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The International Science Programme in Sri Lanka and Thailand

Three decades of research cooperation

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Abstract
Developing capacity for research and higher education takes time, especially in resource scarce environments. Equipping laboratories, building human capacity, and establishing research cultures at teaching oriented universities are complex and slow processes. This book focuses on the long-term cooperation with chemistry and physics research groups at universities in Sri Lanka and Thailand, provided by the International Science Programme (ISP) at Uppsala University, Sweden. It traces and gathers experiences from graduated students and other collaborating partners from supported groups. It addresses questions of if, and how, capacity for research and higher education has developed over the decades of ISP support, and the possible effects, efficiency, sustainability and improvements of it.

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Cover photo: Professor Eric Karunanayake (left) together with Professor Ulf Pettersson (right) at the Biomedical Center, Uppsala University. Photo courtesy: IBMBB.

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Preface

I was given the opportunity to visit Sri Lanka and its oldest university in Colombo for the first time in the beginning of the 1980s, as the supervisor of a young physicists. Sri Lanka is a beautiful country with many friendly people. The architecture of University of Colombo resembled Stanford with long arcades, where students and staff walk between lecture halls and offices. What separated this university from other universities in the world I knew well at that time, was the lack of well-equipped laboratories and ongoing research.
It is here ISP come in, working to strengthen the capacity to carry out research and higher education, with limited resources at hand. For the uninitiated, this could be seen as a hopelessly overwhelming and demanding task, considering all necessary details of the work, and how long-term the support needs to be. Throughout the years, I had the possibility to discuss with many research colleagues and Vice Chancellors around the world regarding how well ISP have succeeded with these challenges. A central component and prerequisite for success is the ownership of the process by the supported research group, faculty and university in the collaborating country. Further, it requires engaged and enthusiastic supervisors and scientific hosts in Sweden and elsewhere. I believe that this engagement is one important explanation of why ISP's collaboration support model is so efficient. A new project starting in ISP's spirit is like a delicate plant. It needs close monitoring, nutrition, compassion, and fertilization to gain momentum. There, the support by ISP and its administration, and by the host supervisors and their research groups, are central for success.

In this report, more than three decades of ISP's collaboration with Sri Lanka and Thailand is professionally reviewed. It is mainly built on interviews with former partners and students, and discusses the experiences and outcomes of the supported projects. It is satisfying to read about positive results and experiences. It is a bit wistful that our Swedish aid has stopped supporting the training of researchers in Sri Lanka and Thailand. It would still most likely be money well spent to continue supporting research and higher education, for the future, and for a better world.

Bo Sundqvist
Former Vice Chancellor Uppsala University
Former Member of the ISP Board
Former Supervisor of Sri Lankan students in ISP supported projects

Uppsala, March 2017

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Abbreviations and Acronyms

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
CISIR	Ceylon Institute of Scientific and Industrial Research
EGAT	Electricity Generating Authority of Thailand
EU	European Union
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on Research and Development
GPI	Gender Parity Index
IAEA	International Atomic Energy Agency
IBMBB	Institute of Biochemistry, Molecular Biology and Biotechnology
IF	Impact Factor
IPICS	International Programme in the Chemical Sciences
IPPS	International Programme in the Physical Sciences
ISP	International Science Programme
ISTRD	Institute of Science and Technology Research and Development
JICA	Japan International Cooperation Agency
KSEK	Thousand Swedish Krona
Lic[1]	Licentiate degree
MPhