, various push and pull factors exist that explain why scientists are interested in international research collaboration (see table 14). The structural push factors relate to the conditions scientists are faced with in their home countries – including academic recognition, access to research infrastructure, and communication technologies that allow them to enter into international academic exchange. The structural pull factors refer to the conditions outside of the scientists' home countries, and include the quality of research equipment, education and training and leading edge researchers - as well as the opportunities to study geographically limited social and natural phenomena.

Table 14: Scientists' motives for international collaboration

	Push factors	Pull factors
Structural factors	– Academic recognition – R&D infrastructure – Communication technologies	– Research equipment – Leading-edge researchers – Education and training – Geographically limited social and natural phenomena
Policy factors	– Mobility programmes – Regional/international S&T cooperation agreements – Rewards for internationally recognized scientists	– Scholarship for foreign scientists – Funding for capacity building – Research funding programmes in the target region (i.e. EU Framework Programme)

Source: Authors' own compilation

Besides structural factors there are policy-related factors that provide incentives for scholars to cooperate on an international level. Depending on the financial support for international research collaboration through mobility programmes or regional and international cooperation agreements, scientists are encouraged to enter into an international R&D exchange. The system of rewards for internationally-recognized scientists with regards to career opportunities has also an impact on the individual motives for international collaboration. The extent to which scholarships, other means of research funding and capacity building are available for scientists abroad also influences their individual decisions.

Policy support for cross-border research collaboration is based on the expectation that international S&T cooperation will have a positive impact on national economic development.[126] Edler[127] distinguishes between a narrow understanding of S&T cooperation support policy by governments and large funding and research organizations that foster scientists (and firms) in their international activities and a broader understanding. The latter include non-science policy objectives such as foreign policy and development aid policy. In her study on drivers of international research collaboration, Boekholt et al.[128] underline that intrinsic science policy objectives interact with non-science ones; namely, 1) collaboration to improve national competitiveness, 2) the support of developing countries' S&T capabilities, 3) the need to cope with global challenges, and 4) the improvement of diplomatic relationships and, indirectly, international security. The analysis of the later policy motivation can be related to historical and political relationships of countries and geographical proximity.[129]

120 The Royal Society (2011), p. 57
121 Wagner, Caroline S. / Leydesdorff, Loet (2004): Network Structure, Self-Organization and the Growth of International Collaboration in Science. Amsterdam School of Communication Research, University of Amsterdam, p. 21
122 Suttmeier, Richard P. (2008): State, Self-Organization, and Identity in the Building of Sino-U.S. Cooperation in Science and Technology, in: Asian Perspective, 32(1), pp. 8f
123 Edler, Jakob (2008): The Role of International Collaboration in the Framework Programme. Expert Analysis in Support of the Ex Post Evaluation of FP6, Manchester Institute of Innovation Research, online at: http://ec.europa.eu/research/evaluations/pdf/archive/fp6-evidence-base/expert_analysis/j.edler_-_the_role_of_international_collaboration_in_the_framework_programme.pdf, most recent access date: 13 September 2011, p. 3
124 Bukvova, Helena (2010): Study Research Collaboration: A Literature Review. Working Papers on Information Systems, Technische Universität Dresden, Germany, online at: http://sprouts.aisnet.org/10-3, most recent access date: 13 September 2011, pp. 3–6
125 OECD (2011a): Opportunities, Challenges and Good Practices in International Research Cooperation between Developed and Developing Countries, Paris: OECD, online at: http://www.oecd.org/dataoecd/40/16/47737209.pdf, most recent access date: 13 September 2011, pp. 4f

Summarizing the policy motivations (see table 15) that drive international research collaboration the push factors include the expected positive impact on local and national economic development, the increase of national S&T capabilities, the awareness of global challenges that need joint approaches and the support for national diplomacy and security policy goals.

Table 15: Motivations for policy makers to support international S&T collaboration

Push factors	Pull factors
– Impact on sustained economic growth – Increase of national S&T capabilities – Tackling of global challenges – Support of national diplomacy/security policy goals	– Funding programmes for scientists and S&T administrators – Access to leading-edge technology – Access to education and training – Regional policy agreements on S&T collaboration

Source: Authors' own compilation

Although international S&T collaboration is regarded by most countries as crucial for innovation-driven economic growth, the extent to which collaboration is actually supported by governments varies widely. Different policies can be related to national S&T development strategies, which either stress independent endogenous technological competence or emphasize rapid technological sophistication through technology transfer via the absorption of foreign direct investments. The term technonationalism is applied to strategies which focus on the nation as the driver for innovation, and which allocates R&D budgets and diffuses technology.[130] Technonationalism is seen as combination of 'a strong belief that the technological capabilities of a nation's firms are a key source of their competitive process, with a belief that these capabilities are in a sense national, and can be built by national action'.[131] In the literature on innovation policies, Japan was traditionally considered to pursue a technonationalist policy, stressing the importance of technological autonomy for national security and benefiting from the absorption of foreign technology without contributing much to new knowledge.[132] Today, China is often cited as an example of a country that adapted a technonationalist approach. In contrast to technonationalism, countries that follow a strategy of technoglobalism do not emphasize the nationality of firms that create new technologies, but aim to benefit from free technology trade and foreign direct investments. This concept is based on the notion that the globalization of new technologies, particularly in the fields of transport and communications equipment, reduces the role of national governments in innovation. Two countries that have strongly applied such an approach are Hong Kong and Singapore.[133]

Technoglobalism is closely related to the term of technoliberalism applied by some scholars to S&T strategies that rely mainly on minimal state intervention, economic liberalization and deregulation. The degree of state intervention in the economy is regarded as the dividing line between those countries following a strategy of technonationalism and others that pursue a strategy of technoliberalism.[134] When transferring this concept to Southeast Asian countries in the late 1990s, Posadas[135] classified Vietnam as following a strategy of technonationalism, in contrast to Singapore, Thailand and the Philippines, which applied a technoliberalist strategy with strong incentives for inward foreign direct investments. Indonesia and Malaysia pursued an in-between strategy, leaning towards technonationalism by trying to become independent in some technologies, but inviting multinational companies for ambitious projects such as the Multimedia Super Corridor in the case of Malaysia.

The discussion of the various national S&T strategies is closely related to the question of how actively countries are involved in international research collaboration. While some countries in Asia followed a technonationalist strategy, motivated by 'the desire of Asian states to free themselves from dependence on Western technol-

126 Suttmeier (2008), pp. 8f
127 Edler (2008), pp. 4–5
128 Boekholt, Patries / Edler, Jakob / Cunningham, Paul / Flanagan, Kieron (eds.) (2009): Drivers of International Collaboration in Research. Final Report for the European Commission. EUR 24195 EN, Bruxelles, pp. 8f
129 Ibid.
130 Edgerton, David E.H. (2007): The Contradiction of Techno-Nationalism and Techno-Globalism: A Historical Perspective, in: New Global Studies, 1(1), p. 5
131 Nelson, R. / Rosenberg, N. (1993): Technical Innovation and National Systems, in: Nelson, R. (ed.), National Innovation Systems, A Comparative Analysis, New York: Oxford University Press, p. 3
132 Corning, Gregory P. (2004): Japan and the Politics of Tech-Globalism. Armonik, New York, and Lynn 2005: pp. 188–189)
133 Lynn (2005), p. 188; Edgerton (2007), p. 1
134 Posadas, Roger (1999): The Development of Science and Technology in South-East Asia: Status and Prospects, in: Science Technology & Society 4(1), p. 128
135 Posadas, Roger (1999): The Development of Science and Technology in South-East Asia: Status and Prospects, in: Science Technology & Society 4(1), pp. 127f

ogies'[136], the dramatic increase in globalization in the last decade forced them to modify their approaches. The surge in S&T globalization was particular visible in the international diffusion of technology at an earlier stage than in the past, the integration of technological complementarities through strategic alliances, and the international mobility of S&T professionals and students.[137]

Before studying the international S&T collaboration of each ASEAN member states, we will have a look at the ASEAN as a regional grouping and its intraregional and extraregional S&T policies.

7.3 The ASEAN's intraregional and extraregional S&T policies

Integration in the ASEAN region has not been left only to the market but has been guided by the idea of the benefits of a stronger institutional framework since the Asian financial crises in 1997. Due to the central role of S&T in economic development, closer technological cooperation has been supported in ASEAN through the establishment of the ASEAN Committee on Science and Technology (ASEAN COST). This Committee aims to guide the formulation of the region's S&T policies and the establishment of programmes. Based on policy decisions made at the ASEAN summits and meetings of ASEAN Ministers for S&T, the COST designed a number of special programmes and actions. The action plan on S&T for the period 2007 to 2011 ('ASEAN Plan of Action on Science and Technology: 2007–2011', (APAST)) incorporated previous action plans (see figure 75) and combined them with national directives and S&T plans.

APAST contains not only policy objectives directed at the region itself, but also guidelines for stronger international cooperation on the part of ASEAN with countries and regions others than the so-called dialogue partners. In detail, APAST lists the following objectives: 1) creating intra-ASEAN S&T cooperation that has extensive synergies and is self-sustaining, with strong participation by the private sector; 2) establishing an S&T network supportive of public- and private-sector human resource development; 3) supporting technology transfer between institutions and industry; 4) increasing awareness of the crucial role S&T plays in economic development in ASEAN; and, 5) expanding S&T cooperation with the international community. This last objective shows that COST is also pursuing an outward-looking S&T strategy.

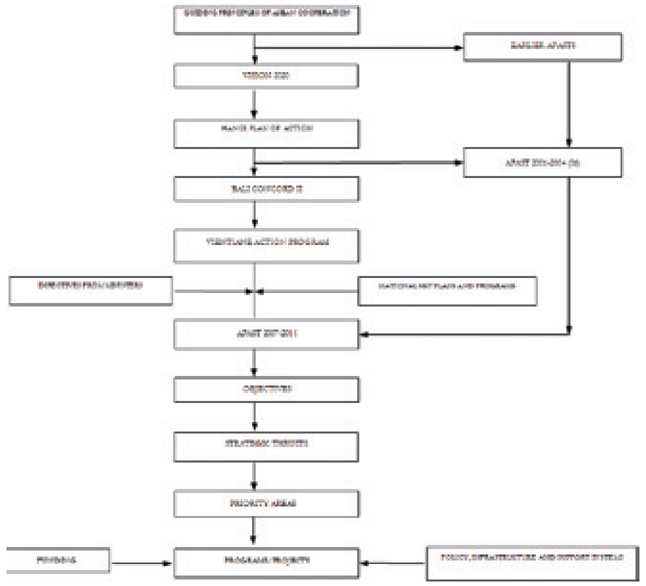

Figure 75: Framework of the ASEAN Plan of Action on S&T (APAST): 2007–2011
Source: ASEAN secretariat

In terms of actions, APAST explicitly requires support for closer cooperation with 'dialogue partners and other relevant organisations on regional projects' as one of its strategic thrusts. In order to achieve this objective, the following actions were proposed:

- development of new strategies for partnership with dialogue partners;
- facilitation of access to the resources of dialogue partners for regional projects, with a focus on the newer member countries of ASEAN; and,
- support for closer relationships with relevant ASEAN+3 (Japan, South Korea, China) S&T agencies for mutually beneficial development in East Asia.

There are eleven S&T dialogue partners listed in the ASEAN action plan on S&T, including China, India, Japan, South Korea, Pakistan, Australia, New Zealand, the EU, the USA, Canada and Russia. Most of the dialogue partners have a specific S&T dialogue forum with the ASEAN to jointly discuss activities, which often takes the form of a joint working group. Japan, South Korea and China are cooperating with the ASEAN through the ASEAN COST+3.

The bilateral fields of S&T cooperation listed in the APAST 2007–2011 are very similar, reflecting the ASEAN's priority programme areas for S&T cooperation in 2007: 1) food S&T, 2) biotechnology, 3) meteorology and geophysics, 4) marine S&T, 5) non-conventional energy research, 6) microelectronics and information technology, 7) material S&T, 8) space technology and applications,

136 Kang, David / Segal, Adam (2006): The Siren Song of Technonationalism, in: Far Eastern Economic Review, March 2006 Issue
137 Posadas (1999): p. 128, and Schüller, Margot / Gruber, Florian / Trienes, Rudie / Shim, David (2008): International Science and Technology Cooperation Policies of Southeast Asian Countries, Consultation Paper, SEA-EU-NET, Hamburg, Vienna and Amsterdam, November 2008, pp. 5–6

and, 9) S&T infrastructure and resource development.[138]

At the 6th Informal ASEAN Ministerial Meeting on Science and Technology (IAMMST–6) held in Krabi, Thailand, in December 2010, the S&T ministers decided to extend the implementation of the APAST until 2015. The ongoing APAST (2007–2011) will be enhanced by including macro-initiatives, while the preparation for the next APAST (2016–2020) is underway. This new policy programme should take into account the recommendations presented at the IAMMST–6.[139] The so-called Krabi Initiative 2010 adopted the motto 'Science, Technology and Innovation (STI) for a Competitive, Sustainable and Inclusive ASEAN', and identified eight thematic tracks as key areas to be implemented: (1) ASEAN Innovation for Global Market; (2) Digital Economy, New Media and Social Networking: (3) Green Technology, (4) Food Security; (5) Energy Security, (6) Water Management; (7) Biodiversity for Health and Wealth and (8) Science and Innovation for Life.

In contrast to the current emphasis on S&T activities confined mostly to the academic domains, the Krabi Initiative requests a paradigm shift in order to focus more on the benefits of science to the ASEAN's citizens. The paradigm shift is represented by a number of goals, including 'STI Enculturation', which stands for the need to mainstream STI into peoples' lives and to support citizens with outstanding STI achievements as role-models. Another goal refers to the 'Bottom-of-the-Pyramid Focus' and focuses on the larger part of the population and their basic needs for food, housing, health and access to information and knowledge. The 'Youth-Focused Innovation' takes into account the large share of the young population and creates incentives to increase their STI potentials and entrepreneurship. As climate change is a hot topic for all of the ASEAN member states, the 'STI for Green Society' goal relates to the introduction of appropriate low carbon technologies. The 'Public–Private Partnership Platform' aims to support the linkages within the innovation system in order to increase the role of the private sector in S&T.[140]

There are six flagship programmes by the ASEAN, focusing on: 1) Early Warning System for Disaster Risk Reduction; 2) Biofuels; 3) Application and Development of Open Software (OSS); 4) Functional Food; 5) Climate Change; and, 6) Health. For these flagship programmes the implementation plans have been finalized as of May 2011. In order to support these programmes, the S&T ministries decided to establish a complementary R&D human resource exchange programme. Another region-wide initiative is the ASEAN ICT Master Plan 2015, which was launched in January 2011 in Kuala Lumpur, Malaysia. The ASEAN's cooperation in ICT with its dialogue partners has also been continued, focusing on joint programmes under the ASEAN+3 with China, Japan and South Korea as well as ICT cooperation with the EU.[141]

Despite the growing importance of the ASEAN COST as a dialogue forum for the coordination of the region's S&T programmes, the institutional and funding capacity of this committee is still rather limited. This holds true for the ASEAN Secretariat altogether, which has to cope with a heavy administrative burden resulting from the increasing pace and extent of regional cooperation and integration. With regard to the financing of S&T cooperation, most of the funding comes from dialogue partners, while the ASEAN Science Fund (ASF) has only a low annual budget.[142] During the IAMMST–6 meeting in December 2010, the S&T ministries requested an augmentation of this fund in order to support the flagship programmes and the implementation of the Krabi Initiative.[143]

Unlike the EU, which is a supranational institution, the ASEAN is an intergovernmental organization and thus has no decision-making power of its own.[144] The ASEAN's international S&T policy is therefore strongly influenced by the interests of individual member countries. The fact that some of the ASEAN–5, the founding members of this regional grouping, have almost similar economic development levels explains, according to some scholars, the fact that they tend to compete in S&T rather than cooperate. Stronger regional cooperation is mostly concentrated in those countries which joined ASEAN last, namely, Cambodia, Laos, Myanmar and Vietnam. The ASEAN-help-ASEAN programme (2001–2004 Action Plan) has been especially designed to support these member countries' S&T development.[145] However, the Krabi Initiative demonstrates that the ASEAN COST strives for closer intraregional cooperation among S&T policies alongside the ambitious aim to also establish an ASEAN Community by 2015.

138 The list of the ASEAN's S&T cooperation programmes with dialogues partners is included in the original 2008 consultation paper (Schüller, Gruber, Trienes and Shim 2008: 7–8).
139 ASEAN (2011): Annual Report 2010–2011, ASEAN Secretariat, Jakarta, p. 39
140 ASEAN (2010): Report of the ASEAN COST. Retreat on the "Future of Science, Technology, and Innovation: 2015 and Beyond", Krabi, Thailand, 11–12 December 2010, online at: http://www.aseansti.net/images/stories/report%20of%20the%20asean%20cost%20retreat%20on%20sti-final.pdf, most recent access date: 13 September 2011

141 ASEAN (2011), pp. 39ff
142 Konstadakopulos (2003): The evolution, substance and priorities of EU and ASEAN cooperation in science and technology, in: Asia Europe Journal, 1(4), p. 563
143 ASEAN (2010): Chairman's Statement of the 6th ASEAN Ministerial Meeting on Science and Technology (IAMMST), Krabi, Thailand, 17 December 2010, online at: http://www.aseansec.org/25723.htm, most recent access date: 13 September 2011
144 Moeller, Joergen Oerstroem (2007): ASEAN's Relations with the European Union: Obstacles and Opportunities, in Contemporary Southeast Asia, 29 (3), p. 480
145 Konstadakopulos (2003), pp. 562f

Table 16: Selected economic and social indicators of ASEAN member states

	Population 2008 (m.)	GDP p.c. annual growth 1970–2008 (%)	GDP growth 2010 (%)	GNI p.c. 2010 ($) (Atlas Method)	Human Development Index 2010**	Global competitiveness ranking
ASEAN-6						
Brunei	1.07	0.2 (VHHD)*	2.0	31,180	0.805	28
Indonesia	230.0	9.3 (MHD)	6.1	2,580	0.600	44
Malaysia	27.5	4.4 (HHD)	7.2	7,900	0.744	26
Philippines	92.0	1.4 (MHD)	7.3	2,050	0.638	85
Singapore	4.84	5.0 (VHHD)	14.5	40,920	0.846	3
Thailand	67.8	4.4 (MHD)	7.8	4,210	0.654	38
ASEAN-4						
Cambodia	14.8	5.6 (MHD)	6.3	760	0.494	109
Laos	6.3	9.0 (MHD)	7.5	1,010	0.497	n.a.
Myanmar	50.0	n.a. (LHD)	5.3	n.a.	0.451	n.a.
Vietnam	87.3	4.2 (MHD)	6.8	1,100	0.572	59

*VHHD refers to very high human development; HHD refers to high human development; MHD refers to medium human development; LHD refers low human development.
**refers to the inequality-adjusted index
Sources: World Bank, Word Development Indicators 2010 and 'country at a glance' statistics; UNDP, Human Development Report 2010; World Economic Forum, Global Competitiveness Report 2010; Asian Development Bank, Key Indicators for Asia and the Pacific 2010. GERD refers to the years given in brackets.

The disparities in the levels of economic development across the region represent a huge challenge for S&T integration (see table 16). Following the categorization of income groups by the World Bank for the ASEAN member states in 2010 (Atlas Method), Singapore and Brunei belong to the group of high-income economies ($12,276 or more), Malaysia and Thailand to the upper-middle-income economies (US$3,976–12,275), and Indonesia, the Philippines, Vietnam and Laos form part of the group of lower-middle-income economies (US$1,006–3,975). Laos and Vietnam have just passed the threshold to become lower-middle income economies in 2010, Cambodia and Myanmar, for which no data are available, fall into the group of low income countries (US$1,005 or less).

While strong income disparities within the ASEAN region are a major feature among this group of countries, economic growth has been relatively impressive in most of them during the period from 1970–2008. However, the growth performance of Brunei and the Philippines has lagged strongly behind the average economic growth rate in the region. Only in recent years has the Philippines been able to catch up (see table 16). In some of the ASEAN countries – especially Indonesia, Malaysia, Thailand and Vietnam – a shift of the sources of economic growth from physical capital accumulation to total factor productivity (TFP), which includes technological progress and technical efficiency change, took place after 2002.[146] Foreign direct investment (FDI) and the associated technology transfer from developed countries play an important role in the technological progress of developing and emerging economies. We can not expect, however, that FDI has a similar impact across the ASEAN member countries. In contrast, the impact depends on the absorptive capacity of each country and on its national policy to realize FDI spillover effects. In the years 2007–2009, Singapore was the most important location for FDI, followed by Thailand, Vietnam, Indonesia and Malaysia (see figure 76).[147] This is in contrast, to a certain extent, with the situation of FDI inflows in previous years, when Indonesia, Malaysia and the Philippines received more foreign capital than Vietnam did.[148]

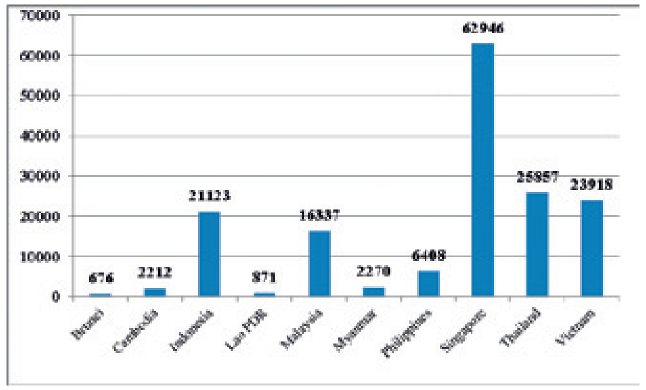

Figure 76: FDI inflows to the ASEAN 2007–2009 (US$ million)
Source : ASEAN Secretariat 2010

The economic disparities within the ASEAN region can also be traced back to the huge differences between each member's current level of S&T development. Comparing various indicators that reflect S&T performance, Singapore is leading the ASEAN member states, followed by Malaysia, Thailand, Vietnam and the Philippines. In terms of expenditure on research and development (R&D) in relationship to GDP (GERD), Singapore achieved 2.3 per cent in 2009. In contrast, Brunei's high income per capita did not lead to an equally high ratio of GERD, which was only 0.05 per cent in 2004 (the latest available year in the statistics). Brunei's economy is strongly dependent on oil and gas (with income from oil contributing more than half of GDP) and has a lack of business R&D. The second highest ratio of GERD was achieved by Malaysia with 0.63 per cent in 2006, which, however, dropped to 0.21 per cent in 2008. Thailand's GERD was 0.24 per cent in 2007, while R&D in Vietnam and the Philippines came up to 0.19 per cent and 0.11 per cent respectively. Although the remaining countries have been able to increase the GERD to some extent in recent years, their expenditure on R&D is still extremely low (see table 17). A similar pattern emerges when analysing the number of researchers. With the exception of Singapore, most ASEAN member states have a severe lack of human resources for R&D and suffer from a brain drain. The publication of journal articles represents another performance indicator of innovation. Comparing the number of S&T publications (journal articles) published in 2010 and indexed in Elsevier's SCOPUS and ISI's Web of Science academic literature databases, Singapore is leading the ASEAN group of countries again, followed by Malaysia and Thailand.

146 Park, Donghyun / Park, Jungsoo (2010): Drivers of Developing Asia's Growth: Past and Future, ADB Economics Working Paper Series No. 235, November 2010, online at: http://www.adb.org/documents/working-papers/2010/Economics-WP235.pdf, most recent access date: 20 September 2011, pp. 8–11, 21. In this study, Singapore belonged to the grouping of the four NIEs (new industrialized economies) together with Hong Kong, South Korea and Taiwan, for which the TFP growth was higher between 1992–1997 than it was in the period 1997–2002. Both the absolute size of the TFP as well as its relative contribution to growth became dominant after 2002.
147 ASEAN Secretariat (2010): Post-Crisis FDI Inflows to ASEAN. ASEAN-OECD Investment Policy Conference, 18-19 November 2010, available online at: http://www.oecd.org/dataoecd/2/23/46485385.pdf, accessed 6 June 2011
148 Schüller, Margot / Gruber, Florian / Trienes, Rudie / Shim, David (2008): International Science and Technology Cooperation Policies of Southeast Asian Countries, Consultation Paper, SEA-EU-NET, Hamburg, Vienna and Amsterdam, November 2008, p. 10

Table 17: ASEAN member countries' technological development level

Country	Year	R&D as % of GDP (GERD) and by sector of performance (%)				Researchers (per 1,000 employees)	Patents (WEF-ranking in 2009)**	Publications in 2007 (according to SCOPUS / Web of Science)
		GERD	Business	Government	Higher education			
Brunei	2004	0.05	0.0.	91.6	8.4	0.32	–	94 / 120
Cambodia	2002	0.05*	12.1	25.3	11.8	0.12	–	157 / 148
Indonesia	2009	0.08	14.3 (2001)	81.1 (2001)	4.6 (2001)	0.36	91	1,396 / 1,334
Laos	2002	0.04	n.a.	n.a.	n.a.	0.03	–	108 / 93
Malaysia	2006	0.63	84.9	5.2	9.9	1.75	36	8,931 / 17,068
Myanmar	n/a	n/a	n/a	n/a	n/a	n/a	–	66 / 58
Philippines	2007	0.11	56.9	17.7	23.3	0.33	82	851 / 840
Singapore	2009	2.3	71.8	7.6	20.5	10.1	16	9,121 / 27,657
Thailand	2007	0.21	45.0	18.0	32.0	1.03	66	6,543 / 17,203
Vietnam	2002	0.19	14.5	66.4	17.9	1.04	88	1,346 / 1,537

*Cambodia GERD private, non-profit 50.8% share in GERD in 2002
**World Economic Forum (2011), p. 25 (USPTO Utility Patents grants)
Source: UNESCO Institute for Statistics, Science Profiles; data for Brunei was supplied at the SEA S&T indicators meeting in Chiangmai, Thailand, June 2011. Data on Singapore is from the Agency for Science, Technology and Research, National Survey of Research and Development in Singapore 2009. Data on publications is from Elsevier's SCOPUS and Thomson Reuters ISI's Web of Science as collected in SEA-EU-NET's bibliometric analyses (cf. www.sea-eu.net/bibliometrics and chapters 1–2 of this book).

7.4 Southeast Asian countries' international S&T cooperation policy

Following the overview of S&T indicators for all ASEAN member states, we will look now at some of these countries in more detail, focusing on the most important actors in their innovation systems, S&T policy in general and international S&T cooperation policy in particular. We explicitly differentiate between pull and push factors of international S&T collaboration of representatives from governmental organizations and individual scientists. Our findings on Laos and the Philippines are based on a study-tour undertaken to these two countries in May–June 2011 and on interviews conducted with scientists and representatives from governmental agencies and universities in Indonesia, Malaysia, Singapore, Thailand and Vietnam in the summer of 2008. Secondary data, including academic articles and website information, complement our findings from the field research. Assembling the subchapters on these seven ASEAN countries into a single contribution represented a stern challenge for us. We had to make some compromises due to the overall limitations on length for the whole contribution. Given the fact that Laos and the Philippines had not been included in the previous study in 2008, and that information on their international S&T cooperation policies is still rather scarce, we decided to present our important findings on these two countries more extensively. Nevertheless, additional information on Indonesia, Malaysia, Singapore, Thailand and Vietnam can be found in our 2008 consultation paper.

7.4.1 Indonesia

7.4.1.1 Key characteristics of Indonesia's S&T system and policy

Indonesia is not only the largest archipelago country, with approximately 17,500 islands, but is also the most populous nation in the ASEAN (230 million people as of 2008). The country has recovered after the Asian financial crisis and also weathered the global financial crisis reasonably well. Between 2001 and 2010, Indonesia's annualized growth rate amounted to 5 per cent.[149] Despite the improvements made, most S&T indictors

149 Geiger, Thierry (2011): The Indonesia Competitiveness Report 2011. Sustaining the Growth Momentum, World Economic Forum (WEF), Geneva, p. vii, available online at: http://www3.weforum.org/docs/WEF_GCR_Indonesia_Report_2011.pdf, most recent access date: 26 August 2011

reveal that Indonesia's economic growth is not yet driven by innovation. Some of the indicators even show a downward trend. While R&D accounted for 0.5 per cent of GDP in 1982,[150] this percentage shrank to only 0.08 per cent by 2009 (see table 17). R&D spending by private companies has recently increased but still remains low, similar to patenting activity. When using the USPTO (United States Patents and Trademark Office) patents-to-population ratio as a proxy for innovation, Indonesia's performance was very weak with only 0.0125 patents per million of the population.[151]

Indonesia's public sector is the most important driving force for the country's S&T development. The government followed a strategy of technoliberalism, emphasising technology transfer from abroad and the opening of markets to create attractive investment conditions for multinational companies (MNCs). In some S&T fields, the endogenous development of technologies has been supported. The policy of 'strategic industries', introduced under the former RISTEK[152] Minister, B. J. Habibie (1978–1998), advocated for the picking of winners among industries that were most likely to play a crucial role in economic development. The execution of this policy required the Agency for Strategic Industries (BPIS) to anticipate any shifts from resource- to knowledge-based international business.[153] Although some scholars doubt whether Indonesia followed a coherent set of policies, others have demonstrated the opposite. They argue that S&T policy concepts were included in the country's overall industrial policy as early as the 1970s, when the Indonesian government adopted a system of five-year development plans. The first R&D activities were supported in the fields of agriculture, industry and mining.[154] In recent decades, policy planning has become more sophisticated and has been extended to new areas. Implementation policies were published by RISTEK, and planning was based on the proposals by the National Research Council (NRC), with many Government Research Institutes (GRIs) also being involved. The former RISTEK minister's idea of 'technological leapfrogging', which focused on the support of a series of high-tech project, was, though, much criticized. The fact that the targeted industries were isolated from private industry reduced their prospects for success.[155]

A number of S&T policies and programmes reflect the different objectives and instruments of the Indonesian government. The National Mid-term Development Plan (NMDP) 2004–2009 focussed on: (1) R&D and engineering priorities in S&T for the private sector and the need of society, (2) the enhancement of S&T capacity and capability by strengthening S&T institutions, resources and networks at the central and regional levels, (3) on creating a suitable innovation climate with an effective incentive scheme to foster industrial restructuring and (4) the implantation and fostering of a S&T culture in order to improve Indonesia's civil development.[156]

The S&T priorities included in the NMDP were: (1) food security, (2) new and renewable energy, (3) the transportation system and its management, (4) ICT, (5) medicine and health technology and (6) defence technology. For each area the government published a White Paper that contained quantitative targets for each priority and for different periods and defined the role of the government, GRIs, and universities therein.[157] The NMDP included several programmes. For instance, the S&T Research and Development Programme aimed to advance the quality of national R&D activities in the fields of basic and applied sciences. The objective of the S&T Diffusion and Utilization Programme was to enhance the dissemination and utilization of research findings by the corporate sector and society. The S&T Institutional Strengthening Programme fostered S&T-related organizational capabilities and the Production System S&T Capacity Enhancement Programme enhanced the technological capacity of production systems in the corporate sector.[158] Among the S&T support programmes for the development of new technologies were the RUT (funding of basic and applied research by GRIs), the RUKK (funding of research in humanities and social sciences) and the RUTI (funding of research by Indonesian scientists in bilateral projects with foreign partners). In addition, various programmes were designed to support the introduction of new technology in the manufacturing industry, and to strengthen the framework conditions and the supply of information on existing technologies.[159]

The National Medium-Term Development Plan (RPJMN) was presented by the National Development Planning Agency in February 2010, covering the period from 2010–2014. It is based on the objectives of the National Long-Term Development Plan 2005–2025, on the one hand, and on the vision and mission of the new president and VP-elect on the other. The RPJMN defines the need for increased productivity as one of the most important challenges in the continuation of national development.[160] Eleven national priorities are listed in the plan – including education, health, poverty reduction, food security, infrastructure, investment in the business sector, energy, environment and natural disasters and technological innovation (together with culture and creativity).[161] The plan requests the turning of 'increasing comparative advantage into competitive advantage, encompassing management of maritime resources towards security in energy, food and the anticipation of climate change impacts. This also includes enhancing skills related to technology and the creativity of the youth.'[162]

Indonesia's S&T system is characterized by a large number of actors, especially in terms of governmental agencies and research institutes (see figure 77). Ministries other than RISTEK are involved in policy-making as well. Some have their own (departmental) research institutes. In addition, seven non-departmental research institutes report directly to the president and are coordinated by RISTEK's BBPT (Agency for the Assessment and Application of Technology)[163]:

- LIPI (Indonesian Institute of Sciences)
- LAPAN (National Institute of Aeronautics and Space)
- BATAN (National Nuclear Energy Agency)
- BAKOSURTANAL (National Coordination Agency for Surveys and Mapping)
- BSN (National Standardization Agency of Indonesia)
- BAPETEN (Nuclear Energy Control Board)

The role of the BBPT is to formulate and implement policies for industrial and technological development. Some of the non-departmental research institutes are centrally administered by the Centre for Research, Science and Technology (PUSPIPTEK), located at Serpong, near Jakarta. Six BBPT laboratories and four LIPI institutes were initially established in this science city.[164] The number has since increased to 30 institutes, which jointly employ a total staff of 3,000.[165] Another research institute of national importance is the Eijkman Institute of Molecular Biology, originally founded in 1888 by the Netherlands. In order to support research in biomedicine and biotechnology, the institute was reopened in 1992/93, with a concentration on tropical diseases.[166]

In order to better coordinate the various S&T policies and programmes, the NRC was established in 2002. The 108 NRC members come from academia as well as from the business sector and the government, and are specialized in the S&T areas of the 'Six Focus Programmes'. As an advisory body, the NRC develops policy suggestions and recommendations. The council acts as an intermediary between industrial needs and the national research agenda. Due to Indonesia's large geographical size, regional research councils (RRCs) exist also at the local level, and are designed to coordinate regional S&T policies. In an assessment of Indonesia's innovation challenges, the NRC came to the conclusion that the major challenges to be addressed are how to increase the predominance of public R&D, improve the sector-development approaches, strengthen the weak linkages among S&T actors, increase the currently few techno-economic cluster initiatives and remedy the limited access to knowledge pools.[167]

The newly-established National Innovation Committee (KIN), which directly reports to the president, is trying to address some of these challenges. Set up in May 2010, KIN is headed by Zuhal, the Chairman of the Indonesian Institute of Sciences (LIPI), with the Bogar Agricultural Institute Rector, Suhardiyanto, as Deputy Chairman. The committee is currently creating conditions for the greater involvement of local communities in R&D. Based on the (economic) Master Plan's division of Indonesia into six economic corridors, KIN aims to strengthen the connectivity between centres of excellence, business and government (the so-called Triple Helix Network) in each of these corridors.[168] According to Zuhal, the most important research areas therein are agriculture, energy, medicine and clean water.[169]

150 Indonesian Institute of Sciences (LIPI) (2006): Indonesian Science and Technology Indicators 2006, LIPI, Jarkarta., p. 116
151 Geiger (2011), p. 25
152 Punas Ristek or National Priority Program for Research and Technology
153 Gammeltoft, Peter and Erman Aminullah (2006): The Indonesian innovation system at a crossroads, in: Lundvall, Bengt-Ake / Intarakumnerd, Patarapong / Vang, Jan (eds.): Asia's Innovation Systems in Transition, Cheltenahm, Northampton, pp. 162f
154 Krishna, V.V. (n.d.): The Republic of Indonesia, UNESCO Report, available online at: http://portal.unesco.org/education/en/files/55596/11999604295Indonesia.pdf/Indonesia.pdf, most recent access date: 20 September 2011
155 Gammeltoft / Aminullah (2006), pp. 162f
156 Taufik, Tatang A. (2007): Indonesia's Subnational System Policy and Programmes, Presented at the National Workshop on Subnational Innovation Systems and Technology Capacity Building Polices to Enhance Competitiveness of SMEs, 3–4 April 2007, Jakarta, available online at: http://www.unescap.org/tid/projects/sisindo_s2_tatang.pdf, most recent access date: 20 September 2011, p. 7
157 Simamora, Manaek and Syahrul Aiman (2006): Policy Approaches and support mechanisms to promote innovation in SMEs in Indonesia: A case of Iptekda, Prepared for the National Workshop on Sub-national Innovation Systems and Technology Capacity Building Policies to Enhance Compeititiveness of SMEs, October 27–30, 2006, China
158 Taufik (2007), p. 7
159 GATE Germany (2006): Länderinformation für internationales Marketing für Bildung und Forschung in Deutschland – Indonesien, Bonn, p. 25f
160 Ministry of National Development Planning (2010): Regulation of the President of the Republic of Indonesia Number 5 of 2010 Regarding the National Medium-Term Development Plan (RPJMN) 2010–2014, available online at: http://bappenas.go.id/get-file-server/node/9374/, most recent access date: 20 September 2011, p. 19
161 Ibid., p. 49
162 Ibid., p. 57
163 GATE (2006), pp. 18f
164 Gammeltoft / Aminullah (2006), p. 170
165 PUSPIPTEK (2008): Science and Technology Park, Power point presentation, Jarkata
166 GATE (2006), pp. 18ff
167 National Research Council (NRC): National Research Council of Indonesia, Presentation at the SEA-EU-NET Visitation to NRC of Indonesia, 27 August 2008
168 'President Gives New National Committees Six-Month Deadline', The Jakarta Post 16 June 2010, available online at: http:www.thejakartapost.com/news/2010/06/16/president-gives…, accessed 10 September 2011; 'Role of KIN and 10 Universities for Nation's Competitiveness', Marwati, 1 August 2011, available online at: http://www.ugm.ac.id/ed/?q=news/role-kin-and10-universities-nat…, accessed 10 September 2011
169 'Govt. "Should Focus" Resources to Encourage Innovation'. The Jakarata Post 11 August 2011, available online at: http://www.thejakartapost.com/news/2011/08/11/govt-'should-focus…, accessed 10 September 2011

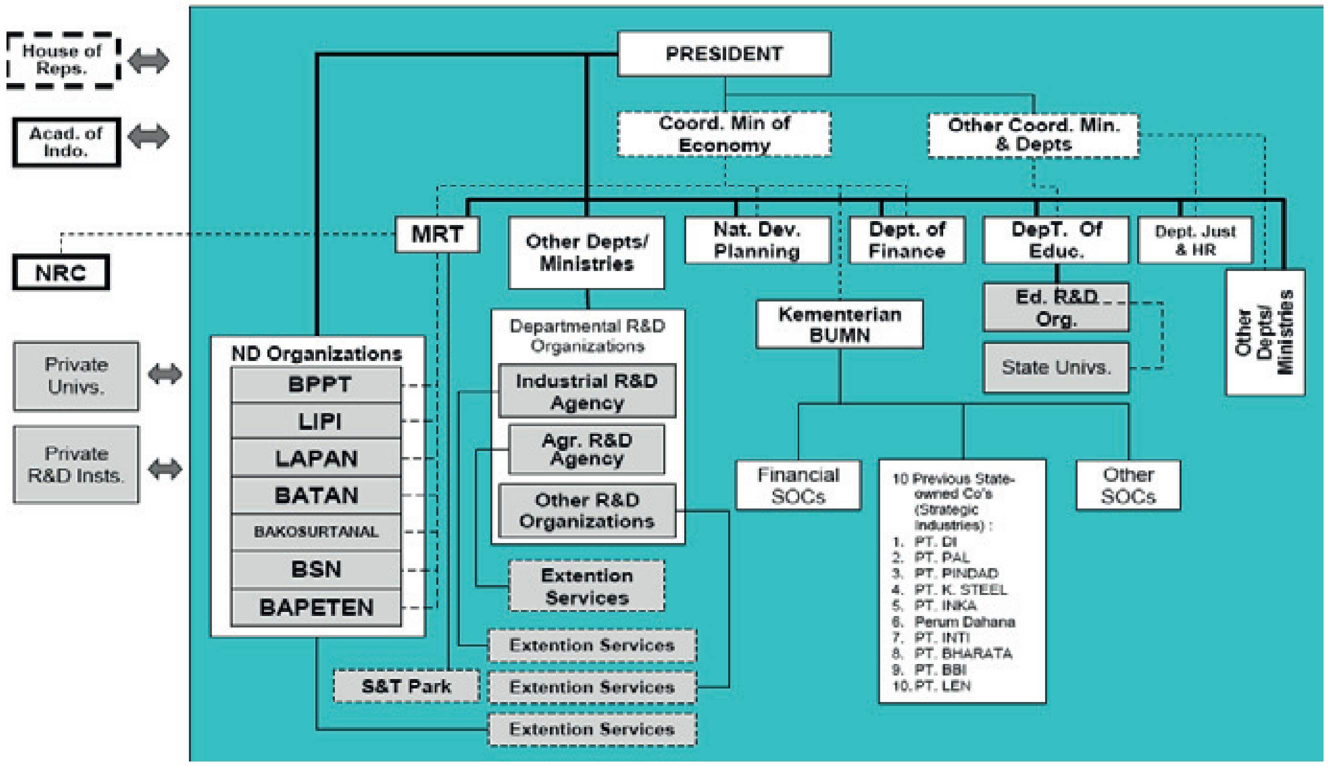

Figure 77: Indonesia's S&T system
Source: Taufik (2007), p. 15

Current S&T policy is based on the government's vision of establishing S&T as the main force driving sustainable development. However, funding to universities and GRIs – such as LIPI or BPPT – remains problematic. Although the government doubled the total state expenditure on R&D between 2005 and 2010, funding and scientific resources were insufficient to support greater research efforts. The departmental GRIs play an outstanding role in R&D. Their share amounted to an estimated 70 per cent of total R&D expenditure in the government sector in 2005. An additional 28 per cent of the total R&D budget was assigned to the non-departmental research institutes, subordinated to RISTEK. The remaining 2 per cent went to local governments' S&T activities. Among all of the GRIs, those under the Department of Agriculture received the largest share, followed by LIPI and the research institutes under the Department of Energy and Natural Resources. The private sector plays a marginal role in financing and undertaking R&D due to the lack of large enterprises, which are generally more engaged in R&D than the smaller ones are. In the Indonesian industrial sector, almost all companies are currently either very small or medium-sized, and seem barely able to invest in the development of any new products and processes.[170]

170 Aiman, S. (2007): Innovation: A key factor to increasing the competitiveness of SMEs – the case of Indonesia, Expert Group Meeting on Promoting Trade Between Asian Subregions, Kunming, China, available online at: http://www.unescap.org/tid/projects/protrade_s3aiman.pdf, most recent access date: 14 October 2008

Government-sector funding for R&D also includes to universities and other institutes of higher education. In 2004, approximately 71 per cent of the latter's R&D funding came from the government.[171] Universities' share of GERD performed remained at the rather low level of 5.6 per cent in the period from 2000–2002.[172] The four most renowned state universities are the Universitas Indonesia (UI), the Universitas Gadja Mada (UGM), the Institut Partanian Bogor (IPB) and the Institut Teknologi Bandung (ITB). The higher-education sector has expanded steadily in Indonesia in recent decades. In 1970, for instance, only 237,000 students were enrolled in the 450 private and government-funded institutes of higher education. By 1990, the number of students enrolled had risen to 1.5 million and the number of institutes of higher education increased to 900. The RPJMN has stipulated that access to university education should increase from an 18 per cent gross enrolment rate to a 25 per cent one by 2014.[173]

7.4.1.2 Indonesia's international S&T cooperation policy

In the last section we discussed the complex network of institutions involved in S&T development in Indonesia. This makes the coordination of policies rather difficult and could have a negative impact on the development of a consistent strategy for international S&T cooperation. Political instability in the past has also contributed to changes in policies and led to inconsistencies in the overall approach. The results of our online questionnaires and interviews during the study-tour tend to support this hypothesis. In this face-to-face contact, representatives from the NRC stressed the significance of weak institutional linkages among GRIs and the general lack of research focus. According to the NRC's survey on innovation policy, approximately one-third of the projects are not in line with the national agenda. This can be explained to some extent by the idiosyncratic preferences of individual scientists, who influence the pattern of international S&T cooperation through a bottom-up process.

171 LIPI (2006), p. 56
172 UNESCO (2008): Draft Regional Report on Asia. Study on National Research Systems. A Meta Review, Paris, France, pp. 20f
173 Ministry of Planning (2010), p. 50

We now turn to the question of what the reasons for international S&T cooperation in Indonesia are. Based on questionnaires and interviews conducted during our study-tour in 2008, we conclude that a mixture of country-specific and global thematic priorities – of co-patenting as well as funding – exist. Transnational learning and innovation benchmarking, in contrast, were rated lower in the assessment of why international S&T cooperation is important (see figure 78).

research funding increasingly becomes more important than before.

At the individual scientist level, the reasons given for international cooperation diverged to some extent from the pattern revealed by government representatives. Up until recently, promotions at GRIs and universities were based not only on academic performance but also on teaching and community service. The latter term is used to describe small-scale projects that have a positive impact on the community that the GRI or university is located in. These projects include, for example, the development of devices for the reduction of environmental problems, the diffusion of agricultural technology, and so on. Given such an incentive structure, most of the scientists did not assess 'co-patenting' as a very important reason for entering into international cooperation (see figure 79). In contrast, access to new S&T knowledge, cooperation networks, exchange of research personnel, access to funding and an increase in reputation were most strongly emphasized by individual scientists. The categories scientific publications, research capabilities, research infrastructure, and the exchange of students were regarded as important, but only to a lesser extent.

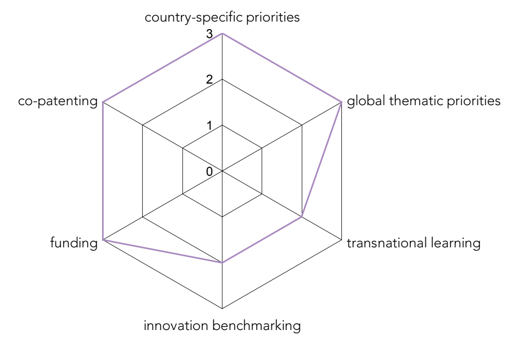

Figure 78: Reasons for international S&T cooperation: the view of governmental institutions in Indonesia
Source: Authors' own assessment based on information from interviews and questionnaires

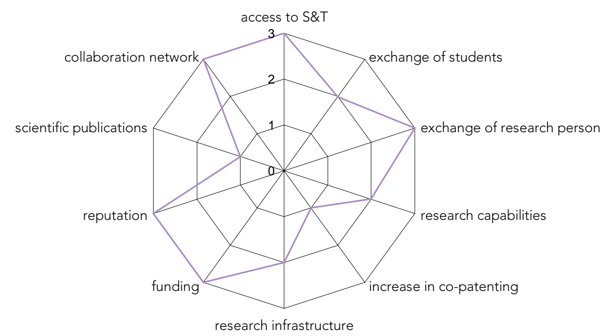

Figure 79: Reasons for international S&T cooperation: the view of scientists in Indonesia
Source: Authors' own assessment based on information from interviews and questionnaires

Funding and access to high-tech research equipment were the major concerns raised during our visits to various departmental and non-departmental GRIs and universities. In 2000, the Indonesian government decided to give autonomy to the four largest universities (UI, UGM, IPB and ITB), turning them into independent legal entities which are now responsible for their own budgets. This policy decision aimed to increase cooperation between universities and industry in R&D, and might reduce the share of basic research in favour of applied research at universities.[174] We might also expect, as a result of the universities' autonomy, a positive influence to occur on international cooperation, as external

174 GATE (2006), p. 26

Fields of international S&T cooperation

We now look at the fields of international S&T cooperation that are most important for Indonesia. For the NRC, climate change, global warming and deforestation are the key thematic focus areas for international S&T cooperation. Although these topics might be easily funded through international cooperation, they do not reflect a long-term strategy with clear objectives and a consistent top-down approach in international S&T. We have also found that some government officials and scientists still think of international S&T cooperation in terms of official development aid (ODA) funding, and not so much in terms of participating and competing in a demanding and ongoing application process. This reality reveals that international research cooperation with Indonesia should be implemented primarily with a few outstanding research institutes and scientists. Due to the slow process of change, however, there is a lack of human resources and funding. Capacity-building programmes are, therefore, necessary to support Indonesia's transition to international research standards in certain S&T fields.

Preferences for specific partners in international S&T cooperation

Generally speaking, the GRIs' level of S&T development has an impact on their international cooperation with specific countries or regions. Some of the Indonesian research institutes are still in the capacity-building stage, with research networks located only among the ASEAN member states. They still are publishing most of their research findings within Indonesia in the national language, Bahasa Indonesia, and not in international journals. These GRIs prefer to enter into 'real cooperation', which includes a long-term approach wherein there is the training of students and post-docs, co-publication and eventually co-patenting. Research cooperation experiences with EU projects and scientists left many Indonesian scientists with the impression that their European counterparts only follow short-term cooperation strategies.

Some of these GRIs that are in the initial capacity-building stage are engaged in traditional S&T cooperation with multinational or regional organizations; for example, with the UNDP and the ADB, working on such topics as the global environment. Other GRIs are already well connected internationally and have very ambitious research agendas, including in the fields of biotechnology, ICT, renewable energy, and environmental sciences. Joint projects financed by the EU Framework Programmes (FPs), however, were very difficult for them to access. Some of the GRIs applied, but most failed to obtain any funding. The application procedures are regarded as too difficult to undertake, requiring a lot of complicated bureaucratic work. Knowledge about how to apply to the FPs was generally lacking in most GRIs in 2008. Generally speaking, there was a lack of information about the FP financing mechanisms and the application requirements among scientists and GRIs. National S&T organizations failed to offer the necessary support to enable a clearer understanding of the programmes.

A common feature in GRIs' international S&T cooperation was, however, that they all had rather strong relationships with Japan as well as some traditional ties with the Netherlands. At the institutional level, these relationships were first established through personal contacts by students or researchers, then supported by exchange programmes and post-doctoral training. Alumni networks for students and long-term personal relationships between Japanese Ph.D. supervisors and their students from Indonesia helped to keep this spirit of cooperation alive. Funding through the Japanese Science Programme and travel grants from the Indonesian government further facilitated the establishment of an S&T partnership between Indonesia and Japan. In contrast to other countries, Japan also offered funding to initiate such cooperation. Indonesia's strong relationship with Japan is also reflected in the list of the current international cooperation agreements as well as in the S&T cooperation of BBPT, LIPI and LAPAN, collected by RISTEK during its visits to these organizations, which are the largest non-departmental GRIs. Research cooperation between these GRIs and Japan occurs mainly in the fields of biotechnology, communications technology and marine science. Cooperation takes place on the basis of a memorandum of understanding (MoU), and it is often not clear as to what extent these framework agreements are active or whether joint research projects are being executed.

Voices from governmental institutions and scientists in Indonesia on international S&T cooperation

Governmental institutions:

"We need support for the identification of potential research partners in the EU. It is difficult to define what the research priorities are in each of the EU countries. Access to funding should be easier, and should consider the thematic research priorities in Indonesia. The exchange of research personnel and students should be less bureaucratic and better funded."

Scientists:

"When S&T cooperation with the EU and Japan are compared, funding from the Japanese side is much easier to obtain. Research networks with Japanese scientists are based more on personal relationships, are long-term-oriented, and involve mutual trust. The EU' FPs are too bureaucratic, and many of the regulations give the impression of mutual distrust."

LAPAN's international cooperation activities focus more on multilateral agencies such as the Asia-Pacific Network for Global Change Research (APN), the ASEAN Sub-Committee on Space Technology and Applications (SCOSA) and so on. At the bilateral level, a mixture of S&T partners from different countries exist in space technology research, including China, Germany, India, Japan and Russia. When studying the list of LIPI's international collaborations, it becomes clear that quite a number of cooperation projects fall into the category of capacity building, because they concentrate on training, exchange of researchers, and general networking. Cooperation with the ASEAN extends to a number of fields and includes scientist mobility programmes, especially

for the awarding of travel grants. Universities are also active in the ASEAN networks, but cooperation is mostly at the faculty level and is strongly diversified. Each faculty has its own programmes, which act independently from each other. There is also a growing interest in their being S&T cooperation with China.

Research cooperation with the US is not well developed. Until the 1960s, many students and scientists went to the US, but this relationship later cooled for a number of political reasons. Only recently has there been renewed interest on the side of both the US and the Indonesian government. According to NRC, most students want to go to the US, Australia or Canada to study. Traditional S&T cooperation with the Netherlands still exists, but its importance seems to have diminished due to more cooperation with Japan, the ASEAN and other European countries.

Summary of findings in Indonesia

In sum, the questions of why Indonesia is engaged in international S&T cooperation, what the most important partners or regions in S&T are, and which fields of cooperation are preferred can be answered as follows:

- International S&T cooperation is viewed by both government representatives and scientists as being very important in order to compensate for existing deficiencies in Indonesian S&T, especially S&T research capabilities, infrastructure and funding.
- There is no specific international S&T cooperation policy, but extra-scientific reasons for collaboration – such as historical relationships/colonial experience (with the Netherlands) – and political objectives – such as regional cooperation policy (ASEAN COST-activity) – shape the collaboration pattern to some extent.
- Cooperation with Japan predominates in Indonesia's international S&T activities. Compared to other partner countries, funding is easier to obtain from Japan and cooperation is based on long-term personal relationships, the mode of collaboration preferred by Indonesian scientists.
- S&T collaboration with the EU and European scientists has essentially taken place within the framework of a centre–periphery relationship; in the past, funding was mostly offered through development aid projects.
- Among Indonesian scientists there is strong resentment about being treated as an 'outdoor laboratory' and as second-grade scientists. The EU FP7 is seen as an opportunity for closer participation on an equal level.

7.4.2 Laos

7.4.2.1 Key characteristics of the S&T system and policy in Laos

The Lao People's Democratic Republic (Laos) is a resource-rich country with a population of around 6.8 million, nearly half of which is below 20 years old. Although social indicators show a strong improvement in recent years, the average annual income in Laos amounted to only US$ 880 (GNP p.c.) in 2009, making the country one of the least developed (LDC) of all the ASEAN member states. Laos' economic transition away from a centrally-planned economy has been quite successful. The market-oriented reform programme, called the New Economic Mechanism (NEM), included the liberalization of foreign trade and investment and was incorporated into the constitution in 1991. The NEM has materialized in higher income from trade and tourism and foreign investment in infrastructure. Economic reforms, investments and success in poverty alleviation have contributed to an annual growth rate of about 7 per cent in the last five years. However, the country is still very much dependent on agriculture both in terms of its contribution to GDP (36 per cent in 2009) and employment (about 80 per cent); only 23 per cent of the population live in cities.[175] In order to become regionally more integrated, Laos joined the Greater Mekong Subregion (GMS) initiative in 1992 and became a member of the ASEAN in 1997.[176] As Laos is not a prominent location for R&D yet, not much has been published with regard to the country's innovation system. The following overview of actors, programmes and international S&T activities is therefore mostly based on the findings during the SEA-EU-NET analysis group study tour to Vientiane that took place in June 2011. Our understanding has profited immensely from talking to experts from the government and from government research institutes (GRIs), to scientists from GRIs and universities as well as to foreign experts and companies.

Laos' innovation system is characterized by very little investment in R&D and a severe lack of human capital for S&T research. According to government representatives' estimates, the GERD amounted to approximately 0.1 per cent in 2009, but should increase to 1 per cent by 2020. The current low level of R&D investment can be explained to some extent by the coun-

175 (ADB) (2011): Asian Development Outlook, online at: http://www.adb.org/documents/books/ado/2011/ado2011.pdf, most recent access date 30 July 2011, p. 250; Phouyavong, S. (2010): Country Report on Information Access and Media and Information Literacy: Presentation for the 5th Asia-Pacific Information Network (APIN) Meeting and ICT Literacy Workshop, November, Manila

176 Oraboune, Syviengxay (2009): Lao PDR and its Development Partners in East Asia (China and Japan, in Mitsuhiro, Kagami (Ed): A China-Japan Comparison of Economic Relationships with the Mekong River Basin Countries. IDE-JETRO, BRC Research Report No. 1, pp. 206–264, online at: http://www.ide.go.jp/English/Publish/Download/Brc/pdf/01_laopdr.pdf (file accessed March 6, 2010), p. 206

try's low economic development level. In addition, the inward-looking economic development strategy of the past did not pay much attention to S&T. Now, the Lao government has embarked on an ambitious roadmap to catch-up and to abandon the LDC status by 2020. Stronger involvement in regional and international S&T collaborations will be of the upmost importance to the achievement of this goal. The new policy direction has been emphasized again in 2010, when the term 'innovation' was introduced into the country's policy planning. However, the implementation of a systemic approach to innovation based on a fruitful exchange of the different actors is very much in its inception. Currently, research takes place mainly in government research institutes (GRIs) and in the context of externally-financed ODA (official development aid) capacity building projects. These projects focus primarily on the Millennium Development Goals (MDGs) rather than on companies and their need for modern technologies. As most research is externally financed by a multitude of different donors, statistics of all projects are not available, not least because such data is not collected by any single government agency. Moreover, the fact that government institutions have been restructured and renamed to better fit the new policy direction in recent years hampers to some extent a complete understanding of those institutions involved in policy-making and programmes.

There are a number of government actors responsible for S&T policy and implementation. While the general S&T policy direction is set by the Lao Government and the Communist Party Central Committee, the Ministry of Planning and Investment (MPI) is in charge of coordinating regional and international S&T cooperation. As international S&T relations always are part of diplomatic and strategic policy-making, the Ministry of Foreign Affairs (MOFA) plays an influential role as well. Under the MPI an Office for Sustainability has recently been established. Depending on the topic, different ministries will be involved in studies related to environmental issues. In energy development, for example, the Ministry of Mining and Energy recently supported a foresight study on energy. The MPI puts strong emphasis on education and S&T development as instruments for fostering the country's industrialization. Higher investments in education and research are seen as necessary, including the encouragement to publish internationally to increase the visibility of Lao research. The establishment of the National Authority for Science and Technology (NAST) was an important step towards an institutional structure supporting S&T. As the successor of the 1992-established State Committee on Science and Technology, the NAST became the authority in charge of S&T policy and implementation in 2007. NAST is subordinated to the Prime Minister's Office (PMO) and has the rank of a (sub) ministry within the central government. NAST comprises departments on S&T, Informatics, Space Technology and the Department of Intellectual Property, Standardization and Metrology (see figure 80). In the middle of June 2011, right after the WP4 group's study visit to Laos, the NAST was elevated to the status of a full ministry, called the Ministry of Science and Technology (MOST). Restructuring will be completed by the end of 2011. Currently, the impact on subordinated administrative units and research organizations is not clear. Therefore, our analysis concentrates on the structure of the governmental agencies before NAST was restructured.

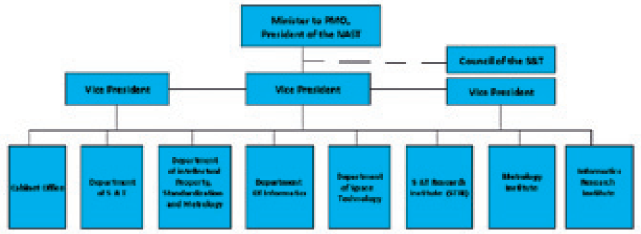

Figure 80: Organizational structure of the NAST in 2010
Source: NAST (2010)

The Department of S&T (DOST) within the NAST/MOST has to work out guidance and strategic plans for S&T development, based on government policies. It is also responsible for formulating S&T-related laws and decrees and for proposing these to the government. According to a DOST representative, his organization is responsible for the coordination and supervision of sectors and local authorities and for the collection and analysis of S&T data.

The coordination and cooperation with international organizations is also part of the DOST's responsibilities. Through this collaboration, the DOST expects to gain experience, financial assistance and enter into a scientific–technological exchange that serves the development of S&T in Laos. Within NAST/MOST there are three GRIs on S&T research (STRI), metrology and informatics. The Information Technology Research Institute (ITRI) was set up in 2007. The institute has been given a crucial role in the implementation of the e-government initiative, launched by the government in 2006. The vision of this initiative is to adopt ICT tools across the different administrative levels.[177] The ITRI has three centres conducting IT-related research. The Network Centre deals with the establishment of the IT infrastructure required for the e-government project, while the Research, Development and Training Centre has the task of the transfer and dissemination of technology. The National Data Centre is accountable for the construction of the national portal and the e-government service centre. Research collaboration exists especially with the National University of Laos (NUOL), but also with scientists at other universities.[178]

The S&T research institute (STRI) serves as a secretary to NAST/MOST and is responsible for all fields – including research, development, technology transfer, promotion, application and S&T services. Within the STRI there are two divisions focusing on thematic issues such as renewable energy and engineering, as well as biotechnology. In addition, the Ecology Centre accommodates the nursery and field trial units, and the Botanical Gardens and Science Park, set up on an area of 98 hectares in May 2011. The General Affairs Division includes the units for personnel and finance, cooperation, information, R&D and services (see figure 81).

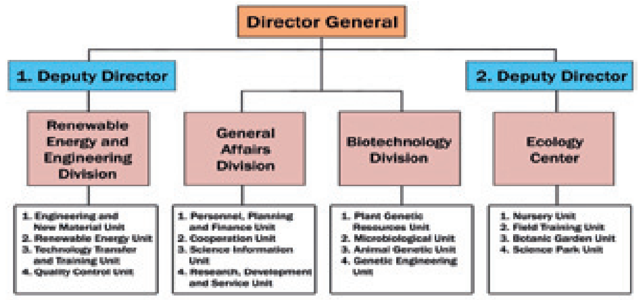

Figure 81: Organizational structure of STRI
Source: NAST (2009)

The funding for the STRI comes mainly from a UN agency, which is currently financing a five-year project (2009–13) for the implementation of a law on biosafety with a budget of US$ 1 million. In biotechnology (BT), research within STRI is undertaken by a total staff of 41 employees, whose academic qualifications vary strongly. While two scientists have a PhD and ten have Master degrees, the other scientists hold only Bachelor degrees; currently, five employees are studying abroad. The establishment of a scientific advisory committee for R&D and risk management is planned with the overall aim to steer research in biotechnology. Due to Laos' high biodiversity, BT research holds strong potential. For example, products based on the development of high-quality local varieties of rice or coffee could be exported as 'organic' to fetch a premium price on the world market. However, national funding to develop organic products is currently insufficient.

While NAST/DOST has the mandate to formulate and coordinate S&T policies, most research institutes are subordinated to line ministries. Figure 82 gives an overview of the GRIs in Laos and their affiliation to specific ministries. Although coordination between NAST/DOST and the line ministries is envisioned, implementation steps and the final organizational structure is unclear. The lack of coordinating power seems to be related to the fact that NAST is not allocating R&D budgets, nor is it undertaking assessment of projects or policies. Nor does it appear to have information about projects proposed or implemented by the line ministries' GRIs. Subordinated to the Ministry of Planning and Investment (MPI), the National Economic Research Institute (NERI) was set up in 1997 as the major academic advisory body on national and provincial socio-economic development strategies. It provides economic data and information and is engaged in the training of officials. The NERI has a total staff of 43, spread across three divisions, i.e. research, training and services. Like most other GRIs, NERI is facing challenges with regard to the professional qualifications of staff and overall budgetary constraints. Although some progress has been made in recent years, most of the staff have limited experience and expertise in conducting large and complex economic research and in the application of sophisticated methodologies and tools. The share of postgraduate staff is still small and interaction with other research organizations, including universities, is limited[179].

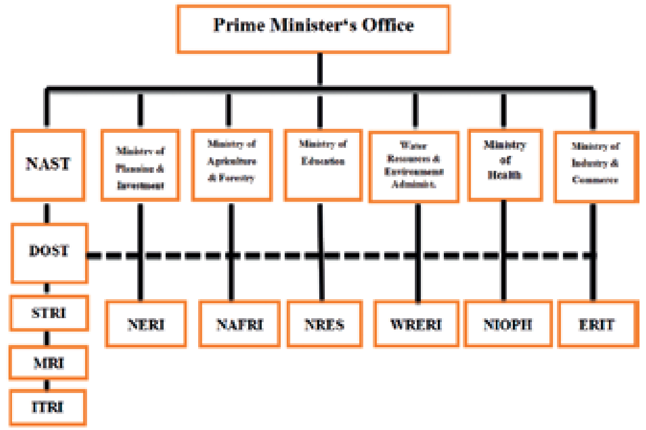

Figure 82: Overview of Government Research Institutes
DOST Department of Science and Technology
ERIT Economic Research Institute for Trade
NERI National Economic Research Institute
NAFRI National Agriculture & Forestry Research Institute
NRES National Research for Educational Services
WRERI Water Resources & Environment Research Institute
NIOPH National Institute of Public Health
STRI Science and Technology Research Institute
MRI Meteorology Research Institute
ITRI Information Technology Research Institute
Source: Compiled from various NAST presentations and publications

The National Agricultural and Forestry Research Institute (NAFRI) is subordinated to the Ministry of Agriculture (MOFA). Established in 1999, NAFRI was mandated to pursue integrated agriculture, forestry and fishery

177 Luanglath, C. (2010): Lao National E-Government Project. ITRI/NAST. Presentation at the Capacity Building Programme on Local E-Government 1–3 December 2010, Seoul, South Korea

178 Phissamay, P. (2010): ICT Infrastructure in Lao PDR. Information Technology Research Institute, Paper Presented in October 2010, online at: http://www.slideshare.net/laonog/ict-infrastructure-in-lao-pdr, most recent access date: 14 September 2011; Phissamay, P. (2011). ICT Development in Lao PDR, online at: http://www.thaiaseanhomeworkers.org/en/index.php?view=article&catid=39%3Apr&id=107%3Aict-development-in-lao-pdr&format=pdf&option=com_content&Itemid=57, 3 August 2011

179 NERI (2007): Strategic Plan 2007–2012. Ministry of Planning and Investment. National Economic Research Institute, online at: http://www.neri.gov.la/Links/NERI%20Strategic%20Plan%202007-12.pdf, most recent access date:10 June 2011, p. 6

research with the aim of providing technical information and management guidelines, and elaborating an agricultural development strategy according to government policies. Existing research centres on agriculture, livestock, fisheries and forestry were combined and restructured in 2007 to better reflect the policy changes. Besides the division on administration and management, NAFRI comprises six commodity-based research centres (rice and commercial crops; horticulture; forestry; livestock; aquatic resources; and, conservation), three non-commodity research centres (agricultural land; agriculture and forestry policy; and, agriculture and forestry research information) and two regional centres (Northern and Southern Agriculture and Forestry Research Centre). Moreover, there are three cross-cutting programmes related to the upland R&D program, national rice research and agro-biodiversity. In 2007, NAFRI revised its research agenda for the period 2007–2012, focusing on improved efficiency, land use management and the feed back of impacts related to agrarian reform to policy-makers.

In 2008, NAFRI employed a total staff of 290, 59 of whom held Master degrees and 45 Bachelor degrees. The improvement of human resource capacity and management is a major focus of the institute's development strategy for 2005–2012. By 2011, the number of PhDs has increased to 10, while most of the academic staff held Masters degrees. The total number of staff declined to some 200, half of whom are now concentrating on research. According to an expert from the National University of Laos (NUOL) many of the NAFRI researchers are NUOL members, undertaking part-time research at NAFRI. Most research activities, however, are driven by ODA institutions, in particular SIDA and CGIAR centres like IWMI, CIFOR and CIAT. Research in NAFRI covers a broad range of topics and follows the general aim of contributing to the solving of specific problems related to agriculture and forestry production.

At the national level, NAFRI cooperates not only with NERI and NUOL, but also with the Research Institute of the Water Resources and Environment Administration (WREA). The Water Resources and Environmental Research Institute (WRERI) is in charge of research, dissemination and implementation of policies, plans and legislation related to water resources, environment, metrology and hydrology. The institute was set up under the auspices of WREA in 2007 and is organized into a division for planning and cooperation and four centres, on water resource research, remote sensing, environmental quality monitoring and environmental research. In water resource research, scientists work on water and hydrological modelling with a focus on the Mekong River Basin. Although some progress has been made in the applications for international scholarships and training programmes by WRERI scientists, the lack of English language proficiency and technical capability still represents barriers for the majority of them. Currently, out of the total staff of the WRERI only one scientist has a PhD, about 20 per cent have Master degrees and all of the others hold Bachelor degrees.

The situation is quite different in the National Institute of Public Health (NIOPH), which was established under the Ministry of Health (MOH) in 1999. Under the former NIOPH director, who was invited to become a member of the National Assembly recently, the institute has been transformed into a recognized regional centre of excellence in public health. The institute comprises six divisions, focusing on research, teaching/training, prevention and treatment. All of these divisions have small budgets funded by international organizations. Among the institute's total staff of 39 employees, there are two PhDs who were trained in Japan as well as two doctorates and one researcher with a Masters degree from Switzerland. Other scientists at NIOPH hold Masters degrees obtained in Thailand, Japan and Laos.

The institute's 4th Five-Year Plan on health research (Master Plan 2007–2011) focuses on the improvement of the health of mothers and children. In order to improve the qualification of medical services and access to the public health system for rural people, the MOH financed the research with US$ 4,000 out of the government budget, while external support provided US$ 60,000. Other topics of research include food safety and the nutritional status of mothers and children, the development of the rural health system, and health research methodology and design for technical staff. Between 2002–2007, the following research projects were completed by NIOPH:

- Child health and nutrition research (Assessment of research priorities and research institutions)
- Completion of health system research projects for the national drug policy implementation
- World Health Survey Lao
- Survey on malnutrition in the southern provinces

Despite the improvements in the qualifications of staff, the NIOPH perceives insufficient research capacity and a lack of knowledge in project administration as major challenges. Proposal writing for third-party funded research projects represents another significant problem. According to the institute's acting director, researchers from NIOPH were only able to participate in FP6 projects because they were part of a joint EU network application. To publish according to international standards is another scope for capacity building. Training can build on the fact that several NIOPH staff members have some experience in international co-publications. To date, NIOPH does not have its own medical journal.

The National Research Institute for Educational Sciences (NRIES) is another GRI. It belongs to the Ministry of Education (MOE) and was established in 2008 after being reorganized. NRIES is responsible for the development of the curriculum (including higher education

curriculum) and research.[180] NRIES has four divisions, including research, student affairs, universities/post graduates and administration. Including the Director General of NRIES the total staff amounts to 35 employees. Recently, the institute has been involved in the planning of community colleges and aims to become a 'Commission of Higher Education' by 2015, coordinating the 154 institutions of higher education, including the national universities. On curriculum development, NRIES has recently completed a study on the standards of education, comparing Laos with 20 other countries on the basis of which it recommended the necessary standards that should be applied to all universities and the private sector.

Currently, the Asian Development Bank (ADB) supports the development of higher education with a grant of US$ 24.8 million from 2011–2016, designated for the expansion and improvement of three public universities – the NUOL, Dong Dok in Vientiane, the Champasak University in Pakse and the Souphanouvong University in Luang Prabang. The project finances also the promotion of research capacities, including skills in scientific working and writing for academic staff. There is also the plan to upgrade the NUOL's Research Coordination Committee (RCC) to a national research centre to encourage the three university faculties to submit research proposals to the government and other government agencies, including the private sector.[181]

In addition to the GRIs, the institutions for higher education conduct research. The NUOL is the largest of the three universities, established in 1995 by merging the 10 existing institutions of higher education into the National University. In 2009, NUOL comprised 11 faculties, 7 centres, 10 administrative offices, a School for Talent and Ethnic Minorities and libraries, with around 41,000 students and a total teaching staff of 1,129. The university's staff included 60 PhDs, and 508 Masters and Bachelor degree holders. Research at NUOL focuses on social and natural sciences, including subjects on demography, education, environment, language, agriculture, forestry, and engineering (NUOL 2010). Currently, the university puts emphasis on applied research.

Although NUOL is regarded as being the best university in the country for education and training, it has not yet contributed much to research. In order to foster research at NUOL, the RCC was established as the facilitator for academic staff who are interested to conduct research. New research topics have been proposed by the RCC – among others, knowledge economy, disaster prevention, higher education, models and best practice in research. Academic staff/professors can apply for funding in one of these fields. The RCC has requested from the government a research budget of some US$ 50,000 for 2011; research equipment is financed from a separate budget.

In some faculties, research is difficult to conduct due to the lack of state-of-the-art equipment. The Faculty of Engineering in particular is faced with this challenge. The faculty comprises seven departments (civil, mechanical, electrical, electronic and telecommunication, road–bridge and transportation, IT and computer and water resource engineering) with around 6,000 students enrolled. Out of the total staff of 289, 17 have a PhD and more than half of the remaining staff hold Masters degrees. Faculty representatives stressed the obstacle that no government funded system for doctoral students exists and that they are thus dependent on external funding.

In the Faculty of Environmental Sciences, teaching courses focus on water and solid waste treatment, sustainable development and environmental protection. Research concentrates on all topics related to environmental management, including water treatment. The faculty cooperates with WREA, using external funding to work together. At present, the faculty has a teaching body of 63 lecturers, of which 20 are on study leave, two of them in Thailand and Canada respectively. Some of the teaching staff have a Master degree from European countries, including Germany, the Netherlands and France.

The enterprise sector's role in financing and undertaking R&D is still marginal, though there are some larger state-owned enterprises in transportation, water supply and the pharmaceutical industry. Laos' private sector is characterized by the predominance of micro-, small- and medium-sized enterprises. Based on the 2006 industrial census, the number of enterprises amounted to around 127,000 with two-thirds operating in the domestic trade services sector and 19 per cent in manufacturing.[182] ODA projects have contributed to the fast increase of the number of private enterprises and their share in investment.[183] The contribution of small enterprises to R&D is limited, although exceptions do exist. Sunlabob is an international award-winning private company, based in Vientiane, which is engaged in the development of decentralized energy systems in Laos and neighbouring countries. Some of the spare parts for solar water heaters, photovoltaic systems and solar bulbs and other renewables energy appliances are produced in Laos and local technicians are involved

180 UNESCO (2011): World Data on Education. IBE/2011/WDE/LS, online at: http://www.ibe.unesco.org/fileadmin/user_upload/Publications/WDE/2010/pdf-versions/Lao_PDR.pdf, most recent access date: 2 August 2011, p. 4

181 Asian Development Bank ADB (2009a): Lao PDR: Strengthening Higher Education Project. Project Administration Memorandum, online at: http://www.adb.org/documents/pams/lao/42134-LAO-PAM.pdf, most recent access 15 July 2011, p. 4

182 ADB (2009): Proposed Asian Development Fund Grant for Subprogram 2. Lao PDR: Private Sector and Small and Medium Sized Enterprises Development Program, online at: http://www.adb.org/Documents/RRPs/LAO/35304-01-LAO-RRP.pdf, accessed 20 August 2011, p. 9

183 ADB (2009b): Lao People's Democratic Republic. Country Strategy and Midterm Review, online at: http://www.adb.org/Documents/CSPs/LAO/2007-2011/CSP-LAO-2007-2011.pdf, most recent access date 5 August 2011, p. 3

in the installation and maintenance of the facilities. The Lao Institute for Renewable Energy (LIRE) is another example of R&D in the sector of environmentally-friendly technology. As a non-profit association, aligned under NAST, LIRE is cooperating with a number of international ODA organizations and private companies to develop cost-efficient solutions to energy supply constraints in remote parts of Laos and water treatment systems for both rural and urban areas. Recent innovations are, for instance, pico-hydropower stations built to generate electricity from small streams and photoactive systems to purify waste water. To explore the bio-energy potentials of the treelet Jatropha curcas, LIRE has also worked together with the Faculty of Engineering at the NUOL.

7.4.2.2 The international S&T cooperation policy of Laos

The Lao government has put strong emphasis on the development of S&T as a driver for economic development. In its National Socio-Economic Development Plan (2006–2010) the country's Committee for Planning and Investment (CPI) requested action to: 'create a technologically advanced nation with a highly skilled workforce. Upgrading the science and technology sector will reduce the disparities between Laos and other countries in the region and facilitate economic integration'.[184] With regard to the period 2006–2010 the CPI stressed the importance of international S&T cooperation (CPI 2006: 132):

The Lao PDR will widely cooperate in scientific research and train researchers in the science and technology of regional countries and of the world. First, in cooperation with the neighbouring countries, the Government will motivate the Lao peoples to develop the use of science and technology. It will improve the organization of people and attract foreigners to invest in the development of science and technology in the country. It will motivate the expatriate experts, particularly the excellent Lao experts who permanently live abroad to return to teach and organize activities on science and technology.

The CPI gives some hints as to the priorities of particular fields of research. It stresses the importance of S&T for the development of agriculture, especially for high productivity and high value crops and animal varieties, post-harvest and agro-processing technologies. Biotechnology is another field of research which is regarded as crucial for agriculture. For the industrial sector, research and application for increased competitiveness were mentioned by the CPI as well, but without any special focus.

Although international S&T collaboration is generally regarded as essential, neither the CPI nor NAST (or its sub-agencies) have designed a common national strategy that specifies sector or partner countries for collaboration. This could be explained by the situation of Laos' international S&T collaboration being mainly based on ODA-related activities with a multitude of different international partners. Based on the interviews conducted with governmental institutions and GRIs in June 2011, we found that the main incentives for collaboration are funding, country-specific aspects and transnational learning, while innovation benchmarking and co-patenting were not yet important rationales for collaboration. However, global thematic priorities, especially those related to environmental issues and climate change, play a role in Laos as well (see figure 83). In the discussion with representatives from the NAST, the intensification of Laos' international S&T collaboration was also understood as being part of the ASEAN policy direction.

With regard to studies on environmental issues, the largest donor institutions – the ADB and the World Bank – have recently been approached by the WRERI, in order to request funding for infrastructure and capacity building so as to establish a system of national laboratories for the monitoring of water quality. The World Bank is already financing the establishment of an inventory for water resources. Research collaboration with European partners have been conducted by WRERI through the ASIA-LINK programme, as well as through the CALIBER programme that provides training for research staff members at the AIT Bangkok and at the Universities of Manchester and Colorado. Some of the staff at WRERI have also received grants for scholarships and training funded through the Erasmus Mundus programme. Research cooperation in water resources and environment takes also place with the EU, for example in the SPLASH project (European Union Water Initiative Research Area Network).

According to the HIOPH's director, the institute participated in an FP6 project on poverty and illness (POVILL), which had a focus on rural poor and health assistance schemes. In this project, NIOPH was involved in the household survey in Laos. Currently, NIOPH cooperates with a large number of foreign institutions, both on the regional and international level. Among the partner organizations from Europe are the Institute of Development Studies, UK, and the Karolinska Institute, Sweden. Regionally, joint projects are conducted with Vietnam and Cambodia on hepatitis, and with Thailand and Japan on various topics. Through the Japanese ODA-funding organization JICA, cooperation in this field is financially supported. Nine scientists from different Japanese universities have conducted studies within a Health Development Studies (HDS) project, which was completed in October 2009. Other collaboration has been undertaken with the Nossal Institute, Australia, and the Institute of Health Economics, Canada.

184 Committee for Planning and Investment (CPI) (2006): National Socio-Economic Development Plan (2006–2010), Vientiane, October, p. 6

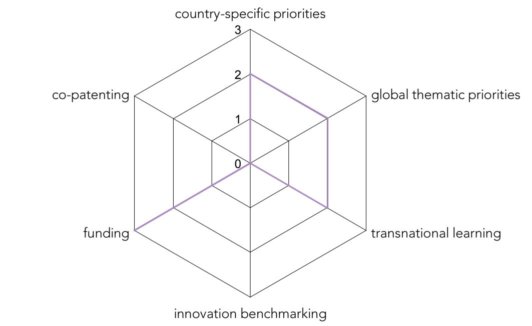

Figure 83: Reasons for international cooperation: the view of governmental institutions in Laos
Source: Authors' own assessment, based on interviews conducted in Laos

Cooperation in agricultural research is funded by many of the donor countries and institutions, including the Australian Centre for International Agricultural Research (ACIAR). The focus of ACIAR is on the upland regions and agricultural diversification. The SDC (Swiss Agency for Development and Cooperation) supports applied research and human resources development in agriculture and a program for biodiversity.[185] The Swedish funding agency SIDA has traditionally been an important cooperation partner for the National Agriculture and Forestry Research Institute (NAFRI). SIDA is the only funding agency that lists 'research' as one of the key focus areas in its cooperation with Laos (MPI 2010: 50). NAFRI cooperates with regional partners – including China, Vietnam and Thailand – with a focus on rubber and forestry research. Collaboration with Japanese scientists concentrates on rice research and with Korea scientists on Jatropha. Within NAFRI, many departments receive external support for staff qualification programmes, including exchange programmes with Germany, the Netherlands and France.

The NUOL has a broad international network of research partners, especially at the regional level. According to the head of the Lao Embassy's Educational Division in Bangkok, Somchit Paseutsak, the university is:

'following government policy on international relations, the National University of Laos (NUOL) as the highest educational institution of the nation is eligible in academic cooperation with foreign educational institutions and organizations. The NUOL has signed the memorandum of understanding (MOU) with 83 foreign universities and institutions in 15 countries, namely: 12 universities in the socialist Republic of Vietnam, 15 universities in Japan, 7 universities in China, 10 universities in Thailand, 9 universities in the Republic of Korea, 9 universities in France, 3 universities in Canada, 4 universities in New Zealand, 2 universities in Australia, 2 universities in Sweden, 3 universities in Germany, 4 universities in USA, 2 universities in Cambodia, 1 university in Denmark and 1 university in Poland'. (sic!)

The university's preference for cooperation within the region was explained by NUOL experts as a result of the lack of national travel funds and limited financial support from the university. NUOL's cooperation with foreign universities often takes the form of scholarship programmes and student exchange. In some cases, experts from foreign universities are also invited to teach. This is, for example, the case in the ICT department, which invited a professor from Singapore to lecture in Laos for a postgraduate course. Funds are borne from different sources. In ICT, some equipment was supplied by Singapore, while the Korean Foundation of Advanced Studies offered software and SIDA staff training.

To summarize, international research cooperation by the GRIs and the NUOL concentrates mainly on partners within the region and research in the fields of health, agriculture and water resources. European countries play a role as traditional partners for Laos, especially France. But due to political and historical reasons, neighbouring GMS countries, in particular Vietnam, and the regional powers China, Japan and South Korea are also all important players. The lack of data for all ODA-related research activities hinders, though, the provision of a full picture of the scope of Lao international research collaboration.

On the individual scientist level, the rationales for international research cooperation covers a broad spectrum of motives (see figure 84). Most important for scientists is the access to S&T, the exchange of students and research personnel. Following the introduction of new incentives for academic careers, young Lao scientists in particular are eager to enter into cooperation so as to increase their research capabilities and reputation and are interested in co-authorships with foreign scholars. Publications in national and international journals have become an important criterion for promotion within the university, especially for the positions of associate and full professorships. Today, the requirements for full professorship include the previous publication of at least two articles in international journals. The lack of modern equipment and laboratories represents another incentive for international collaboration, because it offers access to the research infrastructure of the partner organization.

185 Ministry of Planning and Investment (MPI) (2010): 2010 Development Partner Profiles, Vientiane, pp. 5, 53

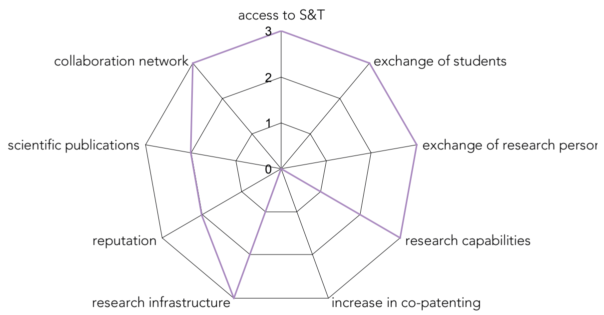

Figure 84: Reasons for international S&T cooperation: the view of the scientists in Laos
Source: Authors' own assessment, based on interviews conducted in Laos

For scientists in GRIs and the NUOL the identification of potential partners for international collaboration represents one of the greatest challenges. Another is the lack of mobility funds in order to participate at regional and international conferences. There is a strong interest in international cooperation with European partners, especially because they are assessed by scientists in Laos as being very experienced in advanced S&T research. Although the FP7 programme is attractive for Lao scientists, many of them lack fluency in English as well as methodological and writing skills. Moreover, the proactive approach of looking for international research partners and funding requires also a change in attitude. While access to ODA-related project funding is relatively easy, international research funding programmes, such as the FP7, are highly competitive. To participate in this programme requires a strategic and proactive approach.

Key findings in Laos

Summarizing the situation of international S&T cooperation in Laos, the following points are important:

- The S&T landscape is highly fragmented with a number of institutions in charge of policy implementation but no major organization overseeing and coordinating the whole sector.
- Although the establishment of the NAST in 2007 has been an important step toward better coordination of S&T policies, most research institutes are subordinated to, and financed by, line ministries.
- Given the manifold development challenges Laos is facing, the implementation of the new policy direction in international S&T and the recognition of newly-established institutions for S&T policy coordination might require more time than in other countries.
- Research funding comes mostly from donor organizations as part of ODA-related projects. The fragmentation of funding and projects explains to some extent the fact that comprehensive S&T statistics are missing.
- Many GRIs and universities lack proper facilities and a sufficient number of qualified human resources to be able to conduct research according to international standards.
- Due to Laos's dependence on ODA funding, preferences for specific countries and regions as partners in S&T play a minor role. However, research cooperation with regional partners seems to be quite important, while cooperation partners outside of the region play a crucial role in terms of funding.
- International S&T cooperation is assessed by government representatives as an important step towards greater regional and international integration and higher competitiveness.
- Research collaboration with European partners is highly welcome, because it allows access to advanced S&T research.
- So far, only a few research projects with the participation of Lao scientists exist, especially in health, agriculture and water resources. In these fields an increased number of better trained local researchers would be needed to expand cooperation in EU-funded projects.
- At the national level, scientists appreciate the new S&T policy that allows better cooperation with foreign experts but stress the lack of mobility funds and necessary support to improve overall communication, especially skills that relate to research applications.
- Most interview partners stressed the need for human resource development in their respective organizations prior to any larger international research collaboration, in order to bridge the gap between national and global standards.
- Thus, for the time being, international partners should take the lead in research programmes.
- Ideally, international donors should also provide funds for courses in project proposal writing, scientific working and reporting, so as to enhance the research capability of Lao partners.
- As the contribution of private national enterprises to S&T and innovation is negligible, interview partners seem to be unaware about the potential collaborations might have to foster this sector in Laos.

7.4.3 Malaysia

7.4.3.1 Key characteristics of Malaysia's S&T system and policy

Malaysia is one of the smaller ASEAN member states in terms of population (as of 2008, 27.5 million people)

but has enjoyed a successful transition from a low- to a medium-level income country. Recent statistics show that Malaysia weathered the global financial crisis quite well and was able to increase the income p.c. (GNI) from US$ 5,308 in 2005 to US$ 8,256 by 2010.[186] Since the introduction of the first development plan in the 1960s, the Malaysian government has emphasized the crucial role of S&T for the country's development and has incorporated technological catch-up into medium- and long-term plans.[187] Parallel to the national five-year plans, special S&T plans were introduced. Malaysia's first long-term S&T plan (Action Plan for Industrial Technology Development, 1990–2000) was designed to tackle the shortcomings in the innovation system by introducing new S&T institutions.[188] Financial schemes intended to promote S&T development in strategic sectors and key priority areas were implemented. After a review of the first S&T plan, the Second National S&T Plan was published in 2003 for the years until 2010. One of its main objectives was to bring government, industry, universities and GRIs closer together. The plan requested an increase in R&D expenditure as a percentage of GDP to 1.5 per cent, and human resources for R&D to rise to 6 researchers, scientists and engineers per 1,000 people in the labour force by 2010.[189] These ambitious goals have not been achieved thus far, despite the support that has been provided by a number of funding programmes and initiatives.

Malaysia's S&T system is currently undergoing some changes in order to better coordinate the various actors and support the implementation of the new, ambitious policy goals. An example is the establishment of the National Nanotechnology Directorate (NND) in 2010 under MOSTI, which demonstrates strong support for this new research field. The Directorate coordinates and should synergize the development activities that are specified in the Nanotechnology Roadmap for 2011–2020 that was presented to the National Innovation Council.[190] Established in 2011, the AIM (Agensi Inovasi Malaysia) was created as a statutory body managed as well by the Prime Minister's Office. It is mandated to identify innovations that could solve problems faced by companies and their customers, using commercialization laboratories.[191]

The MOSTI continues to be the leading governmental institution for policy formulation and implementation (see figure 85). It provides most of the funding for research through various research funds such as the Techno Fund, the Science Fund and the programme for the Strategic Thrusts of Research Areas which have a specific focus, for example, on biotechnology, IT, industry, sea and space. Besides MOSTI, there are other ministries involved in S&T, including the: Ministry of Agriculture, Ministry of Health, Ministry of Plantation Industries, Ministry of Energy, Green Technology and Water, Ministry of Natural Resources and Environment, Ministry of Education, Ministry of Higher Education and Ministry of International Trade and Industry.[192] As an advisory body, the National Council for Scientific Research and Development (NCSRD), which provided advice and policy directions on S&T to MOSTI, was replaced by the National Science and Research Council (NSRC) in late 2010. A few months before, in July 2010, another new institution called UNIK (Unit Inovasi Khas) was set up directly under the Prime Minister's Office to oversee the integration of innovation policies. The government wants to streamline and restructure the S&T system as there so are many departments and agency currently involved in it .[193]

New GRIs have been established by the government in various fields in the last few years, with the special mission of supporting sectors of strategic importance. Traditionally, GRIs concentrated on agriculture (for example, research in commodity crops such as rubber, palm oil and cocoa).[194] Newly-established GRIs have instead been oriented towards the strengthening of industrial development in such fields as ICT, microelectronics, nuclear technology and biotechnology.[195] In addition, a specific research institute with the mission of supporting technology transfer to small- and medium-sized enterprises (SMEs) and guaranteeing improvements in the areas of industrial standardization and quality was established in 1996 as the Standard and Industrial Research Institute for Malaysia (SIRIM).[196]

The business sector has become an important actor as well. Between 1992 and 2004 its share of overall R&D investment grew from approximately 45 per cent to 71 per cent. In the same period, the government sector's

186 Economic Planning Unit of the Prime Minister's Department (2010): Tenth Malaysia Plan 2011–2015, available online at: http://www.pmo.gov.my/dokumenattached/RMK/RMK10_Eds.pdf, most recent access date: 10 September 2011, p. 36
187 Asgari, Behrooz / Yuan, Wong Chan (2007): Depicting the Technology and Economic Development of Modern Malaysia, in: Asian Journal of Technology Innovation 15(1), pp. 171–3, 179
188 According to Asgari and Yuan (2007), p. 180
189 Kamel Mohamad (2010): The Second National Science and Technology Policy (STPII), Presentation by the Ministry of Science, Technology and Innovation, December 22, 2010
190 Opening Remarks by YB Datuk Seri Dr Maximus Johnity Ongkili, Minister of S&T at the International Conference on Nanotechnology Research and Commercialization in Kota Kinabalu, 7 June, 2011
191 OECD (2011b): Review of Innovation: Southeast Asia, Paris, 2011 (forthcoming)
192 Ibid.
193 Day, N. / Amran bin Muhammad (2011): Malaysia. The Atlas of Islamic-World Science and Innovation Country Case Study No. 1, San Francisco, USA, p. 19
194 Well-known GRIs in this field are the Rubber Research Institute of Malaysia (RRIM); the Palm Oil Research Institute Malaysia (PORIM), which was merged in 2000 with the Palm Oil Licensing Authority into the Malaysian Palm Oil Board; the Malaysian Cocoa Board; and the Malaysian Agricultural Research and Development Institution (MARDI).
195 Examples are the Malaysian R&D in ICT and Microelectronics (MIMOS); the Malaysian Institute for Nuclear Technology Research; and the Institute for Medical Research.
196 In 2002, the Malaysian Agricultural Research and Development Institute employed 407 personnel; 358 R&D personnel were working in the Palm Oil Research Institute of Malaysia and 295 in the Forest Research Institute Malaysia.

share fell from 46 per cent to 28 per cent.[197] Large MNCs dominate R&D in the business sector, although 95 per cent of firms are SMEs. Among the domestic companies, large, state-owned companies from the automobile, oil and gas and palm oil industries are the most important actors.[198] Malaysia's R&D expenditure by type of research demonstrated some changes between 1992 and 2004 as well. The share of basic research increased in this period from 12.5 per cent to 16.2 per cent. In contrast, the shares of applied research and experimental development declined from 62.7 per cent to 55.2 per cent and from 38.2 per cent to 28.5 per cent respectively.[199]

Universities also conduct R&D, although only a limited number play a role in research and for the provision of scientific, technological and engineering courses and training.[200] Those designated as research universities by the government are: the University of Malaya (UM), the University of Putra Malaysia (UPM), the National University of Malaysia (UKM), the University of Science Malaysia (USM) and the University of Technology Malaysia (UTM). The universities' share of R&D performed grew from 9.2 per cent in 1992 to 18 per cent by 2004. Generally speaking, the government expects the universities to become more involved in transnational research collaboration and has supported their development through a set of new policies, including the National Higher Education Plan 2020 and the National Higher Education Action Plan 2007–2010.[201]

197 MASTIC (2006): MOSTI Facts & Figures 2006, available online at: http://www.mastic.gov.my/portals/mastic/publications/MOSTIFacts_Figure/Facts&Figures2006.pdf, most recent access date: 23 September 2011, p. 17.
198 OECD Review of Innovation in Southeast Asia, Paris, 2011 (forthcoming)
199 MASTIC (2006), pp. 20, 35
200 Asgari and Yuan (2007), p. 86; Krishna, V.V (Report Malaysia): The Science and Technology System of Malaysia, UNESCO, available online at: http://portal.unesco.org/education/en/files/55597/11999609765MALAYSIA.pdf/MALAYSIA.pdf, most recent access date: 23 September 2011
201 Morshidi, S. / Sadullah, Ahmad Farhan / Komoo, Ibrahim / Lie, Koo Yew / Nik Meriam, N.S. / Norzaini, A. / Farina, Y. / Wong, W. (2010) Research Collaboration in an Expanding Higher Education Market in the Asia-Pacific: The Experiences of Malaysian Universities, in: Findlay, Christopher / Tierney, William G. (2010): Globalisation and Tertiary Education in the Asia-Pacific. The Changing Nature of a Dynamic Market, World Scientific Publishing, Singapore, p. 206

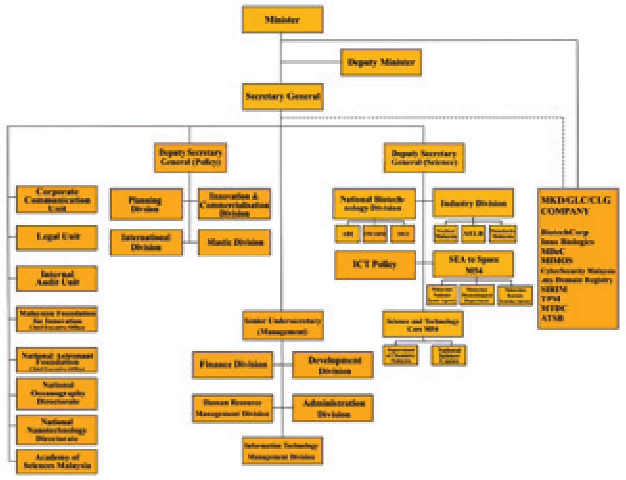

Figure 85: Organization chart of Malaysia's S&T system
Source: MOSTI website

Malaysia's long-term VISION 2020 sees the country as a fully-developed economy by the year 2020. It focuses on nine strategic challenges, the sixth being innovation in the context of the quest that Malaysia 'must confront the challenge of establishing a scientific and progressive society, innovative and forward-looking, which is not only a consumer of technology but also a contributor to the scientific and technological civilization of the future'.[202] In this context, it is interesting to note that the last five-year plan 2006–2010 stressed the greater participation of women in S&T. This policy decision aims to strengthen the incentives for women to go into sciences and, thus, to compensate for the shortages of skilled labour. The plan also emphasized the promotion of international standards in tertiary education through the enhancement of the public service system and international cooperation. In addition, the five-year plan announced that a National Innovation Council (NIC) and a National Brain Gain Programme were to be established. In the newly-designed Tenth Malaysia Plan (2011–15), innovation figures highly as a vital ingredient for productivity and competitiveness. Given the decline of the GERD from 0.69 per cent in 2004 to 0.21 per cent in 2008, the government set a new goal to increase R&D expenditure to 1 per cent by 2015. The plan stresses four key dimensions for the Malaysian innovation system to develop: (1) shaping a supportive ecosystem for innovation; (2) creating innovation opportunities; (3) putting in place innovation enablers; and, (4) funding innovation.[203]

Among the ambitious programmes implemented for the country's technological catching-up are the Malaysian Information Technology and Multimedia Agenda and the programmes on biosciences and engineering.

202 European Trend Chart on Innovation (ETCI) (2006): Annual Innovation Policy Trend Report for SE Asia Countries, http://www.proinno-europe.eu/docs/reports/documents/Country_Report_ASIA_COUNTRIES_2006.pdf, most, recent access date: 10 August 2008, pp. 31–5
203 Economic Planning Unit of the Prime Minister's Office (2010), p. 80

According to the Ministry of Science, Technology and Innovation (MOSTI), Malaysian industry will need support for the further developing of the following key technology areas: advanced manufacturing and materials, microelectronics, biotechnology, ICT, multimedia technology, energy, aerospace, nanotechnology, photonics and pharmaceuticals.[204]

7.4.3.2 Malaysia's international S&T cooperation policy

We now turn to the question of what the reasons for international S&T cooperation in Malaysia are. International S&T cooperation was assessed by most representatives from governmental institutions, during our study visit in 2008, as being very important. As an open economy which relies heavily on technological transfer from abroad, government policy has been designed to increase the country's absorptive capacity and to cooperate with foreign partners in R&D. Looking at the reasons for international cooperation in more detail, the authors concluded that country-specific priorities played a crucial role. Global thematic priorities, on the other hand, were important as well, especially with regard to ICT. Transnational learning, innovation benchmarking and co-patenting were ranked as being equally important. The shortage of skilled labour was an additional driver for international cooperation. The Malaysian government is paying great attention to this topic and established a special programme (Brain Gain Malaysia) at the beginning of December 2006. The objective of this initiative is to leverage the talent pool of the Malaysian Diaspora and/or foreign researchers, scientists, engineers and technopreneurs for the key industries that Malaysia wants to become internationally competitive in. Research funding, in contrast, did not play an important role as a reason for international cooperation, as the government was essentially able to secure research funding.

204 Ministry of Science and Technology (MOSTI) (n.d.): Malaysia's S&T Policy for the 21st Century", available online at: http://www.mosti.gov.my/mosti/images/pdf/dstn2bi.pdf, most recent access date: 15 September 2011

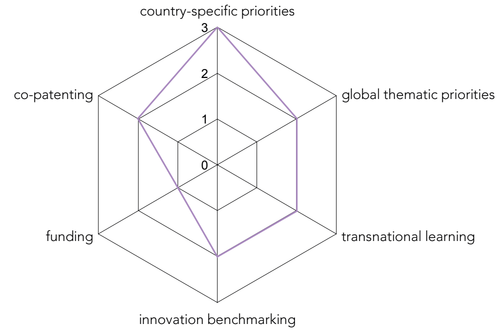

Figure 86: Reasons for international S&T cooperation: the view of governmental institutions in Malaysia
Source: Authors' own assessment based on interviews

From the perspective of individual scientists, the reasons stipulated for international S&T collaboration diverged to some extent from those given by government representatives (see figure 86). Due to the fact that GRIs and universities generally had access to funding and that the research infrastructure was well developed, these factors also did not rank highly as triggers for international S&T cooperation. That co-patenting was also not regarded as being very important for international S&T cooperation fitted with the critique that there was a general lack of commercialization of research findings on the part of scientists. Those factors that did figure highly for scientists were the various forms and the impact of S&T cooperation – including scientific publications, reputation, research capabilities, exchange of research personnel and access to new S&T (see figure 87).

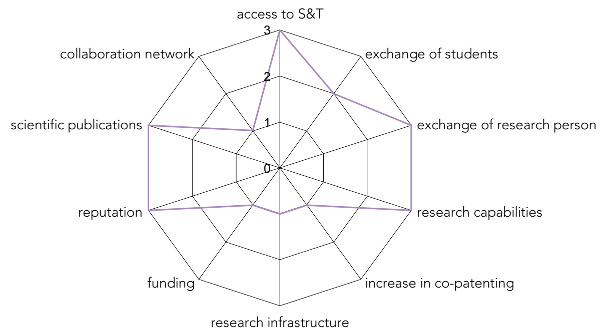

Figure 87: Reasons for international S&T cooperation: the view of scientists in Malaysia
Source: Authors' own assessment based on interviews

The most important thematic focus areas for international S&T cooperation presented to us during the discussion in Malaysia were: 1) genomics and molecular biology, 2) nutraceuticals and pharmaceuticals, and 3) agricultural biotechnology.

Preferences for specific partners in international S&T

According to representatives from the Malaysian governmental agencies, preferences for specific partners in international S&T cooperation were not predetermined and did not exist. They, instead, described the choice of collaboration partners as being 'research driven'. However, mobility funds and funding for international collaboration networks by the government were rather limited in 2008 and as such were not very encouraging for scientists. The focus of the government was on the creation of a general framework for scientists' international cooperation through officially-established bilateral S&T agreements with other countries. Within the wider Asia-Pacific region, these agreements existed for example with Australia, China, India, New Zealand, South Korea and Vietnam. While S&T cooperation agreements (MoUs) with Australia and South Korea had already been established since the middle of the 1980s, most other agreements were only signed in the 1990s, while those with the DPR of Korea, Pakistan and Russia were formulated between 2002–2005. Unsurprisingly, for a long time no MoU existed with the US as relations with that country have traditionally been more difficult and even stagnated to a certain extent after 9/11. The political climate has, however, improved, and both governments signed a MoU over S&T cooperation in 2010.[205]

Traditionally, cooperation in S&T was strongest with the UK, due to colonial ties and their concomitant linguistic parity. The widespread use of English and the similarities in the educational systems have positively contributed to an intensive exchange of students between Malaysia and the UK. Built on alumni networks with UK research institutions and supported by common research programmes financed by the UK, the historically strong S&T collaboration ties have been continuously maintained. Japan is another important S&T collaboration partner for Malaysia. In the 1980s, Japan was the blueprint for Malaysia's industrial policy and – because of its technological leadership position – was a preferred partner in S&T collaboration. Extra-scientific S&T relationships also exist with other ASEAN member countries and with the Organization of Islamic Countries (OIC). The ties with the latter organization are perceived as being part of Malaysia's South–South cooperation, which also involves countries such as Kenya and might also explain cooperation agreements with Egypt, Pakistan, Syria and Tunisia, and, in ICT, with Libya and Morocco (since 2002).[206]

Voices from governmental institutions in Malaysia on international S&T cooperation

MOSTI, Malaysia:

"The key players in R&D, or in knowledge production, have traditionally been the US, Europe and Japan. However, the GERD of the US and Europe is gradually declining, and, instead, China is arising as an emerging economy, along with, to a lesser extent, India. Among the Asian countries, the Republic of Korea, the Republic of Taiwan and Singapore have all broken the 2 per cent barrier in terms of percentage of GDP spent on research and development, while China is on its way to achieving its target of 1.5 per cent."

Source: MOSTI (2006), National Survey of Research & Development – 2006 Report, p. 63

MASTIC, Malaysia:

"Scientists in Malaysia mostly collaborated with colleagues in the country, producing 13,386 joint papers. Collaboration with foreign scientists saw Malaysian scientists working more with those from the United Kingdom (1,043 papers), followed by collaboration with scientists from the USA (790 papers), Australia (531 papers), Japan (530 papers), China (426 papers), India (351 papers), Singapore (269 papers), Thailand (211 papers)."

Source: MASTIC (2003), Science and Technology Knowledge Productivity in Malaysia, Bibliometric Study, p. 6

From the perspective of those scientists that we talked to in 2008, the MoUs between universities were creating a supportive framework for intensifying international cooperation, as the commitment from both sides was usually stronger. Personal relationships with scientists were regarded as being important and helpful. Cooperation with partners in Japan and South Korea had showed good results, due also to their close monitoring and constructive intervention in joint research projects. Cooperation with the ASEAN was geared to Singapore on the one hand, because of interest in collaborating with well-equipped research labs and well-known scientists; and, on the other hand, to technologically less developed ASEAN member states such as Vietnam and Myanmar, because of joint projects within the ASEAN COST programmes.

Participation in the FPs of the EU was rather limited. There were several factors that influenced this phenomenon. There was a general lack of knowledge about FP research areas and funding mechanisms. Those scientists who had had experience in EU funding complained about an inflexible EU bureaucracy. As the success rate of applications was low, not many incentives existed to apply when local research funds or funds from other countries were more easily available.

Among the research universities, the UM collaborated with the US National Institute of Health on HIV-related studies in Malaysia, with the Japanese National Institute of Infectious Diseases on genotyping, with the Korea Ocean Research & Development Institute in Marine Science and with the Seegene Inc. of Korea on the dengue virus. The UMS research collaboration is even more wide-ranging and includes cooperation with 12 countries, 35 organizations and 56 researchers from UMS. The focus of UKM's international R&D cooperation is on East Asia, followed by Southeast Asia, the Americas and Australia and New Zealand. European partners were involved in the ASEAN–European University Network Programme (AUNP).[207]

Summary of findings in Malaysia

In sum, the questions of why Malaysia is engaged in international S&T cooperation, what the most important partners or regions in S&T are, and which fields of cooperation are preferred were answered in 2008 as follows:

- International S&T cooperation was viewed by both government representatives and scientists as being very important. In contrast to other ASEAN member states, funding and S&T infrastructure were not as important to Malaysia's international cooperation.
- For scientists, reputation, scientific publications and access to new S&T were important reasons for S&T cooperation.
- No specific international S&T cooperation policy existed, but extra-scientific reasons for collaboration – such as historical relationships/colonial experience (with the UK), political objectives, such as regional cooperation policy (ASEAN COST-activity) and cultural linkages (cooperation with other Muslim countries) – shaped the collaboration pattern to some extent.
- There has been a shift in S&T partners from Japan (a 'Look East' policy) to other countries in Asia and Europe, and recently to the US. The expansion of scientists' global S&T networks was, however, limited due to the limited size of mobility funding available from the government.
- Knowledge about FPs and participation rates in FPs were low. Easily obtained funding for domestic research projects from sources within Malaysia and greater success in cooperation with countries with more flexible bureaucracies (regarding application and funding procedures) explained this situation to a certain extent.

7.4.4 The Philippines

7.4.4.1 Key characteristics of the S&T system in the Philippines

The Philippines is the second-largest member state in the ASEAN in terms of population (92.2 million people in 2009), but ranks among the lower-middle income economies of the region with regard to GNI per capita ($2,050 in 2010[208]). Although economic growth accelerated in the last decade, it remained much slower compared to that in the ASEAN region as a whole[209]. The country faces many challenges. The level of international competitiveness is low, while unemployment is high and poverty widespread. Recognizing the importance of innovation for the country's catching-up process, the Philippine government adopted a proactive S&T policy approach in recent years. The so-called Filipinnovation strategy developed in 2007 represents this new policy direction towards innovation-driven development. This strategy has four key priorities: 'strengthening Filipino human capital; supporting business incubation and acceleration efforts; regenerating the policy environment for innovation and, finally, upgrading the Filipino mindset towards a culture of innovation'[210].

The country's weak economic performance explains to some extent why expenditure on research and development (R&D) in relation to GDP is well below the average level recommended for developing countries. However, up-to-date and internationally comparable statistics on innovation are not available. Currently, an innovation survey is being prepared that aims to assess recent S&T development, providing data and elaborating policy tools and initiatives. The focus of this survey is on food, manufacturing, electronics and information and communications technology (ICT).[211] Based on the latest available data, the Philippines' expenditure on R&D amounted to only 0.12 per cent of GDP in 2005.[212] There was also a dramatic lack of human capital. Due to more attractive career opportunities for highly-qualified personnel abroad, the issue of brain drain had a strong impact on the R&D personnel development. Between 2002 and 2005 the stock of research personnel increased by 14.7 per cent on average per year, with the total number rising from 9,325 to 14,087. In relation to

205 See MOSTI (2010): US Science Envoy Visits MOSTI, 25 July 2011, available online at: http://gsiac.might.org.my/?page_id=1442, most recent access date: 23 September 2011

206 MASTIC (2006), p. 9

207 Morshidi et al. (2010), pp. 209–224

208 See table 16

209 Posadas, Roger (2009): Scientific and Technological Capabilities and Economic Catch-Up, in: Philippine Management Review, 2009(16), pp. 132f

210 DOST Department of Science and Technology (2008b): Filipinnovation. Unleashing the Innovative Spirit of Filipinos For Global Competitiveness, Manila

211 De La Peña, Fortunato T. (2010): Towards and Innovation-Led Development Path in the Philippines (Ongoing Initiatives on Innovation Studies: Innovation Survey), Presentation prepared for the 11th National Convention on Statistics (NCS), EDSA Shangri-La Hotel, 4–5 October 2010, online at: http://www.nscb.gov.ph/ncs/11thNCS/papers/invited%20papers/ips-07/02_Ongoing%20Initiatives%20on%20Innovation%20Studies%20Innovation%20Survey.pdf, most recent access date: 14 September 2011

212 According to estimates by the Department of Science and Technology (DOST), expenditure on R&D currently amounts to 0.3 per cent.

the overall population, however, this translated into just 165 R&D personnel per million.[213] The low levels of R&D investment and personnel have also been attributed to institutional weaknesses and policy failures, especially with regard to incentives for companies to invest in innovation.[214] Among the various flaws discussed by Philippine experts are: the weak R&D collaboration between the public and the private sector, the lack of an efficient system for the transfer of technology and problems with regard to technology ownership and protection of intellectual property rights.[215] In order to understand the current system of innovation in the Philippines, and the interactions among actors, interviews were conducted with representatives from the government, research institutes and universities in June 2011. The following mapping of actors in the innovation landscape is based mainly on these interviews, but is also complemented by information obtained from the respective institution's websites.

The Philippine innovation system is complex and has a multi-layer structure with institutions on both the central government level and on the local community level (see figure 88). The Department of Science and Technology (DOST) has had the mandate to formulate and implement S&T policy since 1986. Although DOST has a central role in S&T policy-making and the supervision of government research institutes (GRIs), there are also line ministries, the private sector and universities that conduct research. The DOST emanated from the National Science and Technology Authority (NSTA) that was set up in 1982, which introduced five S&T councils for sectoral policies, programmes and strategies.[216] These five councils are the:

- Philippine Council for Industry, Energy Research and Development (PCIERD)
- Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD)
- Philippine Council for Health Research and Development (PCHRD)
- Philippine Council for Aquatic and Marine Research and Development (PCAMRD)
- Philippine Council for Advanced Science and Technology Research and Development (PCASTRD)

Following restructuring and rationalization, the number of research councils was cut by one in June 2010. The PCASTRD and the PCIERD merged into the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD). The newly-established council covers all sectors related to industry, energy, utilities, infrastructure and advanced science. The new Director of PCIEERD, appointed in April 2011, announced on the occasion of the merger's first anniversary that, 'the union will result in the consolidation and streamlining of policies, strategies, programmes and projects that impact on the priority sectoral concerns; the enhancement and strengthening of linkages and networks; and the creation of a culture of sharing ideas and experiences'[217].

While four research councils pursue their mandates in specific sectors, the PCASTRD was responsible for the integration and the coordination of the national research system for advanced S&T. The PCASTRD's priority areas included biotechnology, electronics technology, ICT, material science, photonics technology and space technology applications. One such policy was the 'Nanotechnology Roadmap', which aims to prioritize R&D projects. The PCIERD focused on the planning, monitoring and promotion of S&T research for later application in the fields of industry, utilities and infrastructure. It cooperates closely with the private sector in order to provide market-driven directions and research efforts, share risks and benefits and plan for long-term projects. The PCIERD offers grants-in-aid for approved research proposals open to both the public and private sector. The priority areas are energy, environment and food.

The PCARRD takes a leading role in research on agriculture and natural resources. In 2006, it published the 'Integrated S&T Agenda in Agriculture, Forestry and Natural Resources for CY 2006–2010'. Based on intensive consultation with representatives from the scientific community, industry sector, donor agencies, etc., the strategy intends 'to develop a common agenda for cooperation and partnership among the various stakeholders, and participating research and development (R&D) institutions and users'.[218] Thematic areas for R&D include poverty alleviation and food security, global competitiveness, frontier and cutting-edge science, natural resource management and sustainable development and agricultural and forestry services. The research agenda contains a detailed list of target products, R&D agendas and areas, thematic programme areas and responsible consortia (PCARRD 2006: 4). Climate change and the manifold challenges associated with this issue have been studied by the PCARRD and are presented in the document, 'The Philippine S&T Agenda on Climate Change (PSTACC) 2010–2016'[219]. Through adaptation and mitigation the council expects that specific strategies could be applied to sustain productivity and competitiveness. The document was designed to harmonize national efforts and serve as a reference for S&T collaboration among the various stakeholders. For all three sectors PCARRD is dealing with, agriculture, forestry and natural resources, those areas that are most vulnerable to climate change are mapped, monitored, assessed and S&T priorities proposed. The document lists also the completed, on-going and proposed research projects and the agencies involved.[220]

213 DOST (2009): Innovation, pp. 8–11; Gonzales, Katharina G. / Yap, Josef T. (2011) How can government increase in R&D activities in the Philippines? PIDS Philippine Institute for Development Studies, Policy Notes, No. 2011-01, Makati City

214 Reyes-Macasaquit, Mari-Len (2009): Sources of Innovation of Philippine Firms: Production, Logistics and Knowledge Networks, in: ERIA Research Project Report 2008 No. 4-1, Jakarta; Cororaton, Caesar B. (2002): Research and Development and Technology in the Philippines, PIDS Philippine Institute for Development Studies, Discussion Paper Series No. 2002-23, Makati City

215 Reyes-Macasaquit (2009), p. 91

216 Reyes-Macasaquit, Mari-Len (2009): Sources of Innovation of Philippine Firms: Production, Logistics and Knowledge Networks, in: ERIA Research Project Report 2008 No. 4-1, Jakarta, p. 4

217 DOST (2011): PCIEERD Celebrates First Anniversary and Unveils New Logo, Philippine Council for Industry and Energy Research Development, Manila, online at: http://www.pcierd.dost.gov.ph/index.php/submitted-articles/131-logoanniv PCIERD 2011, most recent access date: 15 September 2011

218 DOST (2006): Integrated S&T Agenda in Agriculture, Forestry and Natural Resources for CY 2006-2010, Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD)

The Council for Health Research and Development (PCHRD) aims to provide leadership in health research. It coordinates, promotes and facilitates health research activities and provides technical, financial and logistical support. PCHARD publishes the regularly updated National Unified Health Research Agenda (NUHRA). Priorities in the 2008–2010 NUHRA include health financing, governance, health regulations, health service delivery, health technology development, health research ethics, and health information system.[221] In the 'Funding Priorities 2009–2010', the PCHRD gave information about the short-listed research priority topics for which funding was available.[222]

The remaining research council, the PCAMRD, is called the 'Water and Fish R&D Center'. It coordinates R&D in national aquatic resources, in order to achieve the sustainable management of these resources. An important aspect of this council's activity is the capacity building in costal resources and fishery management, which is co-funded by a number of international donor institutions (PCAMRD, website). In the council's annual reports, all R&D topics and projects funded through grants-in-aid allocations are listed.[223]

219 DOST (2010): Philippines S&T Agenda n Climate Change, Agriculture, Forestry and Natural Resources Sectors, Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Manila

220 DOST (2010), pp. 2, 10, 21

221 DOST (2008c): National Unified Health Research Agenda 2008–2010, Philippine National Health Research System, Philippine Council for Health Research and Development (PCHRD), DOST Department of Science and Technology, Manila, p. 2

222 DOST (2009): National Unified Health Research Agenda, Funding Priorities 2009-2010, Philippine Coucil for Health Research and Development (PCHRD), Manila

223 DOST (2008a): Annual Report 2008, Philippine Council for Aquatic and Marine Research and Development (PCAMRD), Los Baños, Philippines

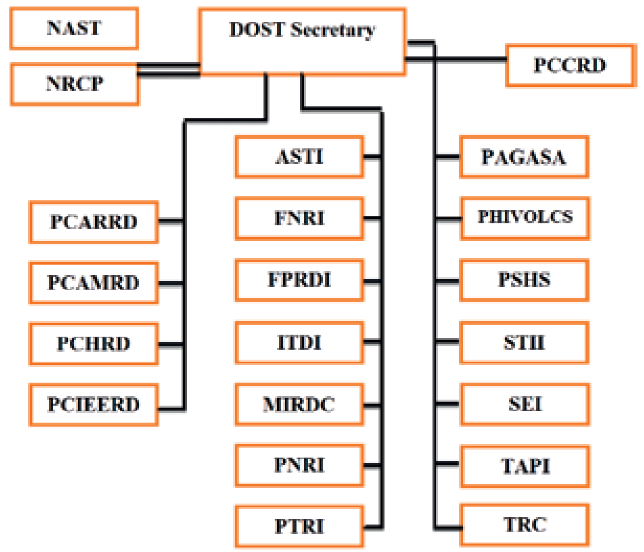

Figure 88: Organizational Structure of the DOST
Advisory Bodies (2):
NAST National Academy of Science and Technology
NRCP National Research Council of the Philippines
Sectoral Planning Councils (4):
PCARRD Philippine Council for Agriculture, Forestry and Natural Resource Development
PCAMRD Philippine Council for Aquatic and Marine Research Development
PCHRD Philippine Council for Health Research and Development
PCIEERD Philippine Council of Industry, Energy and Emerging Technology Research and Development
Research and Development Institutes (7):
ASTI Advanced Science and Technology Institute
FNRI Food and Nutrition Research Institute
FPRDI Forest Products Research and Development Institute
ITDI Industry Technology Development Institute
MIRDC Metals Industry Research and Development Center
PNRI Philippine Nuclear Research Institute
PTRI Philippine Textile Research Institute
Government R&D Coordination Council (1):
PCCRD Presidential Coordinating Council for Research and Development
Source: Based on Yorobe (2010)

In sum, all councils have the mandate to formulate plans, strategies, policies and programmes for S&T development, allocate government and external R&D funds to programmes, monitor and evaluate R&D programmes and projects and generate external funds for R&D. The councils' sectoral policies and programmes are embedded in DOST's medium- and long-term planning. In its critical review of S&T plans, the DOST briefly assessed the Science and Technology Master Plan (STMP), the Science and Technology Agenda for National Development (STAND) and the DOST Medium-Term Plan (DMTP). These plans addressed the weak performance in terms of low expenditure on R&D and the lack of scientists and private sector involvement in S&T. The STMP (1991–2000), for example, requested an increase in R&D expenditure from 0.2 to 1 per cent by 2010. Due to the lack of financial support from the government, this figure was difficult to achieve and therefore reduced to

0.5 per cent R&D to GDP in the updated version of the DMTP, in 2009. A similarly disappointing outcome was reported for the STAND, which focused on picking specific industries as 'export winners' and supporting them. Here, the shortcoming was that too many industries were selected, resulting in little funds eventually allocated to each individual sector. The DMTP (1999–2004) focused on flagship programmes with a long-term view of S&T development, but had to spend too many resources on short-term poverty alleviation.[224]

A long-term policy direction and vision is given in DOST's National Science and Technology Plan (NSTP), covering the period 2002–2020 and in the DOST Seven-Point Agenda (DSPA) for the time span 2006–2010. The broad vision for 2020 is to achieve the level of world-class S&T universities, a well-developed SME sector based on S&T, internationally-recognized scientists and engineers, and the development of the Philippines into a model of S&T management and governance. The plan recommends that the following ideas and challenges should be considered in the future: niching and clustering, human resource development, support of industries – especially SMEs –, acceleration of technology transfer, building of S&T infrastructure, international linkages in S&T, improvement in S&T governance and the popularization of S&T to create a culture of innovation.[225] The NSTP proposed a number of long-term priority areas for S&T: 1) agriculture, forestry and natural resources; 2) health/medical sciences; 3) biotechnology; 4) information and communications technologies; 5) microelectronics; 6) materials science and engineering; 7) earth and marine science; 8) fisheries and aquaculture; 9) environment; 10) natural disaster mitigation; 11) energy; and 12) manufacturing and process engineering.[226] For each of these areas specific thrusts were recommended. In its Seven-Point Agenda (2006–2010), the DOST requested focus on R&D programmes in six core areas: biotechnology, ICT, health products, environment (including water resources), alternative energy, food and agriculture.

Research institutes

The DOST's research and S&T services institutes receive funding from the ministry to implement the policy directions and guidelines. Some of the GRIs focus on specific industries; others on cross-cutting areas. In contrast to Western research institutes, the portfolio of Philippine GRIs does not only revolve around research in the narrow sense but follow three so-called major final outputs (MFO). Besides R&D, they have to get involved in technology transfer and S&T services. Based on DOST's budgetary allocation in 2008, the research institute for the food industry received the largest amount of funds, followed by the research institutes for the nuclear industry, metals industry, forestry, textiles and ICT; the research institute for industrial technology got the largest budget for cross-cutting research activities (see table 18).

The Advanced Science and Technology Institute (ASTI) has a mandate to undertake long-term research to improve S&T infrastructure, conduct R&D in biotechnology and microelectronics and develop computer and information technologies. ASTI's current research in ICT concentrates on advanced networking, wireless technologies and network applications and software. The focus in microelectronic research is on printed circuit board and ASTI–VCTI open laboratories, while for the transfer of R&D output, technology diffusion, collaborative R&D, trainings and seminars are emphasized. International bilateral cooperation with companies and GRIs focus on Taiwan and Singapore. The institute comprises 65 regular staff, while project-related personnel increases the total staff number to 120. Capacity building and international visibility of the institute's research was assessed as being crucial by the ASTI' director.

The Food and Nutrition Research Institute (FNRI) conducts research on the citizenry's nutritional status, with a special focus on malnutrition. In five-year intervals, a national nutrition survey is conducted by FNRI. The institute also develops and recommends policy measures and is involved in the diffusion of knowledge and technologies in food and nutrition. For this purpose, the institute offers technology incubators and library facilities on food and nutrition information as well as training for SMEs. The focus on malnutrition is strongly related to the DOST's project on S&T-based interventions to address malnutrition among children. Research at FNRI covers medical nutrition studies, nutrition intervention and policy studies, nutrition biochemical and education studies.

The Metals Industry Research and Development Center (MIRDC) is supporting the metals and engineering industry. Among the services offered by the institute are: the training of engineers and technicians, trade accreditation services, quality control and testing and business advisory services. The center is currently involved in a joint project on the 'Clustering of the Regional Enterprises of CAR for Agro-Industrial Machinery and Parts Manufacturing' (CREAMM). This project aims to improve the productivity of metals and engineering companies by organizing them into clusters. Similar to the MIRDC, the Philippine Textile Research Institute (PTRI) was established to support the development of one single industry. It conducts applied R&D for the textile sector, transfers it to the end-users or other government units and offers technical services and trainings. Currently, the PTRI assists the Philippine industry in finding market niches, focusing on local natural fibre – such as from pineapple, coconut and banana.

The Forest Products Research and Development Institute (FPRDI) conducts basic and applied R&D to improve the value-added chain of wood and non-wood products. Its R&D programmes are focusing on material science, bio-based composites, furniture and handicrafts, bio-energy, paper and paper products, and clean production technologies for forest-based industries. As of 2010, the total number of staff amounted to 171, including 12 PhDs.

The Philippine Nuclear Research Institute (PNRI) is one of the oldest GRIs. It emanated from the Philippine Atomic Energy Commission, established in 1958, and conducts R&D in the peaceful uses of nuclear energy. Its mandate also covers the transfer of research results to end-users and the licence and regulatory activities with regard to the production, transfer and utilization of radioactive materials. Research includes the application of radiation and nuclear materials in the sectors of food and agriculture (crop improvement through mutation breeding), for pest control and animal production, but also in industrial production and technology. The PNRI offers irradiation services at two gamma irradiation facilities as well as nuclear training.

Unlike the other GRIs, the Industrial Technology Development Institute (ITDI) is involved in cross-cutting and multidisciplinary R&D activities based on the national R&D priority plan. ITDI comprises eight divisions, focusing on chemicals and energy, environment and biotechnology, food processing, materials science, packaging technology, technological services, standards and testing and the national metrology laboratory.

In addition to the GRIs, seven government S&T service institutes are part of DOST. Some of these institutes pursue research activities as well, although only to a limited extent. Based on annual reports that describe their work performance, these institutes receive funding from the government budget, but also have access to grants from the advisory councils. In addition, services offered by the institutes can be used to generate funds. The ITDI's mixture of funding sources provides a good example: 63 per cent of their budget is government allocation, 10 per cent comes from services offered and 10 per cent comes from foreign funding sources. Some of the institutes rely heavily on foreign funding, for example the PNRI. About 40 per cent of the institute's budget is covered by the International Atomic Energy Agency (IAEA), while the rest comes from the allocation for R&D and from services. Compared to scientists in GRIs, those working in the S&T service institutes have greater difficulty to attend international conferences. They have no access to national mobility schemes and need to be invited in order to participate at international conferences. As a result, the institutes often try to compensate for this by organizing international conferences in the Philippines.

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) is one of these service institutes. It comprises ten divisions with about 100 employees. The PAGASA's mandate relates to weather forecasting, climate modelling and data archiving. About 30 per cent of its budget is earmarked for R&D. The topics pursued are weather extremes, i.e. tropical cyclones and other disaster-inducing phenomenon. Scientists working at PAGASA need special skills in advanced computer programmes and simulation techniques. Recently, the institute has been focusing on the upgrade of equipment and capacity improvement. Researchers are offered incentives for publications. For an article published in an international journal scientists receive, for example, a bonus of 15 per cent on top of their salaries.

Table 18: Budgetary allocation to research councils, GRIs and S&T service institutes in 2008

Research councils		GRIs		Gov. S&T service institutes	
Name		Budget (million US$)		Name	
PCASTRD	2.132	ASTI	Budget (million US$)	Name	Budget (million US$)
PCAMRD	0.823	FNRI	1.216	PAGASA	23.769
PCHRD	1.744	FPRDI	3.082	PHIVOLCS	4.521
PCIERD	1.011	ITDI	2.059	PSHS	10.405
PCARRD	6.548	MIRDC	3.705	SEI	11.490
		PNRI	2.765	STII	0.953
		PTRI	3.050	TAPI	1.606
Advisory bodies					
NRCP	0.877				
NAST	0.844				

Source: Based on DOST

The Philippine Institute of Volcanology and Seismology (PHIVOLCS) studies natural disasters, especially earthquakes and tsunamis, and works on disaster forecasting – including tsunami warnings and hazard mapping. Currently they are developing sensors for early-warning systems for tsunamis. The PHIVOLCS comprises eight stations for volcano observation and 66 stations for earthquake observation. It offers free training in monitoring and disaster preparation for local community representatives. In the past, PHIVOLCS successfully worked on the exploration of geothermal sources. Nowadays, this service is offered by another institution. PHIVOLCS is located on the campus of the University of the Philippines, but works independently. Out of the institute's total budget of about 200 million Peso (US$ 4.7 million), a share of 10 per cent is allocated for research. Presently, about 30 per cent of the staff are involved in research, financed mainly through international collaboration. The institute is interested in the improvement of the methodological skills and international research cooperation of their academic staff. The lack of highly-qualified personnel presents a pressing problem. Although the institute could employ as many as 230 peo-

224 DOST (n.d.): Medium-Term Philippine Development Plan (DMTP) 1999–2004, Manila, pp. 5–6
225 DOST (n.d.): National Science and Technology Plan 2002–2020, Manila
226 Ibid.

ple, only 200 actually work at PHIVOLCS. Many of the better-educated scientists prefer to work in the private sector or to go abroad. There is no specific incentive system in place to encourage scientists to publish in refereed journals.

There are a number of advisory bodies that act as intermediaries between different agencies within the Philippines and between domestic and foreign agencies. The National Academy of Science and Technology (NAST) advises the legislators and the Senate, other policy-making bodies and NGOs on policies related to S&T. NAST is also responsible for the recognition of outstanding research achievements by giving awards to Filipino scientists. In addition, the Academy supports international and national scientific linkages and promotes cooperation between Philippine and foreign scientists. Besides the yearly award ceremony, the NAST organizes a large number of roundtable discussions (148 in 2010) and maintains linkages with 35 counterpart organizations in the Philippines and abroad, especially within the US, UK and Australia. In 1998, the NAST established the Philippines Science Heritage Center that exhibits the scientific achievements of Philippine scientists and serves as a location for seminars and lectures. Another advisory body is the National Research Council of the Philippines (NRC), which focuses on basic research. It also supports the set up of linkages with local and international scientific organizations and provides recommendations to the government. The NRC is organized into 13 scientific divisions with a total of 3,176 members coming from the academe, government and private sector with special knowledge and research experience in their fields. The NRC assigns research grants based on the NRC's 'National Integrated Basic Research Agenda'. This agenda is based on the priority areas for basic research of the NSTP (2002–2020).

In sum, the DOST comprises a large network of institutes and agencies that perform a huge number of different tasks. With the country's total R&D budget of about 0.3 per cent of GDP currently, the funding for all these activities needs complementary support from other local government agencies and departments, the private sector and international organizations. Other line ministries – for example the Departments of Agriculture or Energy – also provide funding and conduct R&D. In terms of the total value of R&D funding, the Department of Agriculture has a higher budget than DOST. In order to coordinate the different government agencies' R&D activities and supervise the budget allocation, President Arroyo established the Presidential Coordinating Council on Research and Development (PCCRD) in 2007. Based on the consultation of all agencies and departments involved in R&D, the inter-agency committee agreed upon a list of priorities, which is similar to the long-term R&D plan for 2002–2020. While nanotechnology was added to the new list of priorities, two other fields of research – materials science and engineering and earth and marine science – do not appear on the list. According to the PCCRD's guidelines on R&D priorities, the timeframe for the priorities will be six years, covering the period 2010–2016 and subject to a mid-term review in 2013.[227]

Institutions of higher education

The universities represent another important group of actors in the Philippine innovation system. Private institutions of higher learning dominate the higher education system, accounting for about 80 per cent of the total number present. They are basically tuition-funded and have strong worldwide alumni networks. Two-thirds of these institutions are run by private organizations and about 20 per cent by religious congregations. The enrolments by disciplines show a strong tendency towards business administration and related fields (22 per cent), while most students in S&T-related disciplines can be found in medicine and healthcare. Few students enrol in doctoral courses.[228] Private universities can rely on tuition fees to basically cover all expenses – including salaries, maintenance and research – but can also apply for research grants from the DOST. However, they need to act in a similar way to a private enterprise in order to be profitable. Therefore, research activities represent another source of potential revenue for the schools and private universities who have set up technology-licensing offices to secure royalties from patents.

Leading national universities are the University of the Philippines (UP), the De La Salle University (DLSU) and the Ateneo de Manila University (AMU). While UP is a public university, the other two universities are private ones. All three have become involved in the Filipinnovation strategy that requires firms and industries to upgrade and increase global competitiveness and universities to get more involved in multi-sectoral partnerships with the industry to better train graduates for the industry. The authors conducted interviews with representatives from these universities, as well as the private Mapúa Institute of Technology (MIT). The MIT is ranked number 25 on the list of the 187 institutions of higher learning in the Philippines in 2011. The leading university is the UP, followed by the AMU in second place the DLSU at number 5 and the UP Diliman at number six.[229]

One of the newly-established institutions that provides S&T-related studies and research is the UP Diliman Technology Management Center. This center offers Masters in Technology Management (MTM), short-term executive training courses and research and consulting services. Research is reflected in studies for various departments and agencies on topics related to S&T development and industrial restructuring. Most of the students come from the private sector, are medium-level executives and will go back to their companies after they have obtained their Master degree. In regard to their role in the Filipinnovation strategy, the faculty representatives see themselves as still being predominantly a teaching university. In addition to the Technology Management Center, the UP has set up the first business incubator in cooperation with the Ayala Foundation (UP-Ayala Technology Business Incubator) at the UP Diliman campus. The aim is to commercialize the research output of faculty members and students. The technology-based projects concentrate especially on ICT. Supported by the Department of Science, other incubators and science parks are planned or are already set up on different UP campuses.[230]

The Ateneo de Manila University (AMU) was established by the Jesuits, who started their educational activities in Manila in 1859 by founding a public primary school. After expanding into a college, it was recognized as a university in 1959. At the AMU a number of topics are pursued in line with the Filipinnovation strategy. One of the key research topics is social entrepreneurship, which includes the establishment of industries for under-served communities such as the urban poor and farmers. This research initiative is headed by the School of Management and the School of Science and Engineering. Other topics are related to environmental issues such as water and air quality and education, focusing on teacher's training, curriculum review and the support of schoolchildren's nutrition. The Philippine diaspora and artificial intelligence are other research topics. About 25 per cent of the university staff are engaged in R&D. According to faculty members' self-perception, this university has not yet developed such a strong research culture as the UP; most of the research topics are client-driven and not so much research problem-driven. Scientist's publications play a certain role in internal assessment, however, in contrast to Western countries they are not a major criterion for university funding.

The De La Salle University (DLSU) was established in 1911 by the Brothers of the Christian Schools and became a member of the International Federation of Catholic Universities in 1968. It developed into a large private university with many branches established abroad. The DLSU has 13,058 undergraduate students and 3,431 graduate students and a faculty of 410 full-time faculty members (headcount) of which 196 (headcount) have a PhD (statistics related to the school year 2010–2011). DLSU's share of research in the total budget amounts to 16–17 per cent. Research at the DLSU takes place in 16 out of the 18 units. One third of the faculties are, however, restricted in their research activities due to the lack of full-time researchers. Research is often conducted by PhD students. They have to present their findings at national or international conferences and produce publications. In the College of Engineering, for example, each PhD student has to publish at least two peer-reviewed journal articles. Publications by professors (on tenure track) are encouraged by offering US$ 1,000 for each article or a full month's salary. If the journal's impact factor is high, the university offers to sponsor any conferences or visits for the author.

The Mapúa Institute of Technology (MIT) is a private institution of tertiary education established in 1925 by Tomas Mapúa, a Filipino architect and graduate from Cornell University. The MIT has about 12,000 undergraduate students, 250 graduate students and a few PhD students. 20 per cent of the faculty members have a PhD; there is still broad scope for human resource development. In 2000, the University was taken over by a banking and insurance industry consortium. In order to satisfy the industry's growing need for modern technology, MIT adapted its teaching and research focus. Mapúa is specialized in engineering and has offered degrees in Computer Engineering since the 1980s. The MIT encourages publications from its staff by offering a monetary reward for ISI-abstracted published papers and participation in international conferences. Together with the DLSU, MIT is part of the group of Engineering, Research and Development for Technology institutions that can apply for funding from the DOST. The School of Science and Engineering at UP Diliman receives the major share of the DOST's funding for R&D.

Finally, we take a short look at the private sector's R&D. Compared to other ASEAN member states, company spending on R&D in the Philippines is extremely low. According to the Global Competitiveness Report 2010–11, the Philippines is ranked 85 out of 139 countries in terms of company spending on R&D, close to Kazakhstan and Gambia, while countries like Indonesia and Vietnam are ranked 26 and 33, respectively.[231] The majority of enterprises in the private sector are small, and they are not investing in R&D. Microenterprises and SMEs accounted for 99 per cent of companies in 2008, large companies for 0.4 per cent. The latter employ 38 per cent of all workers.[232] There is a severe lack of technology-based industry. Innovation activities are basically restricted to the adaption of existing products or services directed at the domestic market (Velasco 2010). Although S&T programmes and institutions exist,

227 Presidential Coordination Council on Research and Development (n.d.): Guidelines in the Formulation of Research and Development Priorities Plan, rev. 81109, Manila

228 Velasco, Aida L. (2009): The Role of Philippine Universities in FILIPINNOVATION (Philippine Innovation Systems), De La Salle University, Manila, Philippines

229 Universities in Philippines by 2011 Web Ranking, online at: http://www.4icu.org/ph/, accessed 10 August 2011

230 Valesco (2009)

231 World Economic Forum (2011): Global Competitivenss Report 2010-2011, online at: http://propinoy.net/wp-content/uploads/2011/05/PH-WEF_GlobalCompetitivenessReport_2010-11.pdf, most recent access date: 14 September 2011, p. 490

232 Paderanga, Jr., Cayetano W. (2011): Private Sector Assessment Philippines, ADB Asian Development Bank, Mandaluyong City, Philippines, p. 8

Reyes-Macasaquit[233] points to systemic failures within the innovation system and 'the inability of the government, the private sector and the academe to collaborate meaningfully'.

7.4.4.2 The international S&T cooperation policies of the Philippines

The crucial role of S&T for the country's economic catching-up process has been emphasized by the Philippines government since long. In the medium-term economic development plan for the period 2004–2010 the National Economic and Development Authority (NEDA) dedicated a whole chapter to S&T policy. International S&T collaboration – including technology transfer through foreign direct investment and international R&D cooperation projects – was described by NEDA as important to achieve the country's ambitious goals. The NEDA requested 'to adopt policies focused on making the Philippine National Innovation System work'.[234]

Representatives from GRIs, S&T service institutes and institutions of higher education interviewed in Manila also stressed the need for international collaboration (see figure 89). Most of the interviewees emphasized transnational learning as being the central motive for S&T collaboration. ODA support for Philippine development still plays an important role and, thus, affects access to S&T funding as well. But funding has only a complementary function and was assessed by the interview partners as being not the number one reason. With the rise of awareness that regional and global competitive pressure is growing, innovation benchmarking has become another motive for S&T collaboration. The country-specific and global-thematic priorities are equally important, especially with regard to topics such as climate change, disaster mitigation and adaptation, as well as ICT.

233 Reyes-Macasaquit, Mari-Len (2009): Sources of Innovation of Philippine Firms: Production, Logistics and Knowledge Networks, in: ERIA Research Project Report 2008 No. 4-1, Jakarta

234 National Economic Development Authority (n.d.): Medium-Term Philippine Development Plan 2004–2010, online at: http://www.neda.gov.ph/ads/mtpdp/MTPDP2004-2010/PDF/MTPDP%202004-2010%20NEDA_Chapterx19_Science&Tech.pdf, most recent access date: 14 September 2011, p. 234

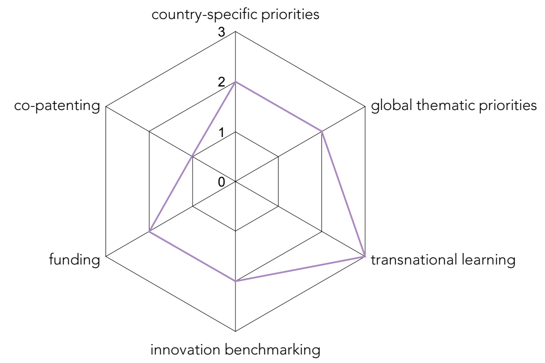

Figure 89: Reasons for international cooperation: the view of governmental institutions in the Philippines
Source: Authors' own assessment, based on interviews conducted in the Philippines

The extent to which GRIs and S&T institutes are involved in international S&T collaboration varies, especially with regard to cooperation with European partners. For example, ASTI – as one of the GRIs – underlined the central role of international cooperation because of knowledge spillover. The institute follows a strategic approach to find partners for research collaboration. Recently, they became aware that Taiwanese research institutes possess a strong capacity in specific ICT fields and approached them to establish joint teaching programmes with the aim of cooperating in research as well. The ASTI participates in the EU FP7-funded ICT projects SEACOOP and the Trans-Eurasia Information Network 2 (TEIN2). These projects offer not only funding, but access to research and education networks, and capacity building, and imply the idea of transferring the project management into Asian ownership. International conferences are assessed by the ASTI's director as being crucial to keeping abreast with cutting edge research outside of the Philippines. The institute encourages its staff to publish in international journals, although not through pecuniary incentives. In the application of research programmes, the institute includes travel costs because of the limited size of its own mobility fund. The ASTI also cooperates with ASEAN partners in the field of microelectronics, organized through the ASEAN Information Center. In this cooperation the ASTI offers ICT training to other ASEAN countries.

For PAGASA international cooperation is essential for funding capacity building and mobility programmes that allows scientists to attend international conferences. Currently, PAGASA's capacity building is supported by a number of donor organizations from Australia, Japan, South Korea and through the World Meteorological Organization. On the regional level, PAGASA cooperates with Vietnam on climate change research and with Thailand and Vietnam in training programmes. It offers a Masters programme on S&T for students from both countries. PAGASA has not participated in EU-funded research projects and is not familiar with the FP7. However, it cooperates with some scientists and institutions from Europe, for example with the National Metrological Services in Germany and Finland.

The PHIVOLCS participates in an EU-funded FP7 project, MIAVITA (Mitigate and Assess Risks from Volcanic Impact). The cooperation includes all aspects of the institute's work, especially disaster preparedness, tsunami warning, and hazard mapping. The collaboration with European partners was described as being very positive, involving a strong research component and a learning process of theoretical and technical knowledge. Another positive impact is the transfer of project management know-how. The PHIVOLCS' collaboration within the region concentrates on Singapore (Earth Observatory), Japan (Kyoto University, Kyushu University and Kagoshima University), Taiwan (Academia Sinica) and Australia; cooperation within ASEAN is assessed as being still rather underdeveloped. There are also S&T cooperations with individual European countries, especially with France. The institute has been offered a collaborative scholarship and training scheme. Most projects are rather small in scope. Some support for training also comes from donor organizations, for example, AusAid, JICA and UNDP.

International S&T collaboration is generally more intensively pursued in institutes of higher education, particularly in private universities. Due to its worldwide network of 72 branches, the DLSU has many cooperative activities within and outside the region. The university established a mobility scheme for its scientists, including funding for participation at scientific conferences, or setting up linkages with other institutions for visiting professorships, invited lecturers and speakers. The DLSU also applies for research grants at the DOST or international donor agencies such as JICA (for scholarship programmes), SIDA, USAID or the Canadian funding agency. International collaboration is intensively sought by all faculties at the DLSU. The College of Science cooperates, for example, with some Japanese universities (in nanotechnology with Osaka) and with Harvard University in the USA (in physics and climate change). DLSU is collaborating with a sister De La Salle University in France, and the College of Computer Studies benefited from existing linkages with the University of Osaka and expanded its cooperation in computer science with a French university.

In contrast to other faculties, the DLSU School of Economics conducts extensive research collaboration with the ASEAN region, for instance with Vietnam, Malaysia and Indonesia. Currently, a research initiative exists with the Chulalongkorn University in Thailand on innovation in Asia (IDRC funded). Individual staff members have also research contacts with the University of Nevada. The College for Engineering is involved in research with EU partners through the ASIA–LINK project. In the development of a biomedical and clinical engineering programme they cooperate with the Royal Institute of Sweden, the University of Pisa in Italy and a university in Indonesia. Many of their professors are UK graduates, making use of their scholarly ties with British universities. Research relations with the Tokyo University of Technology and universities in Kyoto, Hokkaido and Osaka have been funded by JICA. The Swedish ODA agency SIDA funded the Asian Regional Research Programme on Environmental Technology for the period 2004–2010, in which Lund University as well as several Asian universities participated.

At DLSU, evaluation of international research collaborations takes place annually. The internationalization of each faculty is assessed by counting the number of: graduates from foreign universities; research projects funded by foreign institutions; publications in international journals; and, visiting foreign scholars. International collaboration by the Ateneo de Manila University (AMU) covers a broad range of fields and partners. In environmental science, an institutional cooperation takes place with the University of Bordeaux in France; there are also teaching relationships with other universities and a number of partnerships on the level of the individual researcher. Most of the students from this university studying abroad are, currently, in France (70), followed by Japan (20), Germany (15) and Spain (10). In environmental sciences, AMU cooperates with Australia, while the department of mathematics has research contact with Bulgaria and Japan. Japan has become increasingly important, especially in lecturer exchange programmes. Close contacts exist with S&T institutes in Japan, especially in informatics; there is also a cooperation with the University of Osaka. Some funding for Philippine students has been obtained through the ERASMUS Programme, although it is assessed as being very competitive. While academic exchange programmes with Japan and European countries are relatively easy to establish, the implementation of such initiatives with the USA is more difficult due to the high tuition fees and living expenses. However, the University of San Francisco and Canasius College in Buffalo are also sending students to the Philippines. Due to the language barrier, China is not yet an important R&D partner. The Technology Management Center at the UP Diliman Campus cooperates mostly with the Japanese Society for the Promotion of Science (JSPS) and used this contact to establish its PhD programme. They are not yet involved in any EU-funded projects, but are interested in participating in such projects, especially those supporting PhD programmes.

International research collaboration by the Mapúa Institute of Technology concentrates on Taiwan. The establishment of the cooperation with the Chung Yuan Christian University was based on a dedicated personal relationship between faculty members. Through a stepwise approach, the Philippine participants were able to publish a number of ISI-indexed papers. In the past, Mapúa conducted joint research with the TU Delft, Netherlands, on geological engineering. Supported by USAID, a collaboration with the University of South

Carolina on environmental issues was also established. Comparing cooperation with EU partners and the existing cooperation with Taiwan, Mapúa representatives stressed the latter's geographic proximity, facilitating research collaboration.

Summarizing the Philippine scientists' assessment of international S&T collaboration, four objectives seem to dominate (see figure 90). Besides access to S&T and collaboration networks, the increase of reputation and research capabilities were the most important incentives for Philippine scientists to engage in international research collaboration. While the exchange of students and researchers, research infrastructure and scientific publications are regarded as being also important, co-patenting was not a decisive factor for international S&T collaboration.

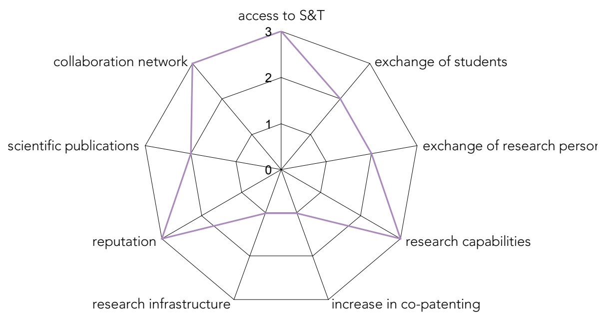

Figure 90: Reasons for international cooperation: the view of Philippine scientists
Source: Authors' own assessment, based on interviews conducted in the Philippines

In conclusion, regional preferences for research cooperation seem to exist. The USA has been mentioned by scientists and representatives from GRIs and S&T services institutes as an outstandingly important research partner. Benefits of S&T cooperation with the USA are: 1) no language barrier, 2) Philippine culture has historically been strongly influenced by US culture and is quite familiar to Filipinos, 3) the legal and administrative systems of both countries are similar, 4) Philippine academic degrees are recognized in the USA, but not in the EU, 5) Filipinos can have dual citizenship in the US and the Philippines.

In terms of preferences for specific partners, cooperation with countries in Asia – especially the ASEAN+3 (including China, South Korea and Japan) – is another focus of Philippine scientists' research cooperation. The Philippines is active in ASEAN–COST and cooperates with a number of other ASEAN member states. Japan has been described by many interview partners as actively seeking research collaboration, supported by the Japanese funding organization JICA. Cooperation with Japanese scientists is also based on similar research topics, especially disaster management. This is also the reason for collaboration with neighbouring countries, including Taiwan. Japan, South Korea and Australia have active donor organizations that provide capacity building programmes and scholarships. China has not yet become important for research collaboration due to the language barrier. However, China is increasingly offering short-term scholarships for Filipino students and researchers.

Those Philippine partners involved in EU-funded research programmes and research activities appreciate the positive impact of knowledge spillover, capacity building and administrative learning. According to some interviews partners, challenges in the cooperation with the EU or European partners in general exist, namely: 1) Information on EU-funded projects is rather difficult to obtain, and the priorities of EU-funded research are not known, 2) there is a language barrier, because not many Filipinos speak other European languages, even Spanish is uncommon, 3) the EU has cooperated with other regions and the Philippines has been downgraded as a S&T partner; closer cooperation with Europe might need an improvement of the Philippine education system, 4) S&T cooperation between universities in the EU and the Philippines is more common with GRIs, but due to differences in the academic year actual cooperation can be difficult to establish, 5) EU-funded projects and scholarships (i.e. FP7, Erasmus Mundus, Marie Curie, etc.) are very competitive and difficult to obtain, 6) the EU is very particular with financial management.

With regard to the field of S&T cooperation, the scientists interviewed stressed that the national research priorities are very important. These priorities have been worked out in cooperation with research organizations in the Philippines and therefore basically represent the interests of the scientists. The national priorities get government basic funding and grants and offer therefore more opportunities for scientists to do research. These national priorities include internationally important topics as well – for example, climate change. In addition, the president's priorities are also reflected in the national agenda, with poverty reduction and other MDGs appearing high on the list. Apart from the national priorities, scientists also take international funding into account when deciding about which research topics to pursue.

Voices from governmental institutions and scientists in the Philippines on international S&T cooperation

The issue of a brain drain has become a challenge to many research organizations in the Philippines. As a reaction, the government introduced a reverse brain drain policy called the Balik ('return') programme to lure highly qualified personnel back home. In this context the following remarks have been made:

"There is an aggressive campaign for student exchange by European countries, they want the best of the students. Don't let them stay in Europe, encourage them to go home."

"DOST might not be able to cope with the financial package necessary to make them come back permanently, so they are invited to spend some time i.e. 3–6 months in the Philippines."

Summary of findings in the Philippines

- The Philippines has a complex national innovation system, characterized by a large number of actors for the coordination of national research activities, by GRIs that have only limited impact on the private sector and by a predominance of private universities that are more focused on teaching than on research.
- The complexity of the system and the large amount of stakeholders – with sometimes conflicting interests – are hindering the implementation of ambitious S&T programmes.
- The national expenditure on R&D is very low and dispersed among the various actors, while international funding is mostly supplied through ODAs. The dispersion of funding among many stakeholders dilutes the low expenditure to even lower amounts, and is thus ineffective.
- Government funding is primarily focused on equipment and research facilities. There are very limited funding opportunities to train GRIs' personnel to use complex tools, and to keep the equipment in working order.
- At the national policy level, funding is, however, not the number one reason to expand international S&T cooperation, but transnational learning is regarded as very important.
- The low level of domestic economic development has an impact on the brain drain of researchers, whose low number already represent a bottleneck to many research organizations.
- Due to the lack of sufficient financial resources to provide internationally competitive incentives, scientists trained abroad often do not return to the Philippines.
- The Philippines introduced a 'brain circulation' programme which allows researchers to come back for a limited period of time, i.e. 3-6 months, to refresh networks and to exchange research ideas for mutual benefit.
- Scientists' interests in international S&T collaboration is strongly related to the factors inherent to science, i.e. reputation, collaboration networks, access to S&T and research capabilities.
- The involvement in EU-funded projects is still limited, while research with partners in the USA and the Asian region predominates due to the lack of knowledge on EU research priorities, language issues and the strong competitiveness of EU research programmes.
- Their proficiency in the English language gives Philippine scientists a comparative advantage over many of their ASEAN competitors when it comes to application for funding and communications skills with partner organizations in the USA and the EU.
- EU funding schemes are almost inaccessible for Philippine researchers under the current conditions. If the EU seeks to raise the level of participation, future programmes should include training courses in project management, administration and reporting tailored to the entrance level of potential partners.
- The industry sector is not a major driver of R&D in the Philippines and there seem to be little cooperation on the basis of public–private partnerships.

7.4.5 Singapore

7.4.5.1 Key characteristics of Singapore's S&T system and policy

Singapore is a city-state with a population of around 5 million people and very limited natural resources. An industrial policy that emphasized technological learning from MNCs played a crucial role in turning this small state first into an international manufacturing centre and then into a knowledge-based economy.[235] Despite governmental support for S&T development, Singapore did not follow a technonationalist approach. Industrial policy concentrated mainly on setting the framework conditions for an outward-oriented economy and for the development of human resources and the strengthening of the transport and telecommunications infrastructure.

In contrast to other ASEAN countries, Singapore does not have a single ministry responsible for S&T formulation and implementation. Long-term economic strategies are set at the cabinet level, with various ministries and agencies involved in detailed S&T policy formulation and implementation. These are, first of all, the Economic Development Board (EDB) and the National Science and Technology Board (NSTB), reorganized into the A*STAR (Agency for Science, Technology and Research) in 2001, both of which report to the Ministry of Trade and Industry (MTI). The MTI formulates S&T policy, assisted by the A*STAR in the design of the five-year plans on S&T. An important role is also played by the Ministry of Information, Communications and the Arts (MICA) and its subordinate the Infocomm Develop-

235 Yue, Chia Siow / Lim, Jamus Jerome (2003): Singapore: A Regional Hub in ICT, in: Masuyama, Seiichi / Vandenbrink, Dolnna (eds.): Towards a Knowledge-based Economy: East Asia's Changing Industrial Geography, Institute of Southeast Asian Studies: Singapore, p. 259; Wong, Ph Kam (1999): National Innovation Systems for Rapid Technological Catch-up: An analytical framework and a comparative analysis of Korea, Taiwan and Singapore, DRUID Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy. Denmark, 9–12 June 1999 ment Authority of Singapore (IDA), which supports Singapore's ICT development. In addition, the Ministry of Education is also involved in R&D. The higher-education sector comprises the three public universities and five polytechnics. Two of these universities are of crucial importance for R&D: the National University of Singapore (NUS) and the Nanyang Technological University (NTU). Approximately 90 per cent of R&D expenditure by the higher-education sector comes from the government, and about 95 per cent of the R&D spending of GRIs is covered by governmental funding.[236]

In 2006, the National Research Foundation (NRF) was created under the Prime Minister's Office – it is mandated with the task of setting the national direction for R&D and coordinating the research agenda of different agencies. It is also responsible for implementing and funding the policies, plans and strategies proposed by the Research, Innovation and Enterprise Council (RIEC), which is chaired by the Prime Minister and several Cabinet Ministers. The A*STAR oversees 21 research institutes, centres and consortia. It comprises two research councils – the Bio-Medical Research Council (BMRC), which is focused on R&D in life sciences, and the Science and Engineering Research Council (SERC), which is responsible for R&D in specific sectors such as ICT, chemicals and engineering.[237]

Long-term visions and plans combined with short-term interventions in some areas are characteristic of Singapore's innovation policy. An example is the targeting of the IT industry and IT research. In the middle of the 1980s the National Computer Board introduced the National IT Plan for Singapore, emphasizing the development of IT professionals and experts, ICT infrastructure and its application. One important element of this IT policy was the liberalization of the telecommunications industry and the development of broadband infrastructure. The introduction of an e-Government Action Plan in the 1990s helped with the diffusion of e-commerce.[238]

Since the 1990s, the strategic focus of S&T policy has changed to some extent and the development of indigenous technological innovation capabilities has been given stronger support. The S&T Plan 2005 underlined the new focus on R&D capabilities in niche areas such as biomedical R&D. An important element in the support of this S&T field is the emphasis on the recruitment of global talents and on strong international research relationships and networks. Policies in support of biomedical development include not only financial incentives but also the attraction of foreign experts and close cooperation with private firms.[239] In order to achieve the ambitious goal of becoming the region's R&D hub, the government has restructured the innovation system by founding new research institutes and broadening its international S&T cooperation.[240] It has also invested heavily in research and industrial parks and introduced financial assistance for start-up companies. Two of the most famous innovation infrastructure projects are the Biopolis and Fusionopolis, which focus on biomedical research and on ICT, media, physical sciences and engineering. Both take part in a larger infrastructure project called the One North.[241]

The Science and Technology Plan 2010 (STP 2010), introduced in 2006 was the country's fourth five-year S&T development plan.[242] This strategic plan aimed to secure sustained economic growth and the strengthening of international competitiveness. It identified five so-called 'key strategic thrusts' for R&D, including:[243] (1) more resources for R&D; (2) focus on selected areas of economic importance; (3) balance of investigator-led and mission-oriented research; (4) encouragement of more private sector R&D; and, (5) strengthening of linkages between knowledge institutions and industry. The STP 2010 also included some quantitative targets. For instance, the government aimed to increase the GERD to 3 per cent. The private sector was requested to be the most important driver for S&T, funding two-thirds of total R&D. In addition, the STP 2010 aimed to increase the number of research personnel and the scientific output. In order to achieve these goals, the government proposed to invest US$ 13.55 billion over the programme's duration. The NRF received US$ 5 billion to fund new growth areas such as water and digital media technologies and strategic programmes. The Ministry of Education was allotted S$ 1.05 billion for its academic institutions, while the MTI was provided with the largest share of S$ 7.5 billion to promote R&D through A*STAR and the EDB.[244]

236 A*STAR (Agency for Science, Technology and Research) (2006): National Survey of R&D in Singapore 2006,available online at: http://www.a-star.edu.sg/astar/front/media/content_uploads/R&D_Survey_Booklets_2006.pdf, most recent access date: 10 July 2008, p. 11
237 OECD (2011b); SEA-EU-NET (n.d.): Info: Singapore, available online at: http://www.sea-eu.net/asia/info/9/singapore.html, most recent access date: 27 September 2011; RIEC (Research Innovation Enterprise Council) (2010): Government Commits S$ 16.1 Billion to Support Research, Innovation and Enterprises for the Next 5 Years and Seeks Ways to Solve Complex National Challenges with R&D, Press Release, 17 September 2010, available online at: http://www.nrf.gov.sg/nrf/uploadedFiles/News_and_Events/Press_Release/2010/4th_RIEC_press_release.pdf, most recent access date: 10 September 2011
238 Yue and Lim (2003), pp. 285–293
239 Chaturvedi, Sachin (2005): Evolving a National System of Biotechnology Innovation: Some Evidence from Singapore, in: Science, Technology and Society 10(1), pp. 109–111
240 Monroe, Trevor (2006): The National Innovation Systems of Singapore and Malaysia, Manuscript, available online at: http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN027022.pdf, most recent access date: 27 September 2011, p. 6f
241 OECD (2011b)
242 The first five-year S&T plan ('National Technology Plan') ran from 1991 to 1995 and had a budget of S$ 2 billion. The second S&T plan (National Science and Technology Plan) has a budget of S$ 4 billion and lasted from 1996–2000. The third S&T plan (Science and Technology Plan 2005) was funded with S$ 6 billion and ran from 2001 to 2005 (MTI 2006: 8).
243 MTI Ministry of Trade and Industry (2006): Science & Technology Plan 2010: Sustaining Innovation-Driven Growth, Report of the S&T 2010 Committee, Singapore
244 Ibid.

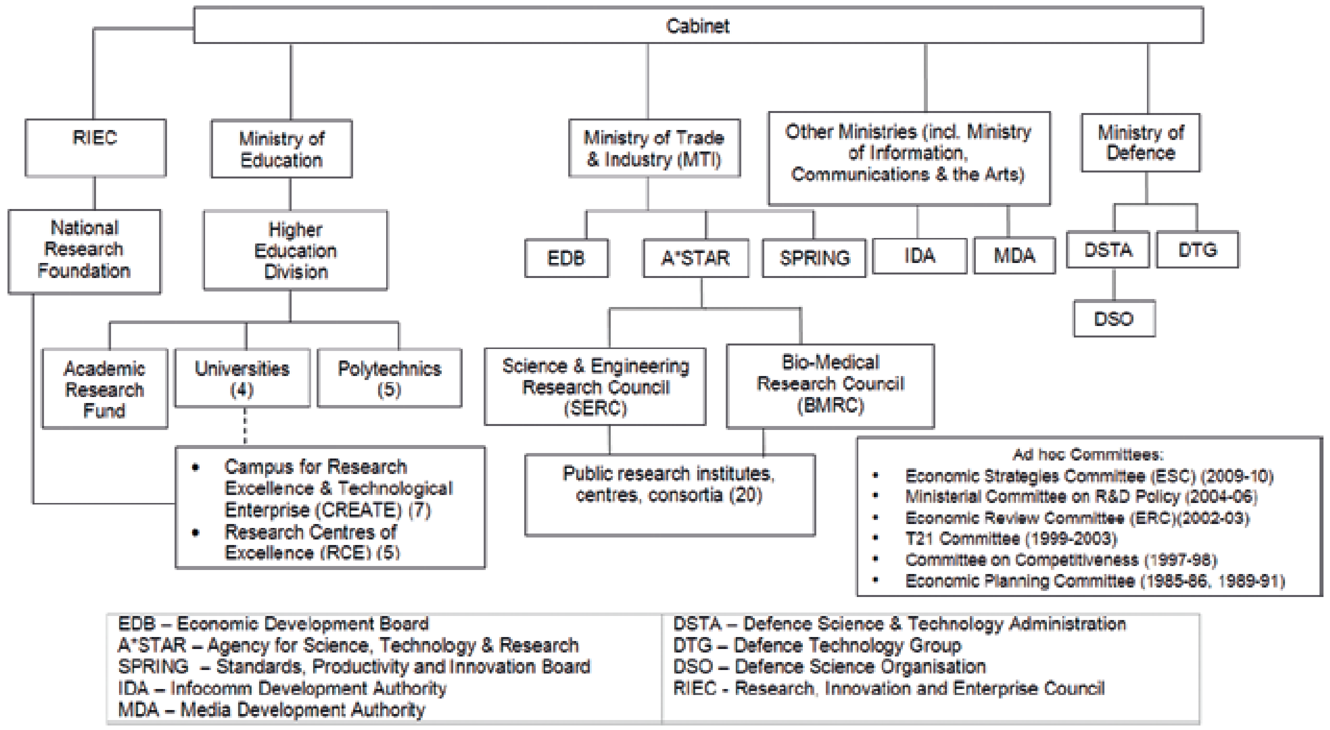

Figure 91: Institutional framework for S&T policy in Singapore
Source: OECD (2011): Review of Innovation: Southeast Asia, Paris (forthcoming)

Under the STP 2010, various programmes were conducted to enhance the identified strategic thrusts. The three research programmes coordinated by the NRF/RIEC are the Biomedical Sciences Translational and Clinical Research, the Environmental and Water Technologies (EWT – Clean Water and Clean Energy) and the Interactive and Digital Media (IDM). To encourage more private sector R&D, the government strengthened the technological capabilities of SMEs through several technical, human resources and financial assistance programmes administrated by the SPRING (Standards, Productivity and Innovation Board). The STP 2010 also requested the establishment of stronger linkages between SMEs and research institutes.[245]

For the on-going five year plan 2011–2015 the R&D budget has been increased by 20 per cent above that of the STP 2010. At the presentation of the budget in 2010, the Prime Minister stressed the growing importance of R&D in Singapore's development and the need to solve complex national challenges with R&D – such as the issues of energy resilience for sustainable growth. By expanding private sector R&D, the new five-year plan requests that total R&D should attain 3.5 per cent of GDP by 2015.[246]

The S&T input and output indicators clearly show the outstanding position of Singapore among the member countries of the ASEAN. However, from the impact of the global financial crisis, Singapore's economy contracted by 3.1 per cent in 2009 and business expenditure on R&D fell by 27.3 per cent. This led to the GERD's overall decline to 2.3 per cent in 2009 compared to 2.6 per cent a year earlier. Out of the total GERD of around S$ 6 billion, business expenditure on R&D (BERD) amounted to S$ 3.7 billion. The private sector's largest share of R&D was in the fields of electronics and ICM, biomedical sciences, precision and transport and chemicals.[247] MNCs are still the most important contributors to private sector R&D, accounting for about three-quarters of R&D in 2009. In contrast, indigenous Singaporean firms remained strongly dependent on technological knowledge produced by MNCs operating in Singapore.[248]

The public sector, including 60 institutions for research, higher learning, hospitals and so on, increased its R&D expenditure by 15.4 per cent to US$ 2.3 billion. Their research was concentrated on similar fields to the GRIs, but with a slightly different ranking of priorities with regard to research funding. The largest share was allocated to biomedical sciences, followed by electronics and ICM, precision and transport and chemicals. Singapore also has an advantage in terms of researcher intensity. Measured in full-time Equivalence/1,000 labour force, Singapore's researcher intensity grew from 9.5 in 2008 to 10.1 in 2009. This compares very favourably with other ASEAN member states and even with the

245 MTI (2006), p. 45
246 RIEC (2010)
247 A*STAR (2009): National Survey of Research and Development. December 2009, Singapore, available online at: http://www.a-star.edu.sg/Portals/0/media/RnD_Survey/RnD_2009.pdf, most recent access date: 2 September 2011
248 OECD (2011b); Wong, Poh-Kam / Ho, Yuen-Ping (2007): Knowledge sources of innovation in a small economy: The case of Singapore, in: Scientometrics 70(2), pp. 223–249

other leading countries in innovation – for example, the USA (9.2 in 2007), South Korea (9.7) and Sweden (9.8).[249]

In sum, Singapore has become one of the most competitive countries in the world in these domains and is the clear leader in S&T development within the ASEAN region. Despite the impressive progress made, though, the city-state's ranking in the World Economic Forum (WEF)'s Global Competitive Report 2011–2012 points to some weaknesses in the innovation policy and system. While Singapore ranked second in terms of overall competitiveness, it was only eighth in innovation. The WEF's critique was focused on the country's capacity for innovation and the sophistication of companies, and suggested that it 'could encourage even stronger adoption of the latest technologies'.[250]

7.4.5.2 Singapore's international S&T cooperation policy

Interviews with representatives from governmental organizations (A*STAR and NRF) that were conducted in 2008 confirmed our initial assessment based on the literature review: namely, that international S&T cooperation is given high priority by the Singaporean government and by scientists in Singapore. Two topics dominated the discussion with local experts – first, the need to concentrate on new or emerging fields of S&T and, second, the shortage of skilled manpower for R&D and possible strategies to overcome this constraint. In both cases, international cooperation was regarded as being crucial. Up to the highest level of government, the experience of foreign experts and advisors from the academic arena and from leading international companies was actively sought. Foreign experts, for example, were involved in the discussion about the S&T fields Singapore should focus on, providing advice on future technology trends.

In our graphical assessment of the reasons why Singapore was cooperating in S&T with other countries, governmental organizations placed great emphasis on transnational learning, innovation benchmarking and co-patenting (see figure 92). In all three areas, the government has designed special policies – including a strict regime for the protection of intellectual property rights (IPR) and incentives for foreign companies to invest in R&D. In contrast to most other ASEAN member countries, global thematic priorities were regarded as much more important than country-specific priorities, a reality which fits with the city-state's overall policy of seeking specific S&T niches. It is interesting to note that funding was given a secondary ranking as a reason for international S&T cooperation. Considering Singapore's overall budget for R&D, this did not come as a surprise.

In the discussion with governmental agencies, the shortage of skilled manpower for R&D was stressed as one of the core motivations for Singapore's search for international S&T cooperation. With the growth of knowledge-intensive industries relying on R&D, this problem became very urgent. In order to be attractive for investment from high-tech MNCs, the shortage of home-grown scientists had to be quickly addressed. In 2008, around 80 per cent of Ph.D. students came from foreign countries. The main reason for this development is the strong preference of local graduates to enter directly into the business world instead of becoming Ph.D. students. The Singaporean government reacted to this problem by designing a special programme (the 'Singha' programme for graduates) that enabled them to study abroad or alternatively to enter global networks. In addition, activities to attract foreign researchers and students to work and study in Singapore were intensified as well.

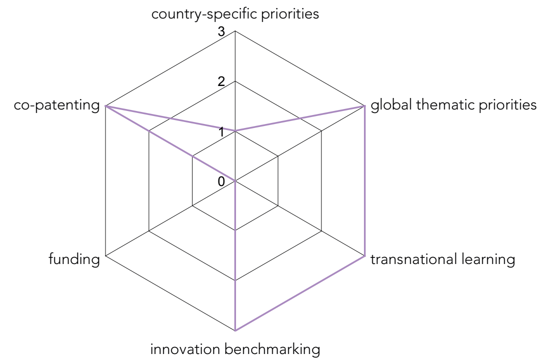

Figure 92: Reasons for international S&T cooperation: the view of governmental institutions in Singapore
Source: Authors' own assessment based on interviews

A complex web of capacity-building programmes at universities, polytechnics and research institutes has been created by the government in order to increase international cooperation. A*STAR is heavily involved in attracting foreign scientists and encourages Singaporean students, at all levels, to go abroad. The NRF provides block grants for specific S&T fields. The NRF Research Fellowship Scheme is a globally competitive programme that enables young researchers to undertake independent research in Singapore. The programme CREATE (Campus for Research Excellence and Technological Enterprise) aims to bring the world's top research universities to Singapore to work together with Singapore's universities and research institutions. The NRF also encouraged the establishment of Research Centres of Excellence (RCEs) at Singapore universities, staffed with renowned international scientists. The RCE's directors are given an attractive R&D budget, which they can spend independently, for example, to invite top scientists from around the world.

249 A*STAR (2009)
250 World Economic Forum (2011): Global Competitivenss Report 2010-2011, available online at: http://propinoy.net/wp-content/uploads/2011/05/PH-WEF_GlobalCompetitivenessReport_2010-11.pdf, most recent access date: 14 September 2011, p. 12

Seen from the perspective of individual scientists, international S&T cooperation was mainly pursued due to factors internal to Singaporean science and related to the intellectual and social organization of science there (see figure 93). Scientists put a strong emphasis on access to S&T, scientific publications, reputation, increases in co-patenting, increases in research capabilities and the exchange of research personnel. While the exchange of students was rated as being quite important, access to funding and research infrastructure were of little importance to scientists in Singapore.

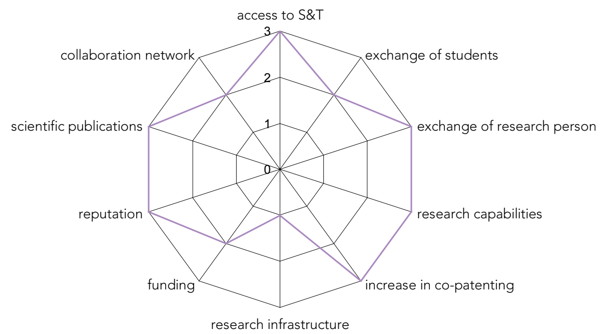

Figure 93: Reasons for international S&T cooperation: the view of scientists in Singapore
Source: Authors' own assessment based on interviews

For scientists working in high-level positions in GRIs or universities, finding well-trained researchers and students for laboratory work was one of the major challenges. Foreign scientists – for example, from Europe and the US – greatly appreciated the comfortable funding situation and the well-equipped labs. Most of them found the environment that they work in very conducive to R&D. However, some of them had their doubts about whether the administration had a comprehensive understanding of the requirements and benefits of basic research, as well as its long-term design.

Fields of international S&T cooperation most important for Singapore

The government's preferences in international S&R cooperation were based on the three strategic areas of research coordinated by RIEC, which are: biomedical sciences translational and clinical research, environmental and water technologies and interactive and digital media. In addition to this top-down approach, the NRF supported individual research activities through programmes such as CREATE and fellowship schemes. This bottom-up approach was intended to make sure that new areas of research other than those currently supported could be identified.

Preferences for specific partners in international S&T cooperation

Based on the interviews, we found that research cooperation with specific countries was still related to Singapore's historical ties with the UK and Japan. Research institutes and universities from these countries paid a great deal of attention to S&T cooperation with Singapore. For example, subsidiaries of their universities were set up in Singapore. In June 2008, the UK's Medical Research Council (MRC) announced the establishment of a Collaborative Research Fund with Singapore with a budget of S$ 6 million for the study of infectious diseases. Both sides (MRC and A*STAR) agreed to contribute half of the fund each. The establishment of this research fund was part of the 'UK–Singapore Partners in Science' programme, which offered workshops and travel grants.[251] Japan was also involved in Singapore's biomedical research network. In September 2005, RIKEN (Japan's network of public research institutes) and A*STAR signed a MoU with the aim of fostering exchange between researchers at RIKEN and Singapore's Biopolis.[252]

EU-Singapore cooperation seemed to be strong in some specific areas, such as ICT. In December 2004 the EU announced the GAPFILL initiative (getting more asian participants involved in IST) and offered € 1.8 billion for collaboration between Singaporean research institutes and EU companies with two IST grants.[253] According to a joint report by Singapore and the EU, under FP6 nearly 90 per cent of applications from Singapore for funding on ICT themes were accepted,[254] demonstrating Singapore's strong research capacity in this area. Other EU countries also intensified S&T cooperation with Singapore, including Hungary and Sweden.

Singapore had an extensive cooperation network with the US because of the latter's prominent position as the leader in many S&T fields. One example was the collaboration between A*STAR, the NUS and the University of California in six research fields, including cancer research and stem cell biology.[255] Various top scientists from the University of California and from the US National Institute of Health joined A*STAR to work in the Institute of Molecular Cell Biology and the Institute of

251 In May 2010, the first Joint Grant Call with a volume of S$ 4.5 million for six collaborative research projects was announced. See: MRC Medical Research Council (2010): MRC and Singapore A STAR Unite to Fight Infectious Disease, available online at: http://www.mrc.ac.uk/Newspublications/News/MRC006840, most recent access date: 2 September 2011
252 A*STAR (2006): Biome – A Newsletter of The Agency for Science, Technology and Research (A*STAR) Singapore, July 2006, Issue 6, p. 8
253 Euro-Singapore Media Release (2005): EuroSingapore 2005 poised to boost stronger ties with European-based research organisations, 27–28 January 2005, available online at: http://www.i2r.a-star.edu.sg/download.php?doc=MR_Euro_Singapore, most recent access date: 27 September 2011
254 European Commission (2007): A New Approach to International S&T Cooperation in the EU's 7th Framework Programme (2007–2013), available online at: http://www.kowi.de/Portaldata/2/Resources/fp7/fp7-newapproach-inco.pdf, most recent access date: 27 September 2011, p. 9
255 Biome (2006), p. 8

Clinical Sciences.[256]

Historical and cultural ties between China and the Chinese diaspora in Singapore explained the large number of exchange programmes for students and scientists at the NTU from China. Other extra-scientific factors help to explain why Singapore cooperates closely with its neighbours. As the most technologically-advanced country within the ASEAN, the Singaporean government is committed to cooperating with other ASEAN member states. Research cooperation was concentrated in 2008 on more advanced neighbours such as Malaysia, while exchange programmes at universities and polytechnic institutes were offered to scientists in other ASEAN member countries that are still in the capacity-building stage.

When we looked in detail at Singapore's international S&T cooperation policy, we found that national S&T policy did not specify any preferences for who S&T cooperation partner countries or regions should be. Singapore's government agencies were globally oriented. A*STAR, for example, picked the best scientists in each research field and approached them directly for cooperation. NRF has no special funding for international networking among scientists. They described their way of finding partners for S&T as a bottom-up process, with universities establishing international cooperation for student and researcher exchanges. For GRIs, in contrast, some special incentives existed to cooperate with foreign partners in cutting-edge technologies. Although students from Singapore were able to choose whichever country they wanted to study in, they preferred the UK or the US due to the absence of a language barrier. That Singaporeans have a strong tendency to study and cooperate in S&T with the US instead of Europe is seen by some scholars as being based on a lack of knowledge about existing academic and research opportunities. Besides the UK and the US, according to some interview partners, the third most important geographical destination for students wanting to study abroad was Japan.

Universities' international cooperation policies have traditionally been oriented towards bilateral S&T relations as the preferred mode of cooperation, and not towards regional entities. The NTU, for example – besides its traditional S&T relationship with the UK – undertakes bilateral cooperation with specific countries in the EU such as France, Germany, Hungary, Italy, the Netherlands, Norway, Sweden and Switzerland. The university is currently extending its cooperation partners to include Croatia and Russia. Within the ASEAN region, research cooperation existed with scientists from Malaysia and the Philippines, while universities in China and India also became attractive for cooperation due to those countries' rapid technological development. Besides student exchange programmes, the NTU runs a Masters of Public Administration, which city mayors from mainland China were able to participate in as well. The research priority areas at the NTU include nanotechnology and nanoscience, interactive and digital media and life sciences.

Research at the National University of Singapore (NUS) was strongly oriented towards English-speaking countries, especially the UK and the US, but the university also collaborated with other EU countries, such as France. Research areas at the NUS included biological science, chemistry, mathematics, pharmacy and physics. Within the ASEAN, research ties with Thailand (Chulangkorn University) were the strongest. In terms of the number of foreign students studying at NUS, most of them came from China and India. The university's student exchange programme (SEP) offered the opportunity to study for one or two semesters at the University of British Columbia, the University of California, the Karolinsaka Institute, King's College, or the University of Melbourne. A double degree programme with the French Grandes Ecoles also existed; it was designed as an elite programme for top students in engineering and science.

Voices from governmental institutions and scientists in Singapore on international S&T cooperation

Government representatives:

"Traditionally, we have approached Europe on a country-by-country basis, often concentrating on the UK due to close historical ties. There is an obvious transition in the role the EU is playing as a representative body of all EU member countries. For most scientists and students in Singapore, however, there are still too many barriers to cooperation, such as a lack of knowledge about the FPs, language barriers, and the lack of traditional networks…"

Source: Face-to-face interviews

Nanyang University:

"NTU has a considerable presence in Europe and is frequently viewed as a partner of choice for top European-based institutions and organizations. Coupled with that is the growing number of high-calibre European faculty and research students joining the university.

Europe continues to be a major source of funding for NTU research. The university has submitted proposals to the French Embassy's science and technology funding initiative, the Merlion Programme, and has also made successful bids under the EU's Asia Link Programme and its Framework Programme for Research and Technological Development."

Source: Nanyang Technological University, Annual Report 2007

256 Biome (2006), p. 10

For individual scientists, the choice of cooperation partners depended ultimately on a complementary exchange of knowledge. They themselves looked for scientists that they wanted to work and form partnerships with. The capability to assess the quality of foreign research partners – which was stressed by most interview partners – was quite strong in Singapore. International research cooperation with the EU already exists on different levels, but some scholars and representatives of GRIs and universities pointed to a surprising lack of knowledge about the EU in general and about EU research-funding schemes in particular. Those who were familiar with the FPs stressed the heavy administrative burden for large projects with various partners in the EU and Asia and the fact that the chances of obtaining funding were not as good when compared to the funding schemes in Singapore. To some very critical interview partners (from Europe), the evaluation procedures of the FPs showed more resemblance to 'a lottery than to an evaluation'. As Singapore is no longer eligible to receive funding for research projects under FP7, the incentives for scientists to apply for project funding were limited. This was viewed quite critically by those foreign scientists we interviewed in Singapore. Because of the city-state's role as an S&T portal for the whole of the ASEAN, they suggested Singapore should be given an intermediary role and FP funding to scientists continued. From the perspective of some foreign experts, EU officials ignored the state-of-the-art circumstances in many S&T fields in Singapore. For scientists in Singapore, the intended objective of cooperation in the FPs – to get to know, and to enter, research networks with the EU – is not very attractive as most of them already have well-established networks with their own academic communities.

Summary of findings in Singapore

In sum, the questions of why Singapore is engaged in international S&T cooperation, what its most important partners or regions in S&T are, and which fields of cooperation are preferred can be answered as follows:

- International S&T cooperation is the key to Singapore's economic and technological success and is strongly supported by the government.
- Attracting and keeping experts in those S&T fields in which Singapore wants to become internationally competitive is one of the biggest challenges facing the city-state in the global race to secure the best experts.
- Biomedical research in particular requires highly-qualified scientists with a good reputation who can serve a pull-function and attract other well-known scientists to come to Singapore.
- As the government offers comprehensive funding for the strategic fields of S&T, the inflow of foreign researchers has grown in the last few years.
- While the EU acknowledges that 'Singapore has emerged as a world-class research performer in its own right', the incentive problem for scientists in Singapore – because they are no longer eligible for direct FP funding – is often overlooked as being a barrier to cooperation.

7.4.6 Thailand

7.4.6.1 Key characteristics of Thailand's S&T policy and system

Thailand has undergone an impressive economic and social transition that is often cited as 'one of the great development success stories'.[257] As of July 2011, the World Bank re-classified Thailand from a lower-middle income economy to an upper-middle income economy.[258] Thailand's outward-oriented development strategy proved to be effective for the absorption of foreign direct investment (FDI) and for becoming a global manufacturing hub. Technological spill-overs from MNCs into the Thai economy, as well as indigenous innovation performance, remained, however, limited and were insufficient to ensure further productivity-driven economic growth.

Although the need to strengthen S&T capacity has been included in many policy documents by the government since the 1980s, the Asian financial crisis triggered a change in policy direction and led to a restructuring of the innovation system. The establishment of the National Science and Technology Development Agency (NSTDA) as an autonomous organization operating under the policy guidance of its own board, and chaired by the Ministry of Science and Technology (MOST) from 1991, was the first step towards a profound change. The MOST controls the NSTDA through the National Science and Technology Board, which is composed of an equal number of representatives from the private and public sectors. The ministry itself was established in 1979 as MOSTE (Ministry of Science, Technology and Energy) and later renamed MOST, reflecting its new focus only on S&T.

The NSTDA defines itself as a bridge between the academic research and innovation requirements of industry and as an umbrella organization that plans and executes four tasks: namely, R&D, technology transfer, human resources development and infrastructure development. It is involved in the formulation of national S&T policy, the funding of R&D projects and the admin-

257 World Bank (2011): Country Brief. Thailand, available online at: http://www.worldbank.or.th/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/THAILANDEXTN/0,,menuPK:333306~pagePK:141132~piPK:141107~theSitePK:333296,00.html, most recent access date: 2 September 2011

258 Upper-middle income economics have average incomes of US$ 3,976 to US$ 12,275. Based on the World Bank's Atlas method, Thailand's GNI p.c. amounts to US$ 4,210. See World Bank (2011): Thailand Now an Upper Middle Income Economy, available online at: http://www.worldbank.or.th/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/THAILANDEXTN/0,,contentMDK:22994296~menuPK:50003484~pagePK:2865066~piPK:2865079~theSitePK:333296,00.html, most recent access date: 2 September 2011 istration of four national research centres. These centres were established between 1993 and 2005 and represent the core technologies on which government support is concentrated: namely, BIOTEC, MTEC (for metal and materials), NECTEC (for electronics and computer technology), NANOTEC and TMC (Technology Management Centre). Another step towards an institutional structure that offers better support to Thailand's transition to an innovation-driven economy was the establishment of the National Innovation Agency (NIA) in October 2003.

Similar to the NSTDA, the NIA was also set up by the MOST as an autonomous agency, operating under the supervision and policy guidance of the National Innovation Board. Since September 2009, NIA has been upgraded to a public organization, but remained under the MOST's umbrella policy guidance. The NIA focuses on strategic and sectoral industrial innovation, national productivity, the coordination of industrial clusters at policy and operational levels and on the fostering of a culture of innovation. Under the roof of NIA two funding schemes have been merged: the Innovation Development Fund, previously attached to NSTDA, and the Revolving Fund of Research and Technology Development, formerly under the direction of the Office of MOST's Permanent Secretary. Both funds are now combined and coordinated by NIA for the support of innovation development, especially strategic innovation and cluster platforms. NIA follows three main goals: (1) the acceleration of innovation capacity, (2) the promotion of an innovation culture and awareness of innovation, and (3) the development of the national innovation ecosystem.[259]

The institutes of higher education play only a minor role in R&D. Most research is concentrated in a few large universities located in the country's capital, Bangkok. In 2009, the Ministry of Education launched the National Research Universities Project with the aim of fostering capacity building, especially human resources in research and innovation. The nine universities selected include Chiang Mai University, Chulalongkorn University, Kasetsart University, King Mongkut Institute of Technology Thonburi, Kohn Kaen University, , Mahidol University, Prince of Songkla University, Suranaree University of Technology and Thammasart University.[260] Critics of the R&D performance of the higher education sector point to the low proportion of S&T graduates compared to social science graduates and to the insufficient participation of industry in curriculum development at universities. This has let to the industrial sector's negative perception of the role that the higher education sector could play in cooperation with companies. Due to a change in government policy towards the higher education sector, comprising the universities' greater autonomy, the introduction of a performance-based budgeting system and the establishment of the University Business Incubator Programme, the climate for closer cooperation between companies and universities was improved.[261] Close university–industry linkages were, however, found only among a few large firms.[262]

The private sector is still investing very little in technological development in Thailand. Between 1999 and 2005 the business sector's share of GERD even declined. This seems to be a reflection of both structural problems in the manufacturing industry and the predominance of small enterprises that are not willing or able to invest in R&D. The percentage of Thai firms doing process innovation is very low (2.9 per cent) compared, for example, to companies in South Korea (21 per cent). Only in recent years has this situation changed to some extent with more large conglomerates investing in R&D and a stronger R&D collaboration between small firms and universities.[263] According to the most recent survey of R&D expenditure, the business sector contributed 55 per cent of total R&D in 2007.[264] MNCs still play an important role in the transfer of technology. According to information from the NSTDA in 2008, about half of the R&D occurring in the business sector can be attributed to foreign companies. Japan is the largest investor in Thailand and thus important in technological cooperation. However, the low absorptive capacity of local firms has not allowed for many spillover effects from FDI.

Although the idea of S&T-based development can be found in most of Thailand's five-year development plans, it was only after the Asian financial crisis that specific policy instruments were designed and agencies established to implement the new policy. Collaboration between public research institutes and industries was given high priority. Among the new policy measures to support the interaction between scientific institutions and firms were the establishment of intermediaries such as incubators, the provision of better S&T networks and services and the transfer and diffusion of technology. The ninth development plan (2002–2006) acknowledged this specific policy in detail.[265]

Thailand's long-term S&T policy document – the National Science and Technology Strategic Plan 2004–2013 (STP 2013) –, issued by the National Science and Technology Policy Committee (NSTPC), requests action to 'enhance Thailand's capability to be able to effectively respond to rapid changes in the age of globalization and to strengthen the country's long-term competitiveness'.[266] The objectives of this plan, as well as MOST's 'vision' statement, can be interpreted as an adjustment of the government's S&T policy in order to better cope with the increased competition from within the greater Asian region – especially from China – as well as on the world market. The plan points to four factors that should be emphasized in future development: (1) the strength of the national innovation system; (2) the strength of human resources; (3) an appropriate environment for development; and, (4) capability in four core future technologies – namely, ICT, bio- and nanotechnology and new materials technology. The five strategies outlined in the policy document include the development of industrial clusters, community economy and quality of life, S&T human resources and S&T infrastructure and institutions. The document also requested the better promotion of public awareness of S&T and reforms of the S&T management system. A broad range of new incentives were introduced by the plan as well, such as the development of Centres of Excellence with international standards, the founding of science parks, and income tax deductions for R&D expenditures (NSTPC 2004: iii; 33–34).

Comparing previous policy approaches with this long-term strategic plan, a broadening of the policy focus can be observed. Instead of a narrow concentration on R&D, human resource development, technology transfer and S&T infrastructure, a cluster-development approach was pursued. The difference between these two approaches lies in the perception of the firms as 'users' of S&T knowledge, as supplied by GRIs and universities. This contrasts with the innovation system approach of creating networks and interactions between actors within the NIS. In addition, the new policy approach supported the creation of scientific knowledge in areas such as life sciences and physical sciences that can provide a foundation for technological development, instead of supporting only the four core technologies: namely, biotechnology, ICT, materials technology and nanotechnology.[267]

To summarize, Thailand has been adjusting its S&T policy since the 1990s. An important new policy direction began with the introduction of the concept of the national innovation system, because it supported the establishment of new intermediaries such as science parks and funding institutions. The problem, however, was that these institutions (approximately 80 public and private sector agencies) were only very loosely connected with each other, resulting in an overlapping of functions.[268] In order to overcome the fragmentation within the innovation system, the government designed a National Science, Technology and Innovation Act, which was approved in 2008. This act requested the creation of a Board of National Science, Technology and Innovation Policy, consisting of the Prime Minister as the chairperson, the MOST minister as vice-chairperson as well as the involvement of other ministries concerned with S&T. The new agency is expected to function as a 'focal point for coordination among research institutes or educational institutions'.[269] The extent to which this agency has also become active is not clear. However, better coordination between agencies, policies and funding will be a necessary precondition to the achievement of the implementation of the desired innovation goals and industrial upgrading.[270]

Although ambitious innovation policies and programmes have been introduced, the indicators that measure innovation performance are rather disillusioning. In 2007 the GERD amounted to only 0.21 per cent. This does not compare very favourably with the situation in 2003 (0.26 per cent) and with the goal of the 10th National Economic and Social Development Plan (2007–2011), which embraced a R&D investment goal of 0.5 per cent. Other performance indicators, such as patents, show a similarly weak performance. In terms of scientific publications, however, Thailand has been performing relatively well.

The new long-term STI policy plan for the period 2012–2021 is currently under discussion. Given the many challenges ahead, the government will increase its R&D investment and encourage the private sector to enlarge its engagement as well. Until 2017, the intention is that the GERD should rise from the current 0.21 per cent to 1 per cent, with the private sector increasing its contribution from 45 per cent to 70 per cent. Researcher intensity is planned to rise as well from the current 0.676 per 1,000 personnel to 1.5 per 1,000 by 2017.[271]

7.4.6.2 Thailand's international S&T cooperation policy

Thailand has traditionally been open to the transfer of technology by MNCs, which required liberal economic

259 Lorlowhakarn, Supachai / Ellis, Wyn (2005): Thailand's National innovation Agency, in: CACCI Journal, Vol. 1, pp. 1–14, available online at: http://www.garrettstokes.com/wp-content/uploads/2010/04/Thailands-National-Innovation-Agency-2005.pdf, most recent access date: 20 August 2011; National Innovation Agency, website http://www.nia.or.th/en/, most recent access date: 1 September 2011

260 See SEA-EU-NET (n.d.): R&D Country Profile Thailand, available online at: http://www.sea-eu.net/asia/info/10/thailand.html, most recent access date: 27 September 2011; OECD (2011b). The Report lists a number of other universities, some of them already engaged in R&D.

261 Intarakumnerd, Patarapong / Chairatana, Pun-Arj / Tangchitpiboon, Tipawan (2002): National Innovation System in Less Successful Developing Countries: the Case of Thailand, in: Research Policy 31(8–9), p. 1451

262 Ellis, Wyn (2007): Thailand's Innovation Landscape. Internal Report to the Thai-German Programme for Enterprise Competitiveness, Bangkok, p. 40

263 Intarakumnerd, Patarapong (2005): Government Mediation and Transformation of Thailand's National Innovation System, in: Science, Technology & Society 10(1), p. 17

264 Office of the National Research Council of Thailand (2009): 2009 National Survey on R&D Expenditure and Personnel of Thailand, available online at: http://gerd2.nrct.go.th/executive-summary_enphp?cate1_id=6, most recent access date: 20 August 2011

265 Altenburg, Tilman / Gennes, Michaela / Hatakoy, Arzu / Herberg, Mirko / Link, Jutta / Schoengen, Sabine (2004): Strengthening Knowlege-based Competitive Advantages in Thailand, Reports and Working Papers 1/2004, GDI German Development Institute, Bonn, pp. 42f

266 NSTPC National Science and Technology Policy Committee (2004): The National Science and Technology Strategic Plan 2004–2013, Bangkok, p. iii

267 Ellis (2007), pp. 10f

268 Ellis (2007), p. 40

269 STI National Science, Technology and Innovation Policy Office (2008): National Science, Technology and Innovation Act, English Translation, available online at: http://www.sti.or.th/th/files/National20Science_Tech_Inno_Act.pdf, most recent access date: 31 August 2011

270 OECD (2011b)

271 Durongkaveroj, Pichet (2011): Direction of Science, Technology and Innovation Policy in Thailand, available online at: http://nis.apctt.org/PDF/CSNWorkshop_Report_P4S4_Pichet.pdf, most recent access date: 2 September 2011 policies. Faced with a low level of innovation capacity, international S&T cooperation has become more important than before. In top-level discussions about the best policy approach for establishing an effective system of interaction between the various actors in the innovation system, foreign advisors are already playing an important role. In 2008, the international advisory committee at NSTDA included a chairman from Japan, two members from Germany, and others from India, Taiwan, the UK and the US.

Seen from the governmental organizations' perspective, transnational learning and country-specific priorities were crucial for international S&T cooperation. Other factors – such as innovation benchmarking, funding and global thematic priorities – were rated as being important as well, but to a lesser extent. Co-patenting was not seen as being a trigger for international S&T cooperation (see figure 94).

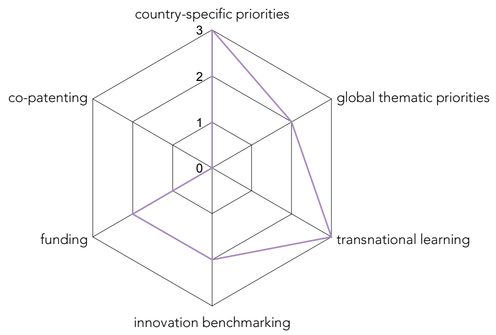

Figure 94: Reasons for international S&T cooperation: the view of governmental institutions in Thailand
Source: Authors' own assessment based on information from interviews and questionnaires

Thai scientists' views on the reasons for international S&T cooperation diverged to some extent from those of the interviewed government representatives (see figure 95). The three most important reasons for collaborating with foreign colleagues were: (1) access to new S&T, (2) access to collaboration networks and (3) research capabilities and funding. Still important, but placed on a lower level of significance, were access to research infrastructure, the exchange of students and reputation. The exchange of research personnel and increases in co-patenting and scientific publications were rated as being of the lowest importance as well. That the exchange of research personnel received such a low rating as a reason for international S&T cooperation came as a surprise to us. Thai people in general – as was explained to us during our interviews in 2008 – were not very eager to stay abroad after their studies had finished because of adverse living conditions. Nevertheless, over the last few years the exodus of Thai scientists has increased and represents both a challenge and opportunity for the government.[272]

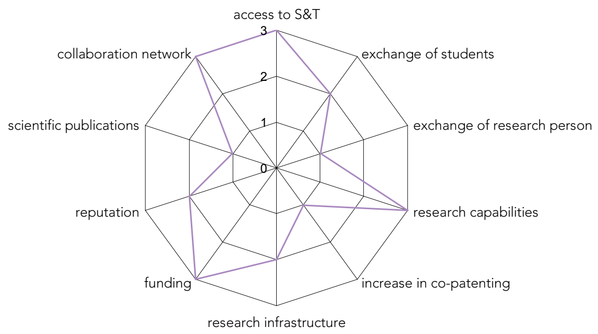

Figure 95: Reasons for international S&T cooperation: the view of scientists in Thailand
Source: Authors' own assessment based on information from interviews and questionnaires

Preference for specific fields and partners in international S&T cooperation

When discussing international cooperation, governmental representatives listed the following S&T priorities: health; food, including agriculture; bio- and nanotechnology; energy; environment; and, ICT.

The international networking of governmental agencies such as NSTA was very extensive in 2008, including connections with more than 15 countries as well as with multilateral agencies and programmes (for example, ASEAN COST and the Asia-Pacific Economic Cooperation (APEC) Industrial Science and Technology Working Group (ISTWG). In interviews with government representatives, we learned that countries were basically chosen as cooperation partners on the basis of their S&T strength in particular technologies. In MOST's assessment of the intensity of S&T cooperation with specific countries or regions, the ASEAN, India and Japan were given the highest rating. Networking and the mobility of researchers were chosen as the most important reasons for cooperation. Only in relation to cooperation with the ASEAN was access to funding also mentioned as a reason for cooperation.

A strong S&T relationship existed with Japan, the technological leader in Asia. Japan is also one of Thailand's most important economic partners. FDI from Japan constitutes the largest share of total investment from overseas. The institutional relationship between the NSTDA and Japan (with the National Institute of Advanced Industrial Science and Technology, AIST) revolves around a MoU. Japan is also driving the discussion on international cooperation in SEA. The Japanese Society for the Promotion of Science (JSPS) organized a conference in Bangkok in February 2008 entitled, 'International Collaboration for the Formation and Development of a Science and Technology Community in Southeast Asia'. Alongside the NSTDA, S&T organizations from Indonesia, the Philippines, Singapore and Vietnam also attended this conference.

Thailand also has a long-standing S&T relationship with the US, based on an S&T agreement that was signed in 1984. Through a Thai–US network (Wisconsin Alumni Association of Thailand (WAAT) and the Wisconsin Alumni Thailand Foundation (WATF), human resources development is supported. The length of the awarded scholarship is one year; participants are scholars and university administrators.

Special programmes initiated by MOST for sending students abroad aimed to transform the inward-looking attitude among academics into a more global orientation. To support the establishment of more extensive Thai student networks overseas, the government has launched a trial initiative and supported the creation of a website for the Greater Boston Organization of Thai Students and Scholars. Because of the location of Harvard University and the MIT (Massachusetts Institute of Technology) in Boston, this network aims to reach some of the top-level students and scholars in the US. Several European countries are also among Thailand's cooperation partners. The selection of European cooperation partners is also based on the latter's specific strengths in S&T. Among the EU countries mentioned as Thailand's major S&T partners in 2008 were: France, Germany, Hungary, the Netherlands, Sweden and the UK. With France, for example, Thailand undertakes cooperation in aeronautics. France (together with Japan) was also a cooperation partner in the training and education programme 'Space Technology: Application and Research' by AIT (Asian Institute of Technology), and was engaged in ICT projects with Thailand.

Based on the 2008 online questionnaire responses from MOST and NSTDA representatives, an overview of the most important collaboration partners is given in table 19 below. Although India was mentioned as one of the most important partners, it does not appear in this table. We can only assume that the reason for this is that up until now no concrete S&T cooperation has been undertaken.

Table 19: Thailand's most important partner countries and regions in selected S&T fields

S&T Field	ASEAN	Australia New Zealand	China	EU	Japan	South Korea	USA
Health			X				
Food, Agriculture and Fisheries, Biotechnology	X				X		
Biotechnology, Life Sciences				X	X		
Nanosciences, Nanotechnologies, Materials and New Production Technologies							X*
Energy					X X*		
Environment (Climate Change)		X			X		

*Programme under preparation. France was named the most important partner in the field of transport and aeronautics.
Source: MOST, online questionnaire

Many Thai scientists are trained in the US and in Europe. There was a strong bias among those scientists we interviewed towards European countries. From the scientists' perspective, funding from Japan is more easily accessed, but it can also be obtained from other research funding institutions such as the Rockefeller Foundation. These institutions have offices in Bangkok; as a result, it is relatively easy to apply, and the success rate of applications is quite high. However, in FPs with partners from Europe the finances are centrally administered (Ministry of Finance) within the S&T institutions, and scientists have to 'beg' for their share in the project from the financing administration. In addition, applying to the FPs is regarded as being very difficult, with a low success rate. One problem is the obtaining of information about potential project partners in the EU. Japan fares better than European countries with regards to S&T cooperation with Thailand. The main difference is that research projects with Japanese partners generally have a substantive follow-up and a research relationship that continues after the completion of the project.

Voices from governmental institutions and scientists in Thailand on international S&T cooperation

Governmental institutions:

"The ideal partner in S&T cooperation is Japan because of cultural similarities. We are both very flexible, are interested in long-term relationships, do not look too much into details but rather into the outcome of a project, and prefer low bureaucratic involvement."

Source: Face-to-face interviews

Scientists:

"Europe is the preferred location for study and research, but S&T networks with European partners are difficult to establish because of a lack of project follow-up. The greatest challenge is funding, which is much more difficult to obtain compared to other partner organizations."

Source: Face-to-face interviews

272 OECD (2011b)

In sum, the questions of why Thailand is engaged in international S&T cooperation, what the most important partners or regions in S&T are, and which fields of cooperation are preferred can be answered as follows:

- International S&T cooperation is regarded as crucial for Thailand's technological catching-up.
- The choice of cooperation partners is primarily based on their strength in a particular S&T field, not on historical or extra-scientific reasons.
- Japan is Thailand's largest source of FDI and ODA and its most important S&T partner.
- The FP application procedures are regarded as being very difficult; access to information on potential cooperation partners in Europe is also limited.

7.4.7 Vietnam

7.4.7.1 Key characteristics of Vietnam's S&T policy and system

Vietnam's outward-oriented market transition has supported economic growth and the gradual upgrading of the country to a lower-middle income economy. Based on the World Bank's means of income classification (the Atlas method), the GNI p.c. amounted to US$ 1,100 in 2010 and has, thus, passed the threshold for lower-middle income economies, which ranges from US$ 1,006 to 3,976.[273] In November 2006, Vietnam became a member of the World Trade Organization (WTO), marking a final step towards its integration into the global economy.

As with other countries in transition, the change from state planning to a market-oriented system has led to a change in S&T policy directions and institutional actors. The Ministry of Science and Technology (MOST) plays a prominent role in policy formulation and implementation, but its position seems to be not as strong as in other countries. Policy directions are set by the Communist Party of Vietnam and the central government (See figure 96). The Committee on Science, Technology and the Environment of the National Assembly and the Department of Science, Technology and the Environment are the most important decision-making bodies in terms of S&T policies and regulations.[274] MOST also has to share its decision-making power with other ministries; according to the prime minister's proposal for the reform of the country's S&T management mechanism from 2004, MOST is required to share and coordinate with other ministries, branches and localities in the development of strategies, mechanisms and S&T policies, which need to be submitted to the government for approval. In addition, MOST is responsible for balancing and distributing the state budget allocated to S&T activities, managing key national S&T tasks, assessing the country's S&T potential and checking and monitoring S&T activities.

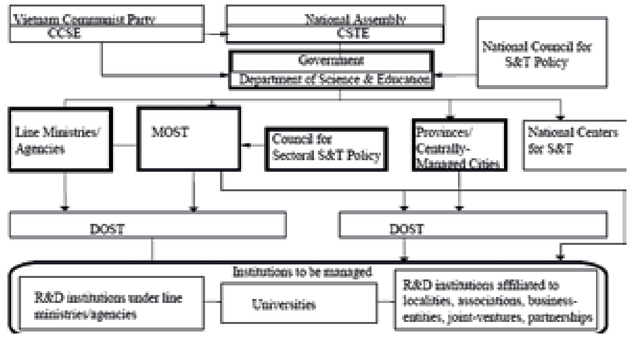

Figure 96: Vietnam's national system of innovation
Source: Nguyeng Thanh Tung, MOST

Other ministries are also involved; for example, the Ministry of Finance is responsible for the allocation and balancing of the state budget and specific financial mechanisms for S&T activities. The Ministry of Planning and Investment has the task of instructing ministries, ministerial agencies and agencies under the control of the central government in order to integrate S&T development plans into regular socio-economic development plans, as well as also coordinating with the MOST in the allocation of funds for S&T infrastructure projects. The Ministry of Education and Training chairs and coordinates, together with the MOST, the plans and policies related to human resources for S&T and to research activities in the nation's universities.[275] Other line ministries include the Ministry of Industry, the Ministry of Agriculture and Rural Development and the Ministry of Post and Telecommunications.

There are also a number of advisory bodies, including the National Council for Science and Technology and the National Institute for Science and Technology Policy and Strategy Studies (NISTPASS). The latter is subordinated to the MOST and has the mandate to undertake research so as 'to provide the foundations for developing S&T strategy, policy and management'.[276] One of the more recent activities of NISTPASS was a joint seminar with the Chinese MOST on 'sharing China's experience in the process of formulating strategies to develop science and technology (S&T)', held at the end of August 2011.[277] R&D funding institutions have been set up in Vietnam as well – including the National Fund for Technology Transfer in 2006, which has, however, not yet started its activities. There are also the National Fund for Science and Technology Support, the National Programs for Science and Technology Development, the National Centre for Technology Promotion and the National Program for Laboratory Development, which are all subordinated to line ministries or other governmental agencies. Funding for basic research is supplied by the National Foundation for Science and Technology Development. The agency in charge of information about S&T, documentation and statistics is the National Agency for Science and Technology Information (NASATI).[278]

GRIs play a predominant role in Vietnam's innovation system, and the two national research centres include many of them. The Vietnamese Academy of Science and Technology (VAST) represents one of these centres, focusing on natural and engineering sciences. It receives direct funding from the central government in order to carry out the so-called 'state S&T missions'.[279] The VAST has 30 national institutes and seven non-academic units (including, for example, the Vietnamese National Museum of Nature, a publishing house for S&T publications, etc.), nine state-owned enterprises, more than 20 'production units' and 35 institute branches, which are mostly located in Hanoi and Ho Chi Minh City. VAST established these enterprises and institutions of higher education after 1992, in reaction to the reform of the S&T structure that allowed GRIs to establish commercial spin-offs. In 2008, total employment amounted to 2,464 permanent staff, including 207 professors and assistants, 673 PhDs and 538 Masters of Sciences. VAST research fields approved by the prime minister comprise, for example, IT and automation, S&T in materials, eco-agriculture and biotechnology, natural disaster prevention, environment technology and sea research.[280] The other significant national research centre is the Vietnamese Academy of Social Sciences (VASS). In 2003, this research centre employed a staff of 1,380 people and was made up of 26 research and support institutes and 15 institutions of higher education.[281]

The total number of R&D institutes has increased remarkably, while there has been a decline in the R&D share of GRIs. Between 1995 and 2005 the total number of R&D institutes in Vietnam grew from 519 to 1220. Some authors attribute the marked increase in the number of GRIs to the need of line ministries to set up institutes that support their research on policies for international integration and the development of long- and medium-term policy suggestions.[282] Within the grouping of GRIs, the number of research institutes subordinated to line ministries increased from 289 in 1995 to 456 in 2005; their percentage share grew from 5.7 per cent to 37.3 per cent. Non-governmental institutes and private institutes also became more important in R&D, with a joint share of about 48 per cent of total R&D institutes in 2005.[283] Incentives for public R&D institutes to commercialize research findings were introduced at the end of the 1990s, but did not show the expected results. In 2005, the separation between those GRIs working in the field of public policy and basic research and those working in applied research and technological development was introduced as a new policy instrument.[284]

Institutions of higher education are under the administration of the Ministry of Education and Training. Their number rose between 2001 and 2009 from 77 to 376, of which 78.5 per cent are public.[285] University research activities are financed, to a limited extent, by the central government, while additional funding comes from contracts with enterprises and almost half from international sources. Researchers at universities were faced with several problems, such as a lack of autonomy in their operations and R&D facilities; heavy teaching loads; and ageing staff.[286] Only a small percentage of teaching staff (20 per cent) are involved in research as well. The Hanoi University of Technology (HUT) represents the largest university in Vietnam, with 40,000 students enrolled and a staff of about 2,000 employees. Commercialization of technologies developed in the HUT is supported by a number of companies that have been set up by the university. Alongside the HUT's involvement, the Can Tho University is also engaged in agricultural research and development for the Mekong River Delta.[287]

The Vietnamese business sector's role in innovation is not very prominent. The majority of enterprises are of a small size and are incapable of undertaking investment in R&D, while research by MNCs is mostly done not in Vietnam but in their overseas headquarters.[288] In 2005, only 5 per cent of scientists and engineers working in the business sector were engaged in R&D, while more than two-thirds worked in national centres for R&D, governmental agencies and universities.[289]

273 Based on World Bank ranking, see footnote 257
274 OECD (2011b)

275 MOST Ministry of Science and Technology (2004): Proposal on the Reform of the Science and Technology Management Mechanism, Vietnam, available online at: http://www.most.gov.vn/Desktop.aspx/Details-Article/Innovation/PROPOSAL_ON_THE_REFORM_OF_THE_SCIENCE_AND_TECHNOLOGY_MANAGEMENT_MECHANISM/, most recent access date: 29 September 2011
276 NISTPASS Website, available online at: http://www.nistpass.gov.vn/, most recent access date: 30 August 2011
277 NISTPASS "Share experience in building scientific development strategy and technology of Vietnam-China", online at: http://www.nistpass.gov.vn/en/index.php?view=article&catid=1:lt..., accessed 2 September 2011

278 OECD (2011b)
279 Krishna, V.V. / Krishna, Usha (n.d.): The Socialist Republic of Vietnam, available online at: http://portal.unesco.org/education/en/files/55606/11999623895VIETNAM.pdf/VIETNAM.pdf, most recent access date: 29 September 2011
280 See VAST Website, available online at: http://www.vast.ac.vn/en/, most recent access date: 2 September 2011
281 Krishna V.V. / Krishna, Usha (n.d.); Hung, Nguyen Vo / Ca, Tran Ngoc (2005): The Role of Academic Institutions in Economic Development: The Case of Vietnam, available online at: http://www.fpi.lu.se/_media/en/research/universidad06-vietnam.pdf, most recent access date: 29 September 2011, p. 6

282 Cung, Nguyen Dinh / Van, Bui / Ha, Pham Hong (2005): Vietnam Public Policy Research Institutions and Their Activities. Asian Development Bank Institute: Hanoi, available online at: http://www.adbi.org/files/2005.12.book.policy.research.vietnam.pdf, most recent access date: 30 August 2011
283 Hong, Vu Xuan Nguyet (2007): Promoting Innovation in Vietnam: Trends and Issues, Central Institute for Economic Management (CIEM), Hanoi-Vietnam, available online at: http://info.worldbank.org/etools/docs/library/239732/InnovationinVietnamPaper.pdf, most recent access date: 29 September 2011, pp. 14f
284 Hong (2007), pp. 22f, 31
285 OECD (2011b).
286 Hung, Nguyen Vo / Ca, Tran Ngoc (2005), pp. 8f
287 OECD (2011b)
288 Ibid.
289 Ibid.

Since the end of the 1990s, a number of important reform policies have been introduced, including:[290]

- The creation of a legal framework (2000: Law on Science and Technology; 2005: Law on Intellectual Property Rights; 2006: Law on Technological Transfer)
- The introduction of new S&T intermediaries (2000: building of 16 national laboratories; 2002: completion of Ho Chi Minh City high-tech park; 2003: establishment of the National S&T Development Support Fund)
- The design of new policy incentives (2004: reform of state management of S&T; 2005: autonomy of R&D public institutions and promotion of firms located in high-tech parks).

The abovementioned policy measures are included in the medium-term S&T policy strategy document that was published by the MOST in 2003.[291] The document, called the Vietnam Science and Technology Strategy by 2010, strives for the country to 'reach the average advanced level in the region by 2010, making S&T really become a foundation and motivation for speeding up the country's industrialization and modernization process'.[292]

Among the S&T development objectives for the year 2010 was the selection of specific high-tech industries that should be established, such as biotechnology and ICT. By 2010, research capabilities in the areas of advanced materials technology, automation technology, biotechnology, ICT and electronic technology should have been improved as well. These fields were selected as the key research fields in the natural sciences. The long-term plan required an increase in total R&D investment to reach 1 per cent of GDP by 2005 and 1.5 per cent by 2010. No quantitative goals were set for the development of human resources, but the plan stressed that 'by 2010 the quality of S&T staff should be improved and developed at the average advanced level of other countries in the region'. The innovation performance remained, however, rather disappointing. While official statistics for recent years are lacking, the OECD estimates that R&D investment increased from 0.19 per cent in 2002 to 0.6 per cent today.[293]

7.4.7.2 Vietnam's international S&T cooperation policy

The Vietnamese government has given international S&T cooperation a prominent place in overall policy making. In the introduction to its long-term S&T development strategy, the MOST stressed the importance of international S&T integration. During our study visit to Vietnam in 2008 we found that government representatives were very much in favour of international collaboration. They see an urgent need to bring Vietnamese scientists into closer contact with the global community, by creating and supporting transnational scientific networks. In addition to the MOST scholarship programme that enables Vietnamese students to train abroad, as well as special programmes by a number of line ministries, the MOST itself has a budget for matching selected projects. To assist scientists in their research, the MOST recently acquired the licences for the Web of Science, the world's leading citation databases. The National Centre for Scientific and Technological Information (NACESTI), part of the MOST, also organizes training courses on how to publish in international journals.

When discussing some of the major reasons for international collaboration, government representatives put most emphasis on transnational learning, country-specific priorities and the acquisition of funding (see figure 97). Other important reasons included thematic priorities and innovation benchmarking, while co-patenting was ranked as being less important as a reason for international collaboration in S&T.

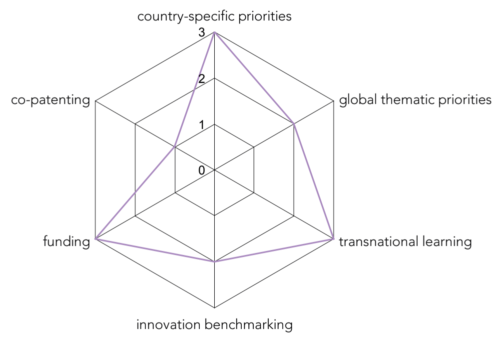

Figure 97: Reasons for international S&T cooperation: the view of governmental institutions in Vietnam
Source: Authors' own assessment based on information from interviews and questionnaires

Seen from the perspective of individual scientists (see figure 98), the most important factors stipulated for international cooperation were: access to collaboration networks and new S&T, the exchange of research personnel and students, the expansion of research capabilities and access to funding. The remaining factors, such as scientific publications, reputation and research infrastructure, were ranked as being less important. Co-patenting was seen as almost completely insignificant as a reason for international S&T cooperation. The last factor was, however, given the highest priority by those GRIs that completed our online questionnaire (the Hanoi School of Public Health, the Forest Science Institute of Vietnam and the Institute of Oceanography). In contrast to those individual scientists that we interviewed, the GRIs heavily emphasized the factors of access to the research infrastructure of partners, an increase in reputation and more scientific publications as important reasons for S&T collaboration.

With the exception of some very well-connected scientists who had prior experience of publishing in international journals, most of those that were interviewed by us published their research findings predominantly in the national language and thus only in domestic journals. Any research collaboration with foreign partners had not resulted in many joint publications. In addition to the language difficulties of publishing in international journals, some of those interviewed found it difficult to choose the appropriate foreign journal in which to publish, for their research field. In addition, financial support from the government for international networking – for example, for participation in international workshops and conferences – was assessed as being very limited.

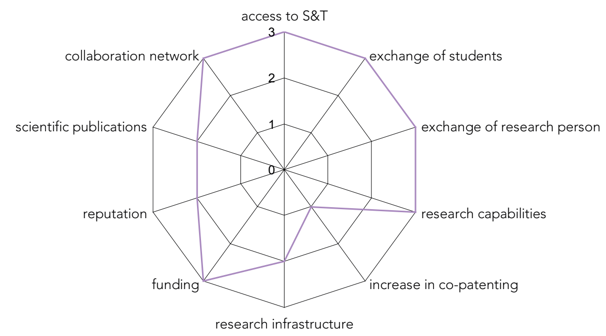

Figure 98: Reasons for international S&T cooperation: the view of scientists in Vietnam
Source: Authors' own assessment based on information from interviews and questionnaires

Fields of international S&T cooperation

The main areas of international S&T cooperation cited by our interviews partners were: 1) ICT, with a focus on software development; 2) biotechnology, with a focus on the application of biotechnology, new crops, seeds, and so on.; 3) health, with a focus on tropical diseases; 4) advanced materials; 5) automation and electronical–mechanical technologies; 6) atomic energy and new energy; 7) space technologies; and, 8) mechanical–machinery technologies. These priorities were also listed in the long-term strategy up to 2010.

Preferences for specific partners in international S&T cooperation

In our discussions with government representatives we learned that a shift in partners and regions in international S&T cooperation has taken place over the last few decades. Before the Vietnam War (which began in 1959) and directly after it (it ended in 1975), collaboration with European countries in the form of technical assistance dominated. Projects were sponsored mainly by Finland, France, Germany, Italy, the Netherlands, Sweden and the UK. In addition, France and the UK sponsored training for public personnel. Cooperation with Russia and with a number of Eastern European countries was quite strong during the Cold War, and even still exists, especially with the Czech Republic and Poland. In terms of funding, the EU, Japan and the US were the most important cooperation partners. Because of the limited S&T budget and the lack of human resources, there was still a strong interest on the side of the government in capacity-building projects, especially the training of Vietnamese scientists. Bilateral and multilateral cooperation projects (with the ADB, Red Cross, UN, UNIDO and the World Bank) were, therefore, often still financed through ODA.

Some sources also pointed to a shift in S&T cooperation partners. While, until the end of the 1980s, Eastern Europe and the former Soviet Union were the most important S&T partners for Vietnam, more collaboration with Asia, Europe and North America has since taken place.[294] Each of the research institutes that the authors visited had already-established S&T cooperation linkages with these countries and regions.

For political reasons, official research collaboration with the US only began in 2001 with the signing of the Vietnam–US Agreement on Science and Technology Cooperation. In May 2006, a 'Vietnam–US Science and Technology Day' was held, and research fields and initial findings were presented. According to the MOST, cooperation in the following fields was included: information technology, standardization and measurement, marine studies, hydrometeorology and environment, public health, agriculture, biology technology, education and research exchange. Through the Vietnam Education Fund, masters- and doctoral-level courses were offered in the US. Compared to bilateral cooperation with other S&T partners, with the US this type of cooperation was assessed as being different by our interview partners from the MOST, because most US actors were from private enterprises. Funding came from a variety of different sources, including universities and philanthropic foundations that have offered support for education and public health.

Cooperation with ASEAN member states started a few years ago. There are some collaborative projects with Thailand, for example, in the field of agriculture and health care. Research collaboration with the EU is regarded as becoming very important now that the process of integration within the EU has been essentially completed, and thus several of Vietnam's former Eastern European cooperation partners are now part

290 Hong, Vu Xuan Nguyet (2007), pp. 28–32
291 The 2006 policy document Directions, objectives and key science and technology tasks for the 5-year period of 2006-2010 (MOST [Vietnam] 2006) is based on this original S&T strategy document from 2003
292 MOST Ministry of Science and Technology Vietnam (2003): Vietnam Science and Technology Development Strategy by 2010, issued enclosed with Decision No. 272/2003/QD-TTg, available online at: http://www.most.gov.vn/Desktop.aspx/Details-Article/ST-strategy/The_translation_is_for_reference/, most recent access date: 29 September 2011
293 OECD (2011b)

294 Bezanson, K./ Annerstedt, J. / Chung, K. / Hopper, D. / Oldham, G. / Sagasti, F. (1999): Vietnam at the Crossroads. The Role of Science and Technology. International Development Centre: Canada of the Union. From the perspective of those government representatives interviewed, S&T collaboration with Vietnamese scientists could be of interest to European partners for many reasons; for example, because it could serve as a possible scientific testing ground in environmental management, bio fuels, and so on. Our Vietnamese interview partners interpreted the very existence of the SEA–EU–NET project as evidence that the EU has a new regional policy perspective and one that includes cooperation with various ASEAN member countries.

From the scientists' perspective, strong research ties – based on either study or research networks – exist with Europe. They feel culturally close to Europe and would prefer to extend cooperation. Experience with FPs, however, was very limited, and applications to become consortia leaders in research projects have not been made so far. However, scientists would be willing to join project applications with European partners and other colleagues from the ASEAN region.

Cooperation with Japan has been expanding recently, and both countries have developed a common institutional framework. In August 2006, the two countries signed a cooperation agreement on S&T and subsequently held the first meeting of the Japan–Vietnam Joint Committee on S&T Cooperation in March 2007. Japan is Vietnam's biggest donor of ODA and the largest investor in the country. Many projects funded by the Japanese involve training and capacity building (Hanoi University of Agriculture). Japan is also supplying the funding for a network of four important universities that have a long-standing Confucian tradition – namely, Beijing, Hanoi, Seoul and Tokyo (information from the Vietnam National University).

Voices from Governmental Institutions and Scientists in Vietnam on International S&T Cooperation

Governmental institutions:

"Regarding the participation in previous FPs, the top-down approach of the government failed. The ministry itself did not have a comprehensive understanding of the programme and was not focused on the collaboration with the EU. Now that Europe has completed its regional integration and is becoming an increasingly important S&T partner for Vietnam, the government will put more energy into supporting scientists' applications to FP7."

Source: Face-to-face interview with representatives from the MOST

Vietnamese Academy of Science and Technology:

"In VAST, international cooperation is always regarded as an important factor to build its capabilities. From 1991 to 2004, VAST established new partnerships with JSPS, JAIST, AIST (Japan), KOSEF (South Korea), CSIRO and RMIT (Australia), CNR (Italy), CEA (France), and some other foreign institutions, which provided funds for VAST's staff training and research. This cooperation has been of great significance to VAST's capacity building. In addition, many scientific institutions in Asia, Europe and North America signed agreements of cooperation with VAST."

Source: Vietnamese Academy of Science and Technology/International Cooperation

In sum, the questions of why Vietnam is engaged in international S&T cooperation, what the most important partners or regions in S&T are, and which fields of cooperation were preferred were answered in 2008 as follows:

- With the transition to an outward-oriented market economy, there has been a shift towards a strategy of open technonationalism.
- S&T cooperation was assessed by Vietnamese interview partners as being of crucial importance and is supported by the government.
- The choice of cooperation partners has diversified from Eastern European countries and Russia to include other European countries and the US.
- Access to funding, research infrastructure and research capabilities all play a major role in scientists' choice of cooperation partners.
- Although there is a positive perception of Europe, cooperation with China and Japan is increasing significantly. Geographical and cultural proximity are among the reasons for this.
- Vietnamese GRIs and individual scientists are eager to cooperate with international partners and are prepared to take on a 'junior partner role' for the time being.

7.5 Conclusion and policy recommendations

Southeast Asia is a region in transition, and one consisting of countries with huge differences in their degrees of economic and scientific development. While some countries already belong to the S&T frontrunners, others are rapidly catching up, but in that are starting from a very low level of innovation. Our study of the S&T policies of the seven ASEAN member states and the ASEAN as a regional grouping demonstrates that governmental actors are very aware of the opportunities that the globalization of R&D and international S&T collaboration offer to them. The common goal underlying the S&T policies of these seven Southeast Asian countries is the desire to achieve innovation-driven economic growth, an ambition that requires for its realization a significant expansion of S&T infrastructure and human resource capabilities. These 'push' factors for international S&T collaboration represent the most important drivers behind governmental actors' choice to support the international networking of scientists through bilateral S&T cooperation agreements, scholarships and mobility funds.

At the level of the ASEAN COST, both the identified priority areas in which S&T cooperation should take place, as well as the flagship programmes, reflect the crucial role that push factors – such as the need to jointly tackle global challenges and to enhance the region's S&T capabilities – play. Within the ASEAN, closer regional cooperation in S&T will be an integral part of ASEAN community-building and will require the transfer of best innovation policies and practices openly between the ASEAN member states, while even more collaboration with external dialogue partners such as the EU will also be crucial. In the case of bi-regional S&T collaboration, the access to research networks that include EU scientists, to education and training as well as to research funding programmes represent 'pull' factors that makes this cooperation attractive for the ASEAN. However, other leading global technology powers (for example, Japan and the US), as well as newly-emerging ones (such as China and South Korea), are actively engaged in fostering new forms of S&T cooperation with the ASEAN member states. Successful mechanisms of cooperation used by these countries should be studied carefully, so as to have a more precise understanding of exactly how and why S&T are evolving within and between them.

Although the ASEAN COST has set up an institutional framework for international S&T cooperation, each country has is own policy focus, preferences for S&T partners and research agendas. Any preferences for S&T collaboration with specific countries or regions seem to have been shifting in most of the ASEAN member states in recent years. Historical ties with EU countries have played a role to a certain extent, but changes in foreign policy relations and increasing global competitive pressure have definitely had an influence on the design of bilateral and international S&T cooperation. Today, most policy-makers in the ASEAN member states strive for collaboration with those partners who hold a leading global position in specific research fields. As their global integration becomes stronger, ASEAN member states' choice of international cooperation partners has diversified. In the ASEAN's competitive S&T arena, countries that want to be at the forefront of S&T innovation have to tackle the very significant issues of brain gain and brain drain.

While most ASEAN member states have no published policies on their international S&T strategies, this issue has gained much importance in recent years as countries have tried to position themselves regionally and globally as competitive players. Through bilateral S&T agreements and MoUs, governments in the ASEAN region have been trying to reduce the burden and costs of establishing international scientific networks for the individual scientist.

Scientists in the ASEAN-5 countries tend to pursue their own academic agenda in order to join international networks, more or less regardless of official policy preferences. Due to the globalization of research and the adoption of international standards in R&D, academic recognition has become an important push factor for entering into international research collaboration. Although scientists from the ASEAN region are pulled abroad by leading-edge research equipment and researchers, international S&T collaboration tends to be significantly connected with alumni networks, personal ties to foreign academic supervisors and to access to funding. Due to the paucity of information on international funding possibilities and the lack of access to scientific networks, scientists in less developed ASEAN member states often rely on established connections with former colleagues and supervisors abroad. Personal contacts, as an important trust-building measure, frequently play a crucial role in establishing and maintaining transnational scientific networks.

There is often an asymmetry between expectations and interests in international S&T cooperation, as ASEAN scientists strive to work in long-term programmes with structural follow-up whereas non-ASEAN scientists tend to see the region as providing opportunities for short-term projects, case studies and the collection of samples and data. Scientists in the ASEAN region find face-to-face monitoring in accompaniment to cooperation projects more helpful than inflexible bureaucratic reporting procedures, which they consider to be a burden and to indicate a lack of trust. EU strategies for closer S&T cooperation with SEA countries should, then, take into account not only different economic and S&T development levels, but also the different cultural approaches to cooperation.

8 The role of EU-ASEAN scientific cooperation in tackling global challenges

Rapela Zaman, Tessa Gardner[295]

8.1 Executive summary

This chapter aims to complement other quantitative and qualitative analysis presented in this booklet. Here we take a case study approach, to explore the challenges, opportunities, and their implications for bi-regional scientific cooperation on global challenges. The conclusions and recommendations are broadly supportive of and consistent with those set out in other chapters in this booklet.

Overall, we argue that owing to it's rapidly developing scientific credentials and it's unique set of population, geographic and environmental features, the ASEAN region is a key region for scientific cooperation on global challenges such as climate change, biodiversity, water and food security and health.

It is encouraging that the EU already leads scientific co-authorship with the region; ahead of the US and nearer- neighbours, China, India, Japan, Australia, South Korea and Taiwan. However, recent analysis suggests EU scientific co-authorship with ASEAN tends not to be in areas of ASEAN research strengths and there is scope to improve the quality of partnerships in global challenges in the face of increasing competition.

Recommendation 1: Successor(s) to the Framework Programme should continue to remain open to participation from ASEAN Member States. This sends an important signal that the EU remains open and committed to building relations with the ASEAN region. A sustained long-term commitment allows for a more comprehensive approach and is a unique selling point for bi-regional collaboration.

Recommendation 2: The European Commission should also consider scope for Specific International Cooperation Actions (or similar actions) for global challenge research that permit greater integration of Southeast Asian research effort. The specific themes and aims for such actions should be co-defined by the two regions, and should build on existing regional frameworks.

Recommendation 3: EU Member States should be encouraged to nurture bilateral research collaboration on global challenges with the ASEAN region. These play an important role in wider bi-regional cooperation.

Recommendation 4: The European Commission and Member States should consider actions (such as bibliometric analysis or other on-line social networking tools) to ensure that current research and collaboration trends are visible to interested parties.

Recommendation 5: The potential wider benefits of scientific research collaboration on global challenges (e.g. tangible impact on local communities) should be recognised and be coupled with an assessment of how funding and collaboration approaches (successors of the FP7) can be modified. New forms of global challenge research cooperation beyond the scope of the Framework Programme, through for example READI (the non-trade related political dialogue) or through other cross-Directorate mechanisms (e.g. innovation platforms), that permit a multidisciplinary 'systems approach' to problem solving are needed.

Recommendation 6: A proportion of bi-regional research effort should aim to deliver tangible impacts for managing global challenges and help towards effecting practical outcomes. This may require more flexibility in the design and approach to specific projects and should take account of policy and local contexts.

Recommendation 7: A diverse range of links to local stakeholders or local networks should be encouraged, and include non-scientists, citizens and civil society groups. These could be engaged through, for example, advisory boards which may also help inform the research effort. Consideration should also be given to the important role of grey literature in informing and disseminating research.

Recommendation 8: Consideration should be given to the allocation of follow-on grants (similar to those deployed by the European Research Council) to encourage researchers to engage in high quality dissemination and knowledge transfer.

Recommendation 9: There should be sufficient time during calls for project proposals to allow participants to identify suitable collaboration partners. There may be a role for Member State's Embassy representatives, EU Delegation representatives and National Contact Points.

Recommendation 10: The EU should support ASEAN-COST in their continued development of multidisciplinary centres of excellence, and research platforms across the ASEAN region.

Recommendation 11: Recognising that strong research relations can take years to mature, where appropriate, the personal interest and commitment of those involved in individuals taking part in projects should be taken into consideration. Sustained commitment and time-spent in country, in both regions should be encouraged and should feature as an integral part of projects where appropriate. This may also require additional opportunities for language training

Recommendation 12: Harnessing diaspora more effectively for bi-regional cooperation would also help capitalise on existing resources.[296, 297]

8.2 Challenges for global collaboration on global challenges

This section sets out four key challenges for bi-regional science collaboration on global challenges and explains the purpose and approach to this chapter.

8.2.1 Generating and co-ordinating global responses

On 7 February 2011, Máire Geoghegan-Quinn, made her first speech in London as the new European Union's (EU) Commissioner for Research, Innovation and Science. In her address to leading scientists at the Royal Society, the UK's national academy of science and one of world's oldest academies, the Commissioner acknowledged that European research efforts must have the scale and scope to tackle major societal challenges.

The major societal challenges of our time are also global challenges. They transcend national and regional boundaries. They require more than ever before that we collaborate effectively with traditional and new partners around the world. Yet there is a big gap between the high-tech research priorities of the best laboratories in the world and the practicalities of responding to global challenges on the ground: to have impact and effect real change, appropriate economic, social and political structures and behavioural changes are also needed. But, science has a major role to play in understanding the nature of global challenges. Science can be used to measure effects, predict impacts, assess risks, contribute to problem solving and suggest alternative pathways for action. In recent decades, science-based innovations have eradicated or attempted to eradicate life-threatening diseases, increased agricultural productivity and pioneered low-carbon technologies.[298] In addition, science can provide the infrastructure (such as information and communication technologies, and trained personnel in the form of scientists and engineers) required to tackle global challenges. The complex nature of some global challenges will require scientific advances to be made, in order to allow successful global responses. They will demand multidisciplinary approaches as well as disciplinary ones. In addition, responses to global challenges will ultimately require human actions and the development of practical solutions. Both are influenced by different contexts and cultures [299]

The challenge for government, scientists, NGOs and others is how best to prioritise, generate and coordinate scientific research, and cooperation in order to deliver real impact where the need exists.

8.2.2 Bi-regional cooperation

The European Union (EU) and the Association of Southeast Asian Nations (ASEAN) are perhaps the two most regionally integrated regions in the world. As other chapters in the booklet have argued, the EU's formal relationship with the ASEAN is therefore a unique bi-regional partnership. It builds on over thirty years of dialogue on political, security and economic issues and complements a plethora of unilateral, bilateral and multilateral initiatives between the two regions.

The EU, through its successive Framework Programmes for Research and Technological Development (FP) has had a major effect on intra-regional European research collaboration. However, the ASEAN equivalent of the EU's Framework Programme, referred to as the 'Krabi initiative' was only recently endorsed in December 2010 and EU -ASEAN bioregional science cooperation remains a relative new-comer on the wider EU-ASEAN political agenda. Formal EU-ASEAN science cooperation is currently enabled through the Framework Programme and the Regional EU-ASEAN Dialogue Instrument (READI), which covers non-trade related partnerships.

295 Both authors are at the Royal Society in London. Corresponding author's email address: rapela.zaman@royalsociety.org

296 See Meyer, J.P. / Brown, M. (1999): Scientific Diasporas: A New Approach to the Brain Drain, and Gaillard, A.M. / Gaillard, J. – Science and technology policies in the context of international scientific migration, for broader discussion

297 See for example: Diaspora Knowledge Networks (DKN) programme http://www.unesco.org/shs/migration/diaspora, Transfer of Knowledge Through Expatriate Nationals (TOKTEN) programme http://www.unv.org/en/how-to-volunteer/unv-volunteers/expatriate-professionals.html and the Brain Gain Network http://www.bgn.org/bgn/

298 Royal Society (2011): Knowledge, networks and nations: Global scientific collaboration in the 21st century

299 See Jasanoff, S. (2010): A new climate for society, for a broader discussion

8 GLOBAL CHALLENGES

As the two regions continue to build their regional scientific strengths and capabilities, the challenge for government, scientists, NGOs and others is to identify and access best opportunities and design instruments , to deliver real impact where the need exists.

8.2.3 The role of science and innovation

Science[300], and the technology and innovation enabled by science, are key to delivering long-term economic and social development.[301] Scientific advice is also a vital asset in governance, through the opportunity to strengthen the basis for robust policy decisions.[302, 303]

Since the beginning of the 21st Century, global spend on research has nearly doubled, publications have grown by a third, and the number of researchers continues to increase.[304] Over a third of research papers are the direct result of international collaboration.[305] In citation terms (a proxy for quality), research collaboration is beneficial. For each international author on an article, there is a corresponding increase in the impact of that paper, up to a tipping point of around 10 authors.[306] In other words, science is collaborative and a growing enterprise.

At the same time, we know that the geography of science is changing. Although the traditional scientific superpowers (the USA, Europe and Japan) still lead the field, new players are emerging. Countries like Singapore are making valuable contributions to the global pool of science.

Table 20 below shows the growth in ASEAN research output, which far outpaces EU albeit from a low base. The average increase across ASEAN stood at over 100% between 2000 and 2007, compared to the EU's ~25% growth (between 2002 and 2008) and the world average ~35% growth (between 2002 and 2008).[307]

This increasing diversity in scientific research is both a welcome and essential development in tackling complex challenges like climate change and energy security, where there is no technological solution.[308] Indeed, multiple lines of inquiry within and across scientific disciplines and regions are vital to understanding how global issues like climate change and energy security might unfold in particular local contexts.

The challenge for government, scientists, NGOs and others will be to access and accept all types of relevant scientific input. In this way it will be possible to respond appropriately to global challenges as they manifest in different ways around the world.[309]

8.2.4 ASEAN's global challenge scientific cooperation credentials

The ten members of the Association for Southeast Asian Nations (ASEAN) region; Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei, Vietnam, Laos, Myanmar, and Cambodia, represent a critical region for global challenge research.

First, the region is highly populated. The ASEAN region is home to 590 million people, accounting for about 9% of the world's total population. Indonesia itself is home to a population of 230 million people, and ranks number 4 in the world behind China, India and the US.

Second, its unique geography and combination of rich natural resources sustain essential life support systems for the region and the world. The region holds only 3% of the world's total landmass but 20% of the world's biodiversity, rich marine life including the most species-diverse coral reefs in the world, and abundant mineral resources. These vital natural resources play a major role in sustaining a wide range of economic activities and livelihoods (including through oil exploration, commercial and small-scale fisheries, and tourism). This combination of population and geography and demography also leave the region particularly vulnerable to the effects of some global challenges. For example, as a result of its climate and huge population the ASEAN region carries over a quarter of the world's burden for infectious and parasitic disease.

Third, science and technology policy play a central role in the national development strategies for many countries in the region[310, 311, 312] and scientific output from the ASEAN region is growing impressively.[313] These developments and ASEAN's recent 'Krabi Initiative', aim to increase and intensify intra-regional scientific cooperation[314] and are in line with wider initiatives for ASEAN integration by 2015.[315]

300 Here, we define 'science' as 'natural knowledge'. In practice, this includes the natural sciences, mathematics and engineering
301 Conway, G. / Delaney, S. / Waage, J. (2010): Science and innovation for development
302 Royal Society (2010): Science: an undervalued asset in governance for development
303 OECD (2011a): Opportunities, Challenges and Good Practices in International Research Cooperation between Developed and Developing Countries, online at: http://www.oecd.org/dataoecd/40/16/47737209.pdf
304 Royal Society (2011): Knowledge, Networks and Nations, table 1.1; original data from UNESCO Science Report 2010, p. 2, table 1; p. 8, table 2; p. 10, table 3
305 Leydesdorff, L. / Wagner, C. (2005): Mapping global science using international co-authorships: a comparison of 1990 and 2000
306 Royal Society (2011): Knowledge, Networks and Nations, p. 59
307 UNESCO (2010): UNESCO Science Report 2010
308 Professor Melissa Leach, Blogpost 29 March 2011 http://blogs.royalsociety.org/in-verba/

309 For a full discussion, see STEPS Centre (2010): Innovation, Sustainability, Development: A New Manifesto
310 UNESCO Science Report 2010
311 Schüller, M. / Gruber, F. / Trienes, R. / Shim, D. (2008): International Science and Technology Cooperation Policies of Southeast Asian Countries
312 See also in particular the national S&T policies of the ASEAN 6; Singapore, Malaysia, Thailand, Vietnam, Indonesia and the Philippines
313 SEA-EU-NET Position Paper on the future RTDI Programme of the European Union, 20 May 2011, see www.sea-eu.net
314 For details of the Krabi initiative see Chairman's Statement of the 6th Informal ASEAN Ministerial Meeting on Science and Technology (IAMMST) Krabi, Thailand, 17 December 2010 available at http://www.aseansec.org/25723.htm
315 http://www.aseansec.org/Fact%20Sheet/AEC/AEC-11.pdf

Based on scientific co-authorship, EU cooperation with the region is already doing well, ranking ahead of the USA and nearer- neighbours, China, India, Japan, Australia, South Korea and Taiwan. However, recent analysis, as measured by publication output[316] shows that EU scientific co-authorship tends not to be in areas of ASEAN research strengths such as nanotechnology, ICT and Industrial Technology. Although Singapore is dominant in these areas, Malaysia and Thailand are active in other areas and research strengths are more diverse. For example with respect to Food, Agriculture, Biotechnology, and Environment, there is widespread research performance across Thailand, Singapore, Malaysia, Philippines, Indonesia and Vietnam.

The challenge for government, scientists, NGOs and others will be to ensure that EU and ASEAN scientists are poised to benefit from research cooperation that is both excellent and relevant to global challenges.

Table 20: Trends in ASEAN science publications (2000–2007)[317]

	Publications*		
	2000	**2007**	**% growth**
Singapore	3,093	5,733	85%
Thailand	1,060	3,123	195%
Malaysia	712	1,832	157%
Indonesia	373	533	43%
Philippines	323	445	38%
Vietnam	281	619	120%
Cambodia	13	75	477%
Myanmar	16	32	100%
Brunei	31	33	6%
Laos	10	39	290%
ASEAN Total**	5,799	12,081	108%

*Articles, reviews, proceedings and notes
**Numbers do not add up to total due to co-publications

8.2.5 The purpose of this chapter and a word on our approach

In this chapter we aim to complement the other chapters in this booklet and the extensive country analyses, quantitative and thematic work already produced by the SEA-EU-net project and others.[318] We take a case study approach, which includes a selection of European Commission FP-funded projects and non-European Commission-funded projects that are related to global challenge themes. Our approach is by no means comprehensive, or representative of the range of initiatives between the two regions. This is not a comparative exercise; the projects are not comparable in terms of scale and scope. We accept that there are gaps and our analysis does not prioritise between and within themes. Rather, by reviewing a range of examples across just five themes we hope to complement the findings of other chapters and identify some broader lessons for the design of future global challenge collaboration programmes between the two regions. The five themes chosen (also discussed in other chapters of this booklet) are climate change, ecosystems and biodiversity, water, food and health. We also include some 'cross-cutting' projects, on education research and information and communication technologies, to complement our thematic understanding. We have selected ten case studies in total and have undertaken thirty interviews with project participants, country experts and other organisations or individuals who have experience of bi-regional collaborations between the EU and ASEAN. A summary of the case studies is presented in table 21 below. The findings of the authors – as well as any mistakes – are entirely the responsibility of the authors.

Table 21: Case study summary

Case study	Name	Global challenge theme	Project type (FP/non FP)
1	Intergovernmental Panel on Climate Change (IPPC)	Climate Change	Non-FP
2	South East Asia Rainforest Research Programme (SEARRP)	Ecosystems and biodiversity	Non-FP
3	Developing ubiquitous restoration practices for Indo-Pacific reefs (REEFRES)	Ecosystems and biodiversity	FP
4	Coral Triangle Initiative (CTI)	Ecosystems and biodiversity	Non-FP
5	EU INCO Integrated Water Resources Management (EU INCO IWRM)	Water	FP
6	International Rice Research Institute (IRRI)	Food	Non-FP
7	Research to support the management of the avian influenza crisis in poultry (FLUAID)	Health	FP
8	Wellcome Trust SEA Major Overseas Programme	Health	Non-FP
9	Supporting International Networking and Cooperation in Educational Research (SINCERE)	Cross-cutting issues	FP
10	EU-South East Asia Cooperation in ICTs (SEACOOP)	Cross-cutting issues	FP

316 Haddaway, P. et al. (2011), Bibliometric Analysis of Science and Technology Strengths in Southeast Asia, available at http://www.sea-eu.net/ and as chapter 1 in this book.
317 Niu, Jacky / Woolley, Richard / Turpin, Tim (2011), table prepared for the Royal Society from Essential Science Indicators, 2011, Centre for Industry and Innovation Studies, University of Western Sydney
318 Available at http://www.sea-eu.net/

8.3 Global challenge research collaboration opportunities

Having set out the challenges for global collaboration on global challenges, in this section we present opportunities for collaboration across themes and introduce the case studies.

8.3.1 Climate change

According to the Intergovernmental Panel on Climate Change (IPCC), the earth is likely to warm by 0.2 °C per decade for the next two decades, and to rise by between 0.6 °C and 4 °C by the end of the century.[319] The implications are complex and include impact on the environment, such as changes in temperature[320] precipitation patterns[321], rising sea levels[322], ocean acidification[323], and extreme weather effects such as droughts[324], heat waves[325], intense rains and floods[326], typhoons, and cyclones.[327]

Climate change will have major implications for the ASEAN population. The region is already experiencing an average temperature increase of 0.1–0.3 °C per decade. This has been coupled with a decrease in rainfall frequency (yet an increase in rainfall intensity) and a sea level rise of 1–3 mm per year.[328] These trends pose a threat to coastal and delta areas, due to increased risk of flooding and reduced freshwater availability through salinisation of groundwater and estuaries. Saline intrusion affects over 10 thousand square kilometres of the Mekong Delta[329] and coastal erosion is occurring at a rate of up to 25 metres per year in some areas.[330]

ASEAN is particularly vulnerable to the impacts of climate change due to the concentration of people and economic activities in coastal areas, its rich biological diversity, resource-based economies, and the increased risk especially presented to the poor.[331] It is therefore a key partner for climate change research where mitigation and adaptation may be informed by high quality research collaboration and local know-how.

The ASEAN community is ready for regional action on climate change. This is described in the 'D10' environmental cooperation priorities set out in the ASEAN Socio-cultural Community Blueprint 2009–2015. See table 22 below. These priorities will be taken forward by the ASEAN Climate Change Initiative (ACCI), which is co-ordinated by the ASEAN Working Group on Climate Change chaired by Thailand and reporting to the ASEAN Senior Officials Meeting on the Environment (ASOEN). In addition, a framework for cross-sector efforts on climate change is also in place.

Table 22: ASEAN strategies and actions on climate change

D1	Addressing global environmental issues
D2	Managing and preventing trans-boundary environmental pollution
D3	Promoting sustainable development through environmental education and public participation
D4	Promoting environmentally sound technology
D5	Promoting quality living standards in ASEAN cities/urban areas
D6	Harmonising environmental policies and databases
D7	Promoting the sustainable use of coastal and marine environment
D8	Promoting sustainable management of natural resources and biodiversity
D9	Promoting the sustainability of freshwater resources
D10	Responding to climate change and addressing its impacts

Mainstream solutions to the challenge of climate change have concentrated on reducing carbon emissions and greenhouse gases from transport and energy sectors. These practical approaches can divert attention away from other solutions such as tropical rainforests, tropical wetlands, and coastal habitats that serve as effective carbon stores and sinks. When healthy, these ecosystems maintain essential water services, reduce vulnerability to climate shocks and natural disasters, and increase local and national resilience to climate change. Conversely, deforested and drained ecosystems are a significant source of carbon emissions; an obstacle to stabilising greenhouse gas emissions. A focus on conservation may therefore serve as an effective approach to abating climate change in Southeast Asia, where rich tropical forest cover plays a major role in carbon dioxide uptake from the atmosphere.[332]

Case Study 1: Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the scientific assessment of climate change and its potential environmental and socio-economic impacts.

As a model for collaborative working, it represents a significant social innovation. Since its inception in 1988, the IPCC has involved 194 nations, engaged over 3,000 scientists through largely voluntary participation and cited over 40,000 peer reviewed publications. It has harnessed global research to deliver a landmark series of global assessments, and sustained the interest and support of the world's governments across a range of issues, contributing also to wider public discourse. Significantly, the IPCC has also committed to building research capacity in developing countries by funding scholarships from its 2007 Nobel Prize funds

The IPCC's decentralised structure and diverse geographic representation has been a huge strength, but can impede the agility of the organisation and the challenges of reaching consensus (if this is possible at all) placing constraints on decision-making. The inclusion of government agencies has also left the IPCC vulnerable to criticisms of politicisation, and increasing demands for transparency in many of IPCC's processes and procedures. The IPCC has found itself under increasing scrutiny after its Fourth Assessment report was found to contain a small number of widely reported mistakes, demonstrating the difficulties involved in synthesising and governing a wide range of research data. These difficulties – and recommendations to help address them – were set out in the InterAcademy Council's Review of the processes and procedures of the IPCC in 2010.[333]

Lessons learned from this novel model of international collaboration are set out below. First, despite the constraints, the inclusion and development of a geographically representative research base has helped to develop a collective sense of ownership and debate. This has strengthened global research capacity and visibility, important for policy development and implementation in a range of political and cultural contexts. Second, the IPPC draws on the 'voluntary' research contributions of the scientific community and 'free-rides' off significant national-level investments in climate change research in order to fulfil its objectives, to provide evidence-based assessments on climate change and its potential social and economic impacts. Third, the IPPC encourages a multidisciplinary approach and recognises the role of a range of actors in effecting climate policies, which may go beyond traditional boundaries. Fourth, the use of 'grey' literature, alongside peer-reviewed journal articles has been an important means to include a more diverse range of expertise. This is particularly true for regions where domestic scientific research capacity is still limited.

8.3.2 Ecosystems and biodiversity

With only 3 % of the world's total landmass, ASEAN's rich ecosystems account for 20 % of the world's biodiversity. Indonesia alone contains 10 % of the world's remaining tropical rainforest. But ASEAN's forest environment is under major threat from the highest relative rate of deforestation of any major tropical region – an activity that contributes to around 25 % of anthropogenically released greenhouse gases.[334] Agricultural practices, growing population and expansion of human settlements, species invasion, land-use change, pollution, and climate change all contribute to forest cover decline at a rate of about 1.1 % each year. This equates to losing up to 75 % of Southeast Asia's original forests and up to 42 % of its biodiversity by 2100.[335]

Regarding marine environment, Southeast Asia has a range of sea and coastal ecosystems including sand dunes, estuaries, mangroves, coastal mudflats, algal beds, and coral reefs. With over 170 thousand kilometres of coastline, it holds one third of the world's seagrass areas, which support economically important fisheries and over one third of the world's coral reefs.[336] The region's rich marine ecosystems bring significant economic advantage to the local population through aquaculture, trade, and tourism.[337]

The high degree of biodiversity generates high productivity from coastal and marine activities, providing a living for around 20 million people and an estimated

319 Intergovernmental Panel on Climate Change (2007)
320 Manton et al. (2001): Trends in extreme daily rainfall in Southeast Asia and the Pacific Region 1961–1998, in: International Journal of Climatology, 21(3), pp. 269–284; Ho, J. (2008): Singapore Country Report—A Regional Review on the Economics of Climate Change in Southeast Asia. Report submitted Asian Development Bank, Manila
321 Manton et al. (2001); Aldrian, E. (2007): Decreasing Trends in Annual Rainfall over Indonesia: A Threat for the National Water Resource? Jakarta: Badan Meteorology Dan Geofisika (Geophysics and Meteorology Agency); Cuong, N. (2008): Vietnam Country Report. Report submitted for RETA 6427: A Regional Review of the Economics of Climate Change in Southeast Asia, Manila: Asian Development Bank
322 State Ministry of Environment (2007): National Action Plan for Addressing Climate Change. Republic of Indonesia, Jakarta; Cuong, N. (2008). Vietnam Country Report; Jesdapipat, S. 2008. Thailand Country Report. Report submitted for RETA 6427: A Regional Review of the Economics of Climate Change in Southeast Asia.Manila: Asian Development Bank
323 IAP (2009): Statement on Ocean Acidification, online: http://www.interacademies.net/10878/13951.aspx
324 Duong, L.C. (2000): Lessons from Severe Tropical Storm Linda. Paper presented at the Workshop on The Impact of El Niño and La Niña on Southeast Asia, Hanoi; Kelly, P. M. / Adger, W.N. (2000): Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation, in: Climatic Change 47:325–52; Glantz, M. H. (ed., 2001): Once Burned, Twice Shy? Lessons Learned from the 1997–98 El Niño. Tokyo: United Nations University; PAGASA (2001): Documentation and Analysis of Impacts of and Responses to Extreme Climate Events. Climatology and Agrometeorology Branch Technical Paper No. 2001-2, Philippine Atmospheric, Geophysical and Astronomical Services Administration, Quezon City, cited in ADB (2009d)
325 Manton et al. (2001)
326 Cruz, R.V.O. et al. (2007): Asia, in: Parry, M.L. / Canziani, O.F. / Palutikof, J.P. / van der Linden, P.J. / Hanson, C.E (Eds.): Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge: Cambridge University Press, pp. 469–506; Boer, R. / Perdinan (2008): Adaptation to Climate Variability and Climate Change: Its Socio-economic Aspect. Proceedings of the Workshop on Climate Change, Bali: Economy and Environmental Program for Southeast Asia
327 PAGASA (2005): Climatology and Agrometeorology Branch Publication on Tropical cyclones. Quezon City: Philippine Atmospheric, Geophysical and Astronomical Services Administration; Camargo, S.J. / Sobel. A.H. (2004): Western North Pacific Tropical Cyclone Intensity and ENSO. Technical Report No. 04-03, International Research Institute for Climate Prediction, New York: Palisades; Emanuel, K. (2005): Increasing Destructiveness of Tropical Cyclones over the Past 30 Years, in: Nature International Weekly Journal of Science 436, pp. 686–88, cited in ADB (2009)
328 ADB (2009)
329 Johnston, R.M. et al. (2010): Rethinking Agriculture in the Greater Mekong Subregion
330 ADB (2009)
331 Letchumanan, Raman (n.d.): Is there an ASEAN Policy on Climate Change?, in: SR004 – Climate Change: Is Southeast Asia Up to the Challenge?, London: LSE, online: http://www2.lse.ac.uk/IDEAS/publications/reports/SR004.aspx
332 Beer, Christian et al. (2010): Terrestrial Gross Carbon Dioxide Uptake: Global Distribution and Covariation with Climate, in: Science, 329(5993), pp. 834–838, cited in: IGBP Diary, Issue 76, January 2011
333 InterAcademy Council (2010): Review of the IPCC: An evaluation of the procedures and processes on the Intergovernmental Panel on Climate Change, available at http://reviewipcc.interacademycouncil.net/
334 FAO (2005): Global Forest Resources Assessment 2005: Progress towards sustainable forest management. FAO Forestry Paper 147. Rome: United Nations Food and Agricultural Organization
335 Sodhi, N.S. / Koh, L.P. / Brook, B.W. / Ng, P.K.L. (2004): Southeast Asian biodiversity: an impending disaster, in: Trends in Ecology and Evolution, 19, pp. 654–660
336 ASEAN report to the World Summit on Sustainable Development, 2002
337 Burke, L. / Selig, L. / Spalding, M. (2002): Reefs at Risk in Southeast Asia, Washington DC: World Resource Institute

annual income of $2.3 billion.[338] Coral reefs provide coastal protection from extreme weather, reducing the need for costly coastal defences. The reefs are also of great value to the scientific community; providing an underwater laboratory to investigate global climate, changes in sea level and acidity. However, rapid urbanisation in coastal areas, agricultural and aquacultural practices, and the characteristic steep slopes of the local terrain[339] all pose a major threat to the resilience of coastal systems.

Globally, 20–30% of all coral reefs are thought to be severely degraded.[340] While this is nothing new (coral reefs have disappeared at previous points in history and some have suggested they will disappear again by the end of the century[341]), human activities are now also a major factor.[342] Within the ASEAN region, 88% of coral reefs are thought to be at risk.

Significant changes to biodiversity and ecosystem functioning threatens the quality of life for many people in the ASEAN region who rely on the forests for their livelihood, food, water, and shelter and will have a significant impact on the global heritage of the rich forest and marine environment.

Case Study 2: Southeast Asia Rainforest Programme

Malaysia's Danum Valley conservation area is one of the largest, best-protected expanses of pristine lowland forest remaining in Southeast Asia. It covers nearly 450 square kilometres and is embedded within an exceptionally large timber/plantation concession that covers over 10,000 square kilometres. The field station was set up 25 years ago with support from the Royal Society, the UK's national academy of science and is the research base of the Society's Southeast Asia Rainforest Programme (SEARRP).

Originally established to document the diversity of the forest and underlying mechanisms that maintain it, today the multidisciplinary research activities focus on understanding how changing climate and agricultural practices affect the forest ecosystem, and how the forest can contribute to a sustainable future. In recognition that oil palm plantation and forest must co-exist, current research includes measurements of gas emissions into the atmosphere to determine how this is altered by changing land use, large-scale rainforest regeneration experiments, and studies on the effects of forest fragmentation on species diversity. The work done at Danum is recognised as world class, making it one of the leading rainforest research centres in the tropical world. As a result, it can provide the evidence-based advice needed by policy makers to manage tropical forests, not just in Malaysia, but throughout the entire tropics. An important legacy of Danum Valley is the people that it trains. These come from all over the world but significantly many of those from Malaysia now occupy positions of influence locally. SEARRP research has attracted generous funding from Sime Darby, a large Malaysian multinational conglomerate, as well as other international organisations, and its future is secure for many years to come.

Case Study 3: REEFRES – Developing ubiquitous restoration practices for Indo-Pacific reefs

Coral reefs provide the largest source of subsistence to people in the Indo-Pacific region. The aim of the REEFRES project,[343] was to develop novel methods for active coral reef restoration, to improve the efficiency of those methods (in terms of physical coral restoration and cost), to strengthen local capacity, and to share expertise and facilities amongst the leading research groups around the world.

The project ran for four years (2005–2008), and was funded by the EU's FP6 and involved a consortium of seven research groups,[344] which were teamed as EU-Asian pairs, each pair working in one of four selected sites based at Eilat, Phuket Island, Singapore, and the Philippines, to develop viable coral colonies. The work demonstrated the feasibility of active coral reef restoration and resulted in 20 scientific papers and a practical reef rehabilitation manual written in simple English that could be used worldwide.

Since the project's completion, participants have offered the following insights: First, most of the practical work involved was 'low-tech' and did not involve or require highly trained or educated people. This meant the project was able to involve local people, such as fisherman on a voluntary basis. The strength of local engagement has helped to ensure the continued use of the research, for example, Thai officials are reported to have used the findings to inform official reef management and partners from the Philippines are now working on different village education programmes to train local people in reef restoration techniques that revive the reef, fish populations and local livelihoods. Singapore is also investigating ways to transplant corals.

Second, the project required some high levels of in-country training and experience. This included six-month post-graduate research placements for one or two EU partners, plus about 15 local postgraduate students, local technicians, facilities and neighbouring-country students too. Third, for a project of this type, the scale and scope this was smaller than other comparative international interventions such as those funded via the World Bank and USAID. At the same time, the project was able to 'free-ride' or makes use of existing investments by other donors.

Case Study 4: The Coral Triangle Initiative

The Coral Triangle Initiative (CTI) was launched as a six-country program of regional cooperation in 2007 to protect the outstanding coastal and marine resources of the Coral Triangle – a geographical area encompassing 5.7 million square kilometres of the coral-rich waters of Malaysia, Indonesia, Papua New Guinea, Timor-Leste, the Solomon Islands, and the Philippines. It is commonly regarded by Southeast Asian partners as an exemplar for regional collaboration.

The CTI was initially proposed by President Susilo Bambang Yudhoyono of Indonesia in August 2007. It was officially launched later that year during the 13th Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) in Bali, following political endorsement from 21 heads of states. An action plan was signed in 2009. The CTI is led by six cooperating governments, with the Asia Development Bank acting as a financing facilitator and co-ordinator. The initiative also includes a wide range of partners and stakeholders as funders, implementers, and beneficiaries. These include the Global Environment Facility, the US Government, the Australian Government and several NGOs including Conservation International, The Nature Conservancy, and the WWF. Mobilisation of resources from this wide range of stakeholders has been of major benefit and has allowed the transfer of expert knowledge on marine conservation and has also generated over US$350 million of funding.

As a model for regional cooperation, the CTI has been praised as "an incredible step forward for conservation" by Rebecca Patton, Chief Conservation Strategies Officer with The Nature Conservancy. According to Professor Terry Hughes, Director of Centre of Excellence for Coral Reef Studies (CoECRS), it is "one of the most important marine conservation measures ever undertaken in the world" and "as much about nation building and food security as it is about reef conservation".

Participants have offered the following lessons. First, governance structures can be complex, but they work for the region. These include summits for Ministers, meetings for senior officials, country co-ordinators, national-level co-ordination groups and participation from a range of national-level ministries (e.g. Ministries for Science, Agriculture, Fisheries, Environment and Natural Resources). Second, countries have their own responsibilities. They each have their own country-level action plans and each country produces 'State of the Coral Triangle' annual reports. Third, the initiative deploys a range of holistic multidisciplinary approaches from marine protection to developing alternative livelihoods. Fourth, awareness of social and cultural contexts, including language, education levels, pace of actions, and an emphasis on knowledge transfer and empowering local communities is crucial to the day to day operation of the programme. Fifth, leveraging wider regional resources and match-funding has helped to generate scale. For example, the Asian Development Bank has recently approved roughly US$12 million of additional support to help Malaysia, Indonesia and the Philippines improve management of the Coral Triangle. The three countries will provide an additional US$3 million in non-cash contributions. The additional investment will be used to build capacity within oversight institutions and provide people living in coastal communities with job alternatives.[345]

8.3.3 Water

Water security presents a major global challenge for the future, owing to the effects of climate change and rapid shifts in land use, and also to a growing unsustainable demand for water. Global water demand has tripled in the past 50 years.[346] Just 2.5% of the world's water is freshwater, of which only 0.4% is available and accessible for use.

Currently, around 2.5 billion people have inadequate access to water for sanitation and waste disposal and nearly 900 million have inadequate access to safe drinking water.[347] Predictions vary but some estimate that by 2025, 1.8 billion people will be living in regions with absolute water scarcity and that two-thirds of the world's population could be under water stress conditions.[348] By 2050, an estimated 4 billion people could be living in countries that are chronically short of water,[349] posing profound challenges to security, human health, economic productivity, national security and the environment.

Within ASEAN, overall water demand is expected to increase by one-third by 2015.[350] Although most Southeast Asian nations do not experience physical water scarcity, seasonal water scarcity can be an issue. High rates of development put pressure on the sustainable

338 ADB (2008): Special Report on Food Prices and Inflation in Developing Asia: Is Poverty Coming to an End? Manila: Asian Development Bank Economics and Research Department
339 UNEP (2001): State of the Environment and Policy Retrospective: 1972–2002, in: UNEP (ed.): Global Environment Outlook 3, pp. 240–269, online: http://www.unep.org/geo/geo3/english/
340 Marine Pollution Bulletin (2008), No. 56, pp. 18–24
341 IAP (2009)
342 Wilkinson, C. (2008): Status of Coral Reefs of the World: 2008. Townsville: Global Coral Reef Monitoring Network and Reef and Rainforest Centre

343 See Gruber, F. / Degelsegger, A. (Eds.) (2009): Spotlight on: Excellent Researchers from Southeast Asia. Results of a SEA-EU-NET mapping study for details
344 The seven groups in the consortium including one small to medium sized enterprise were from Israel, Italy, Philippines, Singapore, Thailand and the UK.

345 Rosenkranz, Rolf (2011): ADB Approves More Funding for the Coral Triangle Initiative (20 May 2011), online: http://www.devex.com/en/articles/adb-approves-more-funding-for-coral-trinagle-initiative
346 Singh, Ashbindu presenting for UNEP: A Tale of Two Trends: providing information and knowledge for decision-making in water-scare regions through water assessments, online: http://www.unwater.org/downloads/www.Singh.pdf
347 WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (2008): Progress in Drinking-water and Sanitation: special focus on sanitation, MDG Assessment Report 2008, p. 25
348 http://www.un.org/waterforlifedecade/scarcity.shtml
349 Clarke, Robin / King, Jannet (2004): The Water Atlas: A unique visual analysis of the world's most critical resource
350 ASEAN (2005): ASEAN Strategic Plan of Action on Water Resources Management. Online: http://environment.asean.org/files/ASEAN%20Strategic%20Plan%20of%20Action%20on%20Water%20Resources%20Management.pdf, most recent access date: 27 May 2011

water supply and sanitation, and increase competition for water resources. Several of the ASEAN member states are unlikely to meet the Millennium Development Goals relating to drinking water and sanitation.

The key water challenges for the ASEAN region have already been set out in the ASEAN Strategic Plan of Action of Water Resources and Management.[351] They include collecting and maintaining high quality data, mitigating the effects of extreme events on water resources (especially to subsistence farmers and the poor), sustaining and improving water quality, improving governance systems, for example of interconnected surface and groundwater resources, and acquiring financing for the development of new water infrastructure.[352]

Massive investments in water technology have enabled some richer nations (such as Singapore) to offset high stressor levels. However without remedying underlying causes, less wealthy nations remain vulnerable.[353]

Case Study 5: EU-INCO Integrated Water Resources Management (IWRM)

EU-INCO IWRM supported about 67 international scientific cooperation projects related to integrated water resources through FPs 4–6 (1999–2006). The projects mobilised 530 research teams across Europe and partner countries in Africa, Asia, Eastern Europe and Central Asia, Mediterranean and Latin America. Participating ASEAN member states included Thailand, Vietnam, Indonesia, the Philippines and Cambodia. The scale of the research effort makes this a valuable case of European Commission-funded international thematic research.

Lessons reported by those involved in the IWRM independent review[354] include that the 'EU-INCO water research-funding model works'. It could be used by other departments within the Commission's Research Directorate, and provided a 'friendly' potential interface to work with other Divisions e.g. Environment, RELEX, Development, EuropeAid and Trade. Indeed the scale and international scope of IWRM has increased its visibility to relevant partners.

In addition, the review also noted the need for a broad recognition of the socio-political context (water-food-trade nexus). As figure 99 below, taken from the review describes, 'research approaches taking as the starting point the socially constructed preferences of water management for human consumption and food security, stand better chances'. This implies wider policy input into the framing of research work programmes would be beneficial.

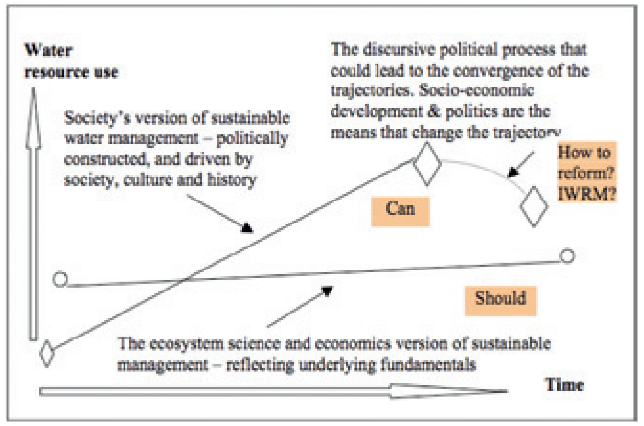

Figure 99: Conceptualising the trajectory of water management determined by society – the upper trajectory; and the trajectory identified by ecosystem scientists and economists – the lower trajectory. Convergence is achieved by getting the science into the political processes that determine water use and policy.

To this end, the independent review also advocates constructive engagement with those at the user end of the process e.g. those involved in water resources allocation and management. In addition, the review notes that successful international cooperation requires centres of research excellence in partner countries and trained scientists and professionals in the sector. There may be benefits in supporting the continued development of regional platforms (centres of excellence and training) alongside scientific cooperation.

8.3.4 Food

Agriculture accounts for 70 % of global freshwater use. Securing future food security under water-scarce conditions and increasing economic and population pressures will be a major global challenge. The World Bank has estimated that demand for food will increase by 50 % by 2030 owing to the growing global population, rising affluence and changes in dietary preferences.[355] It has been estimated that an additional 40 million tonnes of aquatic food a year will be needed by 2030 to meet changing dietary demands, despite catches of wild fish remaining roughly stable at around 90 million tonnes per year for the past quarter of a century.[356]

Regional food preferences, export traditions, and geographical conditions combine to make food security a particularly pressing issue in the ASEAN countries. About 35 % of the region's GDP comes directly from agriculture, but beyond economic productivity, farming is part of daily life in the region and remains a strong part of cultural identity.

Rice is a principle crop and major export of many ASEAN countries, including Thailand, which is the world's number 1 exporter of rice and contributes around 10 million tons of the annual 30 million tons of international rice trade. Rice is also a staple food of the ASEAN diet. Worryingly for the ASEAN population, rice is an extremely thirsty crop – 1 kg of rice grown in paddies requires 1,900 litres of water whereas the production of 1 kg of potatoes requires just 500 litres of water. Rice is also the most sensitive of the major cereals to salinity[357] and extreme temperatures and humidity.[358] In addition primary rock phosphate reserves in the region that are a crucial determinant of crop yields are predicted to be exhausted by the end of the 21st century if current trends continue.[359]

The Pacific positioning and level topology of the ASEAN region renders crops vulnerable to variations in typhoons and El Nino Southern Oscillation (ENSO)[360] dynamics, increased flooding, increased salinity, and long droughts which increase the risk of forest fires. Waterlogging and flooding is also exacerbated by the poor soil quality in the region, which has been categorised by UNEP as Degraded or Very Degraded.[361] Global food production and agriculture is also a major contributor to global warming – accounting for up to 32 % of man-made greenhouse gas emissions, with a particularly large share of nitrous oxide (owing to fertilizer use) and methane (particularly from livestock).[362] Rising affluence amongst the middle classes in the ASEAN region is associated with changes in food consumption patterns, notably towards diets that are richer in meat, dairy, and seafood.[363] To add to these problems postharvest food losses are high at an estimated 10–40 %.[364]

Case Study 6: International Rice Research Institute

The International Rice Research Institute (IRRI) in the Philippines is part of the Consultative Group on International Agricultural Research (CGAIR). Recognising the importance of rice crops to the region, IRRI is focused on improving and diversifying rice-based systems in order to benefit rice consumers and rice farmers. Research carried out in Southeast Asia produces benefits that are not limited to those living in the region – for example, by combining high yield Asian rice strains with pest resistant African rice strains, IRRI has been able to produce new rice varieties for Africa that will reduce national rice import bills and generate higher incomes in rural communities.

The success of the Institute lies in combining cutting edge global research with practical, local intelligence. Benefits flow in both directions: to the local community (through livelihood stability) and back to the global research community by harnessing local scientific knowledge on traditional rice varieties, soil conditions, weather patterns, agricultural practices and even social and dietary preferences. This local knowledge, coupled with education, drives, enriches and broadens the scope for research. Understanding local motivations is also of benefit to the global research community. This allows a greater variety of problem-solving approaches to improve resilience for example by diversifying outputs as well as seeking ways to maximise existing crop yield.

8.3.5 Health

The ASEAN region is home to infectious diseases of the developing world as well as chronic lifestyle diseases associated with developed economies such as obesity, diabetes and cancer.[365]

Although the region holds less than 9 % of the global population, the region carries over a quarter of the world's burden for infectious and parasitic disease.[366] The majority of the region experiences a wet, tropical climate that encourages vector- and water-borne diseases. Major infectious diseases in the area include malaria, dengue fever, bacterial diarrhoea, tuberculosis, Japanese encephalitis, leptospirosis, hepatitis A, typhoid fever, and HIV. Infectious diseases are becoming increasingly problematic as climate change has promoted the spread of previously localised diseases – from rural to urban areas, and across country borders.

There is a long tradition of international collaboration in the field of infectious diseases across the region. Chapter 8.1 shows research strength to be distributed across the region, but notably in Thailand and Singapore. Indeed, collaborative research projects on malaria have been running in Thailand since the early 20th Century. Successes have included the development of several effective treatments and prophylactics for malaria. Nonetheless, poor treatment practices have led to the emergence of drug-resistant strains, particularly along country borders. Major obstacles to overcoming global health challenges include the need for deeper scientific understanding of disease pathology and deeper socio-

351 ASEAN (2005)
352 ASEAN (2005)
353 Vörösmarty, C.J. et al. (2010): Global threats to human water security and river biodiversity, in: Nature, 467, pp. 555–561.
354 Downloaded from ec.europa.eu/research/water.../incowater_fp4fp6_rapport_technique_en.pdf May 2011
355 World Bank, cited in National Intelligence Council (2008): Global Trends 2025: A Transformed World, Washington: US Government Printing Office
356 FAO (2006): State of World Aquaculture
357 Munns, R. / Tester, M. (2008): Mechanisms of salinity tolerance. In: Annual Review of Plant Biology, 59, pp. 651–681
358 Wassmann, R. et al. (2009): Climate Change Affecting Rice Production: The Physiological And Agronomic Basis For Possible Adaptation Strategies, in: Sparks, Donald L. (Ed.): Advances in Agronomy Vol. 101, San Diego: Academic Press, pp. 59–122
359 FAO (2004): Use of phosphate rock for sustainable agriculture, Fertilizer and Plant Nutrition Bulletin, Rome, online: http://www.fao.org/docrep/007/y5053e/y5053e00.htm
360 ENSO is a period phenomenon of climatic inter-annual variability causing drought during El Niño periods and floods during La Niña periods.
361 UNEP (2009): Degraded soils. UNEP/GRID Arendal Maps and Graphics Library. Available online at: http://maps.grida.no/go/graphic/degraded-soils
362 Garnett, T. (2008): Cooking up a Storm: Food, greenhouse gas emissions and our changing climate. Food Climate ResearchNetwork, Centre for Environmental Strategy, University of Surrey
363 von Braun, Joachim (2007): The World Food Situation: New Driving Forces and Required Actions. IFPRI's Bi-Annual Overview of the World Food Situation
364 Johnston, R.M. et al. (2010)
365 Popkin, B.M. (1998): The nutrition transition and its health implications in lower income countries, in: Public Health Nutrition, 1, pp. 5–21
366 Cited by Jaime Montoya, Philippine Council for Health Research and Development, Philippines, 3rd SEA-EU-NET conference: Sharing the Benefits of Joint Research, 24–25 November, 2010. Presentation available at http://www.sea-eu.net/object/event/1638.html

logical understanding of what causes these and how this can influence the effectiveness of health interventions.

With growing research and clinical capacity, the region holds potential for providing a significant pool of talent in the field of health and has emerged as a competitive location for large-scale clinical drug trials. The Philippines have won three WHO Sasakawa Health Prizes over the last ten years and the world's largest HIV vaccine clinical trials were conducted in Thailand in 2009.

Case Study 7: FLUAID – Generation of Information and Tools to Support the Management of the Avian Influenza Crisis in Poultry

The FLUAID project was a Specific Targeted Research Project (STREP) under FP6 and received €120,000 of EC funding. 13 partner countries were involved including Indonesia, Thailand, and Vietnam. Coordinated by a research partner in Italy, the project ran for 46 months, starting in 2006. At that time, the Avian Influenza Epidemic had already caused the deaths of over 200 million birds in the preceding 5 years. The losses to the poultry industry were severe and were a serious concern for food security. Recognising the lack of scientific information on several aspects of the disease, the FLUAID project aimed to increase scientific understanding of the virus and to develop and apply novel diagnostic tools and vaccines to combat avian influenza in poultry. The project turned out to be extremely timely - planning was already underway before the emergence of the new human virus H5N1, leaving the consortia well-placed to support contributions to the global response.

Key lessons shared by those involved highlighted the increased relevance and demand for research and collaboration, in turn, increased competition for partners. Maintaining the credibility and visibility of projects and instruments with far-away partners requires a unique selling point and mutually interesting global public health objectives. Scale and longevity can sometimes be an advantage. In addition, frequent interactions between laboratories, in both directions and in both locations, is essential for building sustainable collaboration platforms. Focussing collaborations on fewer centres of excellence and strengthening the links between them can be beneficial for those involved. This requires effective partner identification and selection – a process which could also be strengthened. One interviewee also noted that they had "no complete overview of how well-connected we [Europe] are". This suggests there may be merit in sharing more widely analysis which tracks cooperation trends in specific fields to inform future research effort.

Case Study 8: Wellcome Trust Southeast Asia Major Overseas Programme

The Wellcome Trust Southeast Asia Major Overseas Programme began in 1979 as a collaboration in tropical medicine research between scientists at the UK's University of Oxford and Thailand's Mahidol University. With half the world's population within a 2000 mile radius of Bangkok, research at Mahidol is a major global hub and the bilateral partnership has since forged multilateral links with other institutes in the region including the Hospital for Tropical Diseases in Vietnam and Mahosot Hospital in Laos. The programme is now a firmly established network with operationally independent teams across Southeast Asia and clinical research collaborations with groups in a number of African countries.

The model of collaboration, as described by Nick White, Director of the Southeast Asia Major Overseas Programme has been "a bit different, a low slow burn". Over the years, the Wellcome Trust have committed significant amounts of money including around £3 million of core funding annually, which has underpinned the programme's current standing as a global leader in tropical medicine research. The Programme employs around 370 people, over 90% of whom are local staff. Although training is not a primary mandate, the programme supports postgraduate and postdoctoral courses. It also offers an English Language for Science programme.

The teams are committed to delivering practical local benefits and work with Principle Investigators permanently based in-country. This helps to ensure that local perspective and experience shape the research agenda. For example, in the case of malaria research, host priorities may be in fieldwork and clinical investigation, which contrast with EU research focus on animal models and basic science. Although both approaches may be necessary, it is true that "infectious diseases account for half of all preventable deaths in the developing world and simple research can have big population effects".

The Programme is strongly integrated with existing academic structures (not necessarily with government involvement), and retains strong bilateral links with the UK and other international networks.

This modest model of working is described as 'more of a strawberry plant than an oak tree', and throws into perspective the importance of personal relationships. Personal characteristics such as understanding, respect and empathy for local cultures are crucial for building trust with host institutions and lead to harmonious working.

8.3.6 Cross-cutting issues

The impact of global science is underpinned by national infrastructures, which reflect the research priorities, capacity and strengths of individual countries[367]. Ideas and solutions, no matter how innovative, cannot be realised without people with the relevant skills and facilities to explore and implement them. A pool of skilled researchers is therefore crucial to boosting international collaboration on global challenges.

[367] Royal Society (2011), p. 36

8.3.6.1 Education and training

Training new generations of talent can be particularly problematic in some ASEAN countries where education infrastructure is still comparatively poor. ASEAN education enrolment rates are generally lower than in the EU, particularly for tertiary education. Nonetheless, the investment of ASEAN countries in education is significantly higher than the investment in science and technology and national plans for education have become substantially more ambitious in recent years. In 2009, Thailand started a National Research University initiative, part of a 15-year national Plan for Higher Education of the Office of Higher Education Commission (OHEC), which aims for the country to become a world-class regional academic and educational hub. 2009 also saw the national government of Myanmar following a European initiative on bridging Burmese education with European education. Nonetheless, the talent pool for scientific research in ASEAN remains small. One interviewee correspondents described the ASEAN research community as "very elite and very limited", giving the example of Indonesia in which S&T professionals are seldom recruited from educational institutes outside the top 5 universities.

Table 23: ASEAN education trends[368]

	Public spend on education % GDP	Tertiary education enrolment (% gross)	Literacy rate, adult total (% people ages 15 and above)	Ratio of female to male tertiary enrolment (%)
Brunei	–	17 (2009)	95 (2009)	176 (2009)
Cambodia	2.1 (2009)	10 (2009)	78 (2008)	54 (2008)
Laos	2.3 (2008)	–	–	78 (2008)
Indonesia	2.8 (2008)	24 (2009)	92 (2008)	92 (2008)
Malaysia	4.1 (2008)	36 (2008)	92 (2009)	130 (2008)
Myanmar	–	11 (2007)	92 (2009)	137 (2007)
Philippines	2.8 (2008)	29 (2008)	95 (2008)	124 (2008)
Singapore	3.0 (2009)	–	95 (2009)	–
Thailand	4.1 (2009)	45 (2009)	–	124 (2009)
Vietnam	5.3 (2008)	–	93 (2009)	–

CASE STUDY 9: Supporting International Networking and Cooperation in Educational Research (SINCERE)

The Supporting International Networking and Cooperation in Educational Research (SINCERE) project ran for 2 years from 2006 under FP6. The project received €399,800 of EC funding and was coordinated by an Italian partner, with seven partner countries including Malaysia. The project emphasised the need to open the European Research Area in the field of education, training and Lifelong Learning so as to support international networking and cooperation between EU researchers. The SINCERE project resulted in a Green Paper, which mapped future educational research proposals. It plotted a timetable for international cooperation to enhance understanding of how to address the real educational and socio-economic needs and concerns of citizens.

8.3.6.2 Information and Communication Technologies

Improving capability in Information Communication Technologies has been a shared objective for national and regional development across the ASEAN Member States.[369] In addition, research in these technologies has been identified as an area of comparative strength in the region, with Singapore, Malaysia and Thailand leading the field.[370]

Encouragingly, the EU has a good tradition of working with Southeast Asia, for example through the Trans-Eurasia Information Network (TEIN3) project, which has provided a dedicated high-capacity internet network for research and education communities across Asia-Pacific, including those in Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. EU Digital Agenda Commissioner, Neelie Kroes, has recognised that Europe needs Information and Communication Technologies if it is to face up to grand challenges. According to interviewees, the major challenges for researchers in Southeast Asia are found in developing the quality and quantity of human-resources and in developing the physical and policy infrastructure to support ICT.

Case Study 10: EU-Southeast Asia cooperation in ICTs (SEACOOP)

The SEACOOP project was set up to promote and support the development of cooperation on ICT research between Europe and ASEAN. It has involved the national agencies in charge of ICT research in all 10 of the ASEAN member states and was conducted in 2 phases. Phase I ran for 18 months and focused on identifying and analysing opportunities for cooperation. Phase II (known as SEALING), ran for 24 months and focused on support for policy dialogues. The aims were to identify ICT policy and research priorities and develop synergies with other FP projects.

The project structure included an Advisory Committee, formally supported by the ASEAN Secretariat, and

[368] Data from World Bank, available at http://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS

[369] Interview feedback, ASEAN ICT Masterplan 2015 available at http://eurosoutheastasia-ict.org/files/2011/02/SEALING_D2.2.pdf

[370] Haddaway, P. et al. (2011): Bibliometric Analysis of Science and Technology Strengths in Southeast Asia, available at http://www.sea-eu.net/; see also chapter 1 in this book

national ICT representatives from all 10 ASEAN Member States. That all 10 ASEAN Member States have been involved in FP7 (despite no specific requirement for ASEAN involvement) is a testimony to the high-level interest and commitment of those involved.

Lessons to note include the recognition that relationships have matured through engagement in multiple activities (including on-line surveys and workshops) and a budget that has enabled mobility of experts between the two regions. The project has also made use of existing ASEAN platforms (ASEAN Secretariat, COST, Telecommunications Senior Officials Meetings). In addition, although the project has succeeded in retrospectively integrating ASEAN partners into FP7 projects, this process could have been made more effective by involving partners in setting priorities, particularly on the content of specific work programmes. Finally, the project has benefited from wider bilateral engagement from other EU (non-FP) funded cooperation tools across Directorates, e.g. the appointment of an EU ICT Counsellor to work with ASEAN COST and ASEAN ICT National Contact Points, AIDCO, Marie Curies, Erasmus.

8.4 Conclusions and recommendations

This short review has not permitted a detailed analysis or assessment of the scientific research priorities under global challenge themes. Here we simply hope to make some observations that may be helpful in shaping future strategies for bi-regional collaboration. We believe the conclusions presented here are broadly supportive of and consistent with those set out in other chapters in this booklet.

Within the sample, genuine bi-regional cooperation, that is EU-wide and ASEAN-wide research collaboration, is an aspiration rather than a reality. This is to be expected. In most cases, projects have at their core, a smaller number of active institutions, and a minority of Southeast Asian partners. Few of the Framework Programme projects in particular, leverage the growing research capacity of the Southeast Asian region to a significant degree. This suggests that the high potential for bi-regional research collaboration and impact towards global challenges is defined and to some extent constrained by the instruments available to take collaborations forward; the Framework Programme and READI (non-trade-related political dialogue).

Nevertheless, it is encouraging that bibliometric analysis places the EU ahead of the US and near-neighbours (China, India, Japan, Australia, South Korea and Taiwan) in co-authorship with the ASEAN region. In addition, a unique selling point of existing instruments is that all areas of the current FP7 work programme are open to the participation of ASEAN researchers and research organisations, and co-ordination and support actions are also available within the FP (e.g. INCO NET) through other EU Directorates (e.g. SEACOOP is a support action under DG INFSO) and through non-trade political dialogue (e.g. READI). Growing ASEAN participation across successive FPs is also encouraging. To further enhance the mobilisation of Southeast Asian research effort relevant for global challenges, the European Commission may also consider a limited number of Specific International Cooperation Actions (SICAs) within the existing cooperation fields. These could offer more targeted programmes of work relevant to global challenge research with the region, and build on existing regional frameworks for cooperation, such as those listed above on climate change, environment and water.

Recommendation 1: Successor(s) to the Framework Programme should continue to remain open to participation from ASEAN Member States. This sends an important signal that the EU remains open and committed to building relations with the ASEAN region. A sustained long-term commitment allows for a more comprehensive approach and is a unique selling point for bi-regional collaboration.

Recommendation 2: The European Commission should also consider scope for Specific International Cooperation Actions (or similar actions) for global challenge research that permit greater integration of Southeast Asian research effort. The specific themes and aims for such actions should be co-defined by the two regions, and should build on existing regional frameworks.

Within some case studies, bilateral initiatives, on which wider regional links and platforms have been built have been important (e.g. REEFRES, SEARRP, CTI, Wellcome Trust Southeast Asia Major Overseas Programme). Each ASEAN member state has its own rich history, differing education legacies, relationships with other nations, and levels of development. Engaging with the ASEAN region is therefore very different from engaging with, say, China or India, or even a region such as Latin America where there is shared language and history amongst countries. This is compounded by the complication of deciding how best to work with each individual ASEAN member state. Whilst working in areas of growing regional consensus will be a priority for the EU, a "one size fits all" approach may not be appropriate in all cases.

Here, bilateral partnerships can play an important role. They allow recognition of, and respect for independent national strengths, priorities and needs. Bilateral partnerships can quickly allow rapport and trust to flourish between the individuals, and for intercultural understanding to deepen. Some interviewees made the case that fewer partners reduce the administrative and logistical burden of coordinating many different countries, and allows more room for the joint pursuit of personal academic agendas at a faster pace. Crucially, it enables more frequent personal face-to-face interactions, a factor reported by many FP interviewees to be essential for collaborative success. A strong platform of bilateral relationships between a limited number of partners plays a complementary role to that of multilateral partnerships, and in some cases seeds them.

Across the Member States, these bilateral initiatives form a crucial component or pre-cursor for wider bi-regional collaboration efforts and can serve as complementary hubs of experience and expertise to European-funded actions. There are strengths in having a range of links between the two regions, although these are not always visible to interested and new parties. Country Embassies have an important role to play in strengthening bilateral links in order to pave the way for high quality bilateral relationships between scientific communities. Yet they do not substitute for direct local links. The value of having permanent National Contact Points (NCPs) in place to support the strengthening of bilateral links should also be recognised. NCPs provide personalised guidance, practical information, and individual assistance on all aspects of participation in FPs; advice covers a wide range of issues including choosing a partner, writing proposals, distributing documents, administrative procedures and contractual issues.

Yet a number of international competitors also recognise ASEAN's potential in the S&T arena; the ASEAN Science and Technology Plan of Action lists 11 formal dialogue partners.[371] Individual ASEAN Member States have also been sought after for lucrative bilateral partnerships including the US-Indonesia Comprehensive Partnership which has seen the US commit $136 million over 3 years towards developing an array of environmental programmes in Indonesia. Norway have committed $1bn to the REDD programme to reduce emissions for deforestation and forest degradation. A major challenge for FP succession will be to competitively complement existing instruments, whilst recognising that scale and long-term commitments are needed. European Commissioner for Research, Innovation and Science, Máire Geoghegan-Quinn, has already acknowledged "European Research funding is currently spread across too many small programmes and different instruments, sometimes with insufficient scale and scope to make real breakthroughs in a visible way".[372]

Recommendation 3: EU Member States should be encouraged to nurture bilateral research collaboration on global challenges with the ASEAN region. These play an important role in wider bi-regional cooperation.

Recommendation 4: The European Commission and Member States should consider actions (such as bibliometric analysis or other on-line social networking tools) to ensure that current research and collaboration trends are visible to interested parties.

Within some of the case studies, most notably in health (FLUAID, Wellcome Trust Southeast Asia Major Overseas Research programme) and ecosystems and biodiversity (REEFRES and CTI), the different perceptions, priorities and capacities for research across partners were acknowledged as having an impact on the scope and approach to joint-working. Essentially, this requires partners' willingness to accept differences and expand the scope for research collaboration around mutually beneficial outcomes for all. This can be difficult to achieve within some research programmes. For example with respect to the focus of malaria research (cited above), Southeast Asian research priorities may be in fieldwork and clinical investigation, which contrasts with EU research focus on animal models and basic science. It is encouraging that current research applications to the Framework Programme are assessed equally in terms of research excellence, implementation and impact. However it is important to note that differences exist in defining these parameters. In addition there are significant 'non-research excellence' gains from the conduct of global challenge research (e.g. direct impact on local communities) that may fall outside the remit of existing research collaboration instruments but within the scope of wider bi-regional actions on health, transport, education, trade, etc.

Recommendation 5: The potential wider benefits of scientific research collaboration on global challenges (e.g. tangible impact on local communities) should be recognised and be coupled with an assessment of how funding and collaboration approaches (successors of the FP7) can be modified. New forms of global challenge research cooperation beyond the scope of the Framework Programme, through for example READI (the non-trade related political dialogue) or through other cross-Directorate mechanisms (e.g. innovation platforms), that permit a multidisciplinary 'systems approach' to problem solving are needed.

In some projects, effecting tangible impact and outcomes in the region were primary motives for collaboration (e.g. REEFRES sought to develop methods for active coral reef restoration, CTI seeks to protect marine and coastal resources). For these projects, simple and practical approaches to research that were adapted to suit local needs were sufficient to generate the impacts and outcomes desired. For example, the REEFRES project and CTI were designed to include and work with local communities, such as fishermen, even though knowledge of foreign languages and education levels may have been limited. Joint work is sensitive to language and cultural differences, and can in turn be informed by local knowledge and experience. A diverse range of local partnerships can also ensure that projects take account of wider political and local contexts. This was identified as critical in the review of EU INCO IWRM, whereby the water-food-trade nexus is seen as central to framing research effort on sustainable water resource management. This in turn requires a multi-disciplinary approach to projects, and willingness to draw on local and regional data (and grey literature) in order to in-

371 See also Schüller / Gruber / Trienes / Shim (2008): International Science and Technology Cooperation Policies of Southeast Asian Countries
372 Máire Geoghegan-Quinn, Speech at the Royal Society, 7 Feb 2011

clude a more diverse range of expertise.

The independent review of EU-INCO IWRM recognised the importance of socio-political contexts. The social application of science can only be effected through close and habitual ongoing dialogue with policy makers and civil society, which would, in turn, enable scientists to understand how to more effectively target their project implementation and dissemination whilst retaining reasonable expectations of the impacts of their research activities. The IPCC stands out as a good example of maintaining effective dialogue between scientists and civil society through engagement with grey literature, and between scientists and policymakers through line-by-line negotiation processes with government officials. Working in this way, the IPCC has stimulated and sustained policy debate over two decades.

The complex nature of global challenges has resulted in a concentration of specialised experts at the top of their field, meaning that S&T research often remains distinct from political and social application. Just as each field of science has its own organised knowledge and explanations for understanding the world, so too does each social culture have its own organised knowledge and explanations for classifying and understanding the world them.[373] The STEPS Centre New Manifesto called for scientists to pay attention to social dimensions, emphasising that capacity building for S&T must move beyond a focus on technicalities to support science that works more directly for diverse social and environmental needs[374]. Failure to incorporate local knowledge can lead to suboptimal implementation of research projects, resulting in tensions between researchers and local knowledge and undermine the legitimacy of scientific findings in the eyes of local communities. The challenge is to both employ and disseminate science within an appropriate cultural framing that complements local understanding[375].

The STEPS Centre New Manifesto also pointed out that innovative S&T initiatives can often founder in the face of local realities, and emphasised the importance of indigenous wisdom that is rooted in local cultures, histories and practices. Harnessing this knowledge may significantly shorten the amount of time it would take to survey and map local conditions, enriching the awareness of specialist researchers and broadening the scope for research; yet only a small percentage of local knowledge becomes globalised[376].

Understanding local perceptions is of particular benefit through more subtle channels that might not be immediately apparent to non-locals. CGIAR'S IRRI in the Philippines successfully combines cutting edge global research with practical, local impact through harnessing local knowledge on traditional rice varieties, soil conditions, weather patterns, agricultural practices, and even social and dietary preferences. This enables the local Philippine community to benefit from science whilst also recognising the value of the local knowledge and offering an opportunity for local citizens to impact upon the work of experts and open up previously hidden innovation pathways. It is similarly beneficial to acknowledge the importance of local output in disseminating scientific solutions; local actors are much better suited than outside professionals to disseminating knowledge in the form of a culturally appropriate regime. Without local engagement, research is at risk of losing focus on its essential purpose of providing employable solutions to global challenges.

Recommendation 6: A proportion of bi-regional research effort should aim to deliver tangible impacts for managing global challenges and help towards effecting practical outcomes. This may require more flexibility in the design and approach to specific projects and should take account of policy and local contexts

Recommendation 7: A diverse range of links to local stakeholders or local networks should be encouraged, and include non-scientists, citizens and civil society groups. These could be engaged through, for example, advisory boards which may also help inform the research effort. Consideration should also be given to the important role of grey literature in informing and disseminating research.

Recommendation 8: Consideration should be given to the allocation of follow-on grants (similar to those delayed by the European Research Council) to encourage researchers to engage in high quality dissemination and knowledge transfer.

Projects participants used a variety of methods to identify and select their Southeast Asian partners. This includes making use of existing contacts (SINCERE), focussing on institutions with the necessary specialist facilities (REEFRES) or location (SEARRP), official nomination processes (SEACOOP) and recommendations from third parties (FLUAID). Some interviewees noted increasing competition for partners in region and indicated that the processes for identifying the best research partners could be strengthened, particularly for new talent and emerging centres of research excellence.

Recommendation 9: There should be sufficient time during calls for project proposals to allow participants to identify suitable collaboration partners. There may be a role for Member State's Embassy representatives, EU Delegation representatives and National Contact Points.

Recommendation 10: The EU should support ASEAN-COST their continued development of multidisciplinary centres of excellence , and research platforms across the region.

373 Snively, Gloria / Corsiglia, John (2000): Discovering Indigenous Science: Implications for Science Education, in: Science Education, 85(1), pp. 6–34

374 STEPS Centre (2010)

375 Somuny, Sin in: Jones, Nicola / Jones, Harry / Walsh, Cora (2008): Political Science? Strengthening science-policy dialogue in developing countries. Overseas Development Institute Working Paper 294

376 Tomforde (2003) cited in Gerke, Solvay / Evers, Hans-Dieter (2006): Globalizing Local Knowledge: Social Science Research on Southeast Asia, 1970–2000, in: Sojourn: Journal of Social Issues in Southeast Asia, 21(1), pp. 1–21

For some projects (IPCC, IRRI, Wellcome Trust Southeast Asia Major Overseas Research Programme), partnerships take time, sometime decades to mature. This has been crucial to nurturing the collaboration, build trust and to allow the collaboration to evolve. A tacit recognition that projects are in it for the longer term gives an important signal to those involved, and can influence the approach to joint-working. In addition, a minority of interviewees commented that the personal characteristics of individuals involved were also very important to nurturing good relations. This was particularly true for projects which had more on-the-ground contact with Southeast Asian partners (SEARRP, Wellcome Trust Southeast Asia Major Overseas Programme). Here, empathy and respect for local cultures are critical to developing collaborations based on mutual trust.

Whilst most projects have built on existing links between the regions, among the non-FP projects in particular, (SEARRP, CTI, IRRI, Wellcome Trust Southeast Asia Major Overseas Programme), the quality and extent of engagement with local partners appears to be stronger. This is demonstrated by their permanent location in the region (SEARRP, IRRI, Wellcome Trust Southeast Asia Major Overseas Programme), official or political support (IPCC, CTI), the extent to which research agendas have been co-constructed by those involved (CTI, SEARRP, IRRI, Wellcome Trust Southeast Asia Major Overseas Programme), and the range of local partners involved, including the public and civil society (for examples, CTI and REEFRES involved fishermen or other locals). This encourages reciprocity and mutual benefits from the collaboration, and ensures the needs of the region can be understood and factored in to the project.

Recommendation 11: Recognising that strong research relations can take years to mature, where appropriate, the personal interest and commitment of those involved in individuals taking part in projects should be taken in to consideration. Sustained commitment and time-spent in country, in both regions should be encouraged and should feature as an integral part of projects where appropriate. This may also require additional opportunities for language training, to support

Recommendation 12: Harnessing diaspora more effectively for bi-regional cooperation would also help capitalise on existing resources.[377, 378]

377 See Meyer / Brown (1999)

378 See for example: Diaspora Knowledge Networks (DKN) programme http://www.unesco.org/shs/migration/diaspora, Transfer of Knowledge Through Expatriate Nationals (TOKTEN) programme http://www.unv.org/en/how-to-volunteer/unv-volunteers/expatriate-professionals.html and the Brain Gain Network http://www.bgn.org/bgn/

Conclusions

The studies presented in this book are inspired by the SEA-EU-NET project's goal of supporting bi-regional policy dialogue on S&T cooperation, including thematic priority setting and the design of S&T cooperation programmes. We hope that it will help to increase cooperation levels between Southeast Asia and Europe, leading to collaborative solutions for joint problems and mutual social, cultural and economic benefit.

The analyses highlight the strengths of ASEAN research, and the manifold opportunities and potential for greater ASEAN-EU cooperation. Based on different kinds of quantitative analyses, the first part of the book compiles evidence on current research output and cooperation. Thematic areas are identified where ASEAN research is already strong and where Southeast Asia and Europe are most intensely cooperating.

The studies presented in the second part of the book are based on expert interviews, focus groups and site visits. They outline S&T policies of ASEAN countries, indicating areas to which ASEAN public funding and resources are being directed and where future research strengths will likely develop. In addition, these chapters discuss opportunities and pitfalls in S&T cooperation, offering a series of recommendations for the development and implementation of collaborative research and the design of related programmes. The SEA-EU-NET Foresight study provides input to further inspire debate on how to define and ensure a successful future S&T cooperation scenario. A detailed account of major ASEAN countries' internationalisation policies shows what patterns and priorities future cooperation can build upon. The final analysis explores the increasingly important role of research and international cooperation to address global challenges.

The compilation and publication of these analyses seems timely with the ever increasingly internationalised nature of both the scientific community and the research being undertaken, as well as with significant developments in the research landscape currently ongoing in both ASEAN and the EU.

In Southeast Asia, the ASEAN Member States are in the process of establishing an ASEAN Community by 2015. This ASEAN Community will be built on the existing three pillars of ASEAN, including the development of an ASEAN Socio-Cultural Community (ASCC), which aims to increase access to applied S&T. Furthermore, at the 6th Informal ASEAN Ministerial Meeting on Science and Technology in Krabi/Thailand, the ASEAN S&T Ministers agreed to extend the current ASEAN Plan of Action on Science and Technology until 2015 and coordinate activities with the development of the ASEAN Community. The six flagship programmes of the APAST[379] are an important step towards the regional integration of S&T.

In the EU, work is underway to develop the next Framework Programme for Research and Innovation, 'Horizon 2020', which will run from 2014 until 2020. The European Commission will finalise a proposal for Horizon 2020 by the end of 2011. The end of this decade is also envisaged by the EU's global strategy for smart, sustainable and inclusive growth, 'Europe 2020'. The concept of an 'Innovation Union' is one of the flagship initiatives of the Europe 2020 Strategy. The Innovation Union commits the EU and its Member States to treat international scientific cooperation as an issue of common concern and to develop common approaches.

Within this wider context, SEA-EU-NET has initiated an ASEAN-EU Year of Science, Technology and Innovation 2012, which is endorsed by ASEAN and the European Commission. This initiative will highlight, promote and extend the reach of scientific cooperation between Southeast Asia and Europe. It will be a year long campaign to stimulate bi-regional scientific collaboration, increase awareness of scientific excellence in both regions and the opportunities to collaborate, as well as communicate the benefits of science to societies. By focusing on topics of strategic importance to both regions as well as being of global relevance, the Year will increase the impact and visibility of S&T cooperation between ASEAN and Europe.

379 Early Warning Systems for Disaster Management (led by Indonesia); Biofuels (Malaysia); Application and Development of Open Source Systems (also by Indonesia); Functional Food (Thailand); Climate Change (Philippines and Vietnam) and Health (Singapore)

This book is not least conceptualised as an input to the ASEAN-EU Year of Science, Technology and Innovation. It is concluded with four sets of policy recommendations and one set of best practice guidelines produced by SEA-EU-NET. They have been developed in expert- and community-driven participatory processes following SEA-EU-NET's mandate to support bi-regional S&T cooperation policy dialogue. The recommendations have been through a consultation process with all SEA-EU-NET partners. They do not represent the official view of any individual government.

The first set of recommendations identify the most strategic areas for future Southeast Asian-European research collaboration, which are derived from qualitative research, expert consultation, the outcomes of SEA-EU-NET brokerage events and the quantitative analyses in the first part of this book. Secondly, recommendations are presented for optimising the policy framework for bi-regional collaboration. Subsequently, there are future-oriented recommendations offering ideas how to maximise engagement of researchers in cooperation programmes. The second and third sets of recommendations are supplemented by best practice guidelines for developing and participating in international S&T projects. The chapter closes with a summary of the recommendations from the analysis on international S&T cooperation to address global challenges.

Thematic recommendations

The analysis considers the national S&T policies, the annual level of output of scientific publications and citations, participation in the European Commission's seventh framework programme, as well as the unique characteristics of the Southeast Asian region, with the aim of identifying which thematic areas would generate the greatest mutual benefit for Europe-Southeast Asia collaboration. A number of policy recommendations have been produced from this analysis outlining the thematic areas which will give rise to the greatest opportunities for mutual benefit from Europe and Southeast Asia cooperation:

Health

Health is a key thematic area for Europe-Southeast Asia partnerships. Within the broad heading, there are specific gains to be realised from directing resources to translational research in infectious diseases, including vector borne diseases (including but not limited to malaria, dengue), neglected infectious diseases, and potentially new and re-emerging infections. Joint research on drug resistance is also extremely important. Research on aging populations and lifestyle diseases are also growth areas for Europe-Southeast Asian partnerships. Evidence-wise, health is also the most important subject area (together with physical and biological sciences) in academic co-publications of authors from Southeast Asia and the EU. Infectious diseases is the most prominent detailed subject category in EU-ASEAN co-publications in absolute numbers, followed by physics and engineering, but also several other medicine-related categories. Oncology has been the field with the strongest relative growth in bi-regional co-publications from 2000 until 2010. When comparing the research outputs from Southeast Asia and Europe in this area, a lower percentage than in other areas is observed. Nevertheless, health is among the FP7-themes where participation from Southeast Asia is strongest (together with environment and FAFB).

Food, Agriculture and Fisheries, and Biotechnology (FAFB)

Food, Agriculture and Fisheries, and Biotechnology research is a very important area for Europe-Southeast Asia research partnerships, specifically in the areas of sustainable agriculture, sustainable exploitation of food resources, resilience and adaptation of crops to climatic change, public awareness of food safety, exploitation of genetic diversity, optimised animal health, production and welfare. FAFB is among the areas where participation from Southeast Asia in FP7 is strongest. The ratio of Southeast Asian to European research output is in the mid range, higher than in the case of health, lower than in the areas of nanotechnology, ICT or energy. Biological sciences are among the most relevant areas in co-publications, as well, with biochemistry and molecular biology showing high numbers of co-publications.

ICT

ICT is also a very important area for Europe-Southeast Asia collaboration, and the SEACOOP project (www.eurosoutheastasia-ict.org/) is working towards developing deep and sustainable long term collaborations. There are significant opportunities in research on the network of the future, digital libraries and technology-enhanced learning and ICT for the environmental management and energy efficiency. Academic co-publications are not yet that strong in the area of ICT, although the percentage of the overall research output of Southeast Asia compared to European output is among the strongest in this field.

Growth area: Environment

There is great potential in Europe-Southeast Asia collaboration in environment research, especially in biodiversity research, although to date, this has not been one of the strongest focuses of Southeast Asia. There are substantial benefits from joint research on the evaluation of the social and economic value of biodiversity, coastal and marine management, the reduction of landscape fragmentation and defaunation, as well as sustainable palm oil production. This area is already among the strongest when it comes to Southeast Asian countries' participation numbers in FP7. The number of co-publications is also rather high in this field, although not as high as in Health or FAFB (which might have to do mostly with the size of the scientific field itself). However, ASEAN publication output in this area is rather low compared to the number of European publications. Consequently, the share of ASEAN-EU co-publications in ASEAN overall publications is highest in this thematic area. Compared to other areas, a larger part of the ASEAN research output in the field of environment is produced with European partners.

Policy framework recommendations

The following list of recommendations results from the qualitative analysis work on opportunities, pitfalls and drivers of international S&T cooperation between Southeast Asia and Europe. They result from participatory consultation and discussion processes involving policy-makers, programme-owners and members of the scientific community in both regions.

- An enhanced EU-ASEAN dialogue on S&T between political decision makers should develop common strategic priorities. Collaborative R&D should be funded in these priority areas by international programmes between Europe and Southeast Asia.
- Mechanisms for feedback and input from Southeast Asian and European stakeholders (including the scientific community) should be implemented both in priority setting decisions and the development of programme procedures for international collaborative research programmes at every stage of the decision-making process. National differences should be taken into account in the development of regional policy.
- Policymakers should ensure all policy directly relating to science, technology and innovation is carefully aligned with all other policy indirectly relating to science, technology and innovation.
- Framework programmes should include substantial dedicated funding calls targeted at scientific collaboration with the Southeast Asian region. Joint calls should further be developed bi-regionally.
- Programme rules should be simple, stable, consistently applied and well communicated, as well as adaptable and able to tolerate risks inherent to scientific endeavours. Rules should be based on common standards and encourage equal project participation and leadership.
- Information on potential partners for Europe-Southeast Asia collaboration should be easily accessible to all, and regular networking and relationship building activities should strengthen relationships between researchers in Europe and Southeast Asia.
- International programmes should support the development of strong national research infrastructures within the Southeast Asian countries by establishing inter-regional centres of research excellence and assisting in the development of a strong base of human research capital.
- Inter-regional mobility should be enhanced through the development of instruments and removal of barriers, resulting in an equal exchange of European and Southeast Asian researchers between both regions.
- Funding programmes for the Southeast Asian region should include science for international development components, where required.
- Programme mechanisms should be cultivated to capitalise on the innovative elements of projects and ensure engagement of the private sector. Mechanisms should, additionally, consider the potential benefits to the economy and the society.
- Easily accessible information on FP7 and the opportunities it provides for Southeast Asian researchers should be broadly disseminated within Southeast Asia, especially using the network of National Contact Points.
- Sufficient time between the release of calls for proposals and the deadline for submission of proposals must enable potential projects to identify partners, form consortia, and draft successful project proposals.

Recommendations to maximise researcher engagement in international S&T cooperation

The following recommendations are aiming at increasing long term S&T cooperation between Southeast Asia and Europe (circa 2020). Within SEA-EU-NET's Cooperation Foresight exercise, they have been identified bottom-up by S&T policy-makers and scientists with experience in collaborative research between Southeast Asia and Europe (see also chapter 7).

- It must be taken into account in the design of international funding mechanisms that the most important motivation for scientists to collaborate internationally, is to work on state-of-the-art research with like-minded researchers. Researchers are also motivated by (though to a lesser extent), solving global challenges, contributing to national development, access to a particular field, expertise or equipment, as well as developing friendships or improving international reputation.
- S&T cooperation should be sustained on a long-term basis.
- A balance should be found between flexible funding of cooperation activities in research projects defined bottom-up and the dedicated funding of S&T cooperation with a thematic focus.
- A balance should be achieved between supporting cooperation in basic and applied research.
- Mechanisms to support mobility must be put in place to enable researchers to develop personal contacts, crucial to the development of long term research collaboration. Mobility support mechanisms must promote equilibrated mobility in both directions redressing the imbalance of greater flow of researchers from Southeast Asia to Europe.
- Existing human and network resources should creatively be harnessed. Among the many options, established scientific conferences could be invited to convene in Southeast Asia; retired scientists could be offered part-time positions, senior scientists could be willing to engage in cooperation and exchange in the framework of sabbatical themes.
- PhD student exchange, joint PhD programmes and particularly co-supervision of PhD students should be supported to a higher degree.
- Southeast Asian Diaspora academics in Europe should be addressed as possible facilitators of S&T cooperation.
- Return and reintegration support schemes should be considered, especially for Southeast Asian scientists who have spent longer periods of time in Europe.
- Reward schemes for successful cooperation should be considered as potentially increasing the motivation to cooperate.
- Quality metrics for assessing the success of international S&T cooperation projects have to be further developed.
- Regional training networks, joint research centres and other joint research infrastructure can help to increase cooperation intensity.
- Bridging institutions offering administrative, research management and partnering support should be considered as a means to increase cooperation levels.
- Administrative burdens hampering S&T cooperation like visa issues, material exchange and field access clearance procedures should be simplified.
- Open access to literature and sample databases should be supported.
- The results of joint research should be made available in the respective regions, not only in international journals.

Best practice guidelines for participation in international scientific collaboration

As it is related to the preceding set of recommendations, we also want to include in this concluding section the best practice guidelines for developing and participating in international S&T projects that has been cited above at the end of chapter 4. These guidelines are the result of previous work within the SEA-EU-NET analysis work package.

- Collaborative projects between the EU and SEA must have sustainable direct benefits to all participants. The benefit to researchers, institutions and society as a whole must be clearly defined and identifiable.
- All partners must understand the scientific objectives of the potential collaboration before the project design is embarked upon.
- All project partners and stakeholders should be included in the planning and design phase of the project as early as possible. Project partners must be fully engaged in the project.
- Collaborative projects should be led by experienced and knowledgeable project managers (either European or Southeast Asian) who act as 'champions' for the project.
- Projects should be well designed and both the managerial framework and decision making processes must be established in clear terms of reference. Indicative project costs should be clearly determined.
- Cultural differences and differing socio-economic needs should be given due consideration in collaborative project design.
- The project, including project partners, must be stable and sustainable. The value of continuity should be enforced in all projects.
- Full evaluation of all project outcomes must be included in the project design and mechanisms introduced to prevent any potential negative outcomes. (e.g. "Brain drain.")
- The project terms of reference should determine how the project outcomes will be allocated between partners including clarifying how intellectual property issues will be dealt.
- The participation of industry partners should be positively encouraged within projects.

Recommendations derived from the analysis of science cooperation for global challenges

We close this concluding chapter with the recommendations identified by the study on S&T cooperation in the area of global challenges (see also chapter 8).

- Successor(s) to the Framework Programme should continue to remain open to participation from ASEAN Member States. This sends an important signal that the EU remains open and committed to building relations with the ASEAN region. A sustained long-term commitment allows for a more comprehensive approach and is a unique selling point for bi-regional collaboration.
- The European Commission should also consider scope for Specific International Cooperation Actions (or similar actions) for global challenge research that permit greater integration of Southeast Asian research effort. The specific themes and aims for such actions should be co-defined by the two regions, and should build on existing regional frameworks.
- EU Member States should be encouraged to nurture bilateral research collaboration on global challenges with the ASEAN region. These play an important role in wider bi-regional cooperation.
- The European Commission and Member States should consider actions (such as bibliometric analysis or other on-line social networking tools) to ensure that current research and collaboration trends are visible to interested parties.
- The potential wider benefits of scientific research collaboration on global challenges (e.g. tangible impact on local communities) should be recognised and be coupled with an assessment of how funding and collaboration approaches (successors of the FP7) can be modified. New forms of global challenge research cooperation beyond the scope of the Framework Programme, through for example READI (the non-trade related political dialogue) or through other cross-Directorate mechanisms (e.g. innovation platforms), that permit a multidisciplinary 'systems approach' to problem solving are needed.
- A proportion of bi-regional research effort should aim to deliver tangible impacts for managing global challenges and help towards effecting practical outcomes. This may require more flexibility in the design and approach to specific projects and should take account of policy and local contexts.
- A diverse range of links to local stakeholders or local networks should be encouraged, and include non-scientists, citizens and civil society groups. These could be engaged through, for example, advisory boards which may also help inform the research effort. Consideration should also be given to the important role of grey literature in informing and disseminating research.
- Consideration should be given to the allocation of follow-on grants (similar to those deployed by the European Research Council) to encourage researchers to engage in high quality dissemination and knowledge transfer.
- There should be sufficient time during calls for project proposals to allow participants to identify suitable collaboration partners. There may be a role for Member State's Embassy representatives, EU Delegation representatives and National Contact Points.
- The EU should support ASEAN-COST in their continued development of multidisciplinary centres of excellence, and research platforms across the ASEAN region.
- Recognising that strong research relations can take years to mature, where appropriate, the personal interest and commitment of those involved in individuals taking part in projects should be taken into consideration. Sustained commitment and time-spent in country, in both regions should be encouraged and should feature as an integral part of projects where appropriate. This may also require additional opportunities for language training
- Harnessing diaspora more effectively for bi-regional cooperation would also help capitalise on existing resources.

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Figures and tables

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Science and technology cooperation between Southeast Asia and Europe has been steadily increasing in recent years. This trend can be attributed to the global internationalisation of S&T, but also to significant efforts between the two regions to increase cooperation levels and harness the benefits of joint research.

SEA-EU-NET, launched in 2008 and set to run until December 2012, is a European Union Seventh Framework Programme (FP7) funded project supporting these efforts and facilitating joint research. It brings together 22 partner organisations from across Europe and Southeast Asia with the goal of deepening S&T cooperation between the two regions in a strategic manner. SEA-EU-NET addresses this overall goal by identifying opportunities for S&T cooperation, creating a policy dialogue between the countries of Europe and Southeast Asia on S&T cooperation, and increasing the participation of researchers from Southeast Asia in the EC's FP7.

SEA-EU-NET is also providing the analytical input and evidence base required for the implementation of these activities. The various kinds of analyses undertaken by SEA-EU-NET are presented in this book.

The first part of the book features quantitative analyses of ASEAN countries' research strengths and S&T cooperation with Europe. The second part presents qualitative studies of ASEAN countries' S&T policies as well as opportunities, pitfalls, drivers and future scenarios of S&T cooperation between Southeast Asia and Europe. Furthermore, internationalisation priorities and patterns of ASEAN countries' S&T landscape are explored and global challenge related science cooperation analysed.

The analyses are targeted to inform decision-makers and programme-owners involved in S&T cooperation and policy development between Southeast Asia and Europe, as well as provide useful background information for the broader scientific community engaged in collaborative research and those interested more generally in Southeast Asian innovation systems and research priorities. Furthermore, the analyses offer input for the upcoming ASEAN-EU Year of Science, Technology and Innovation 2012.

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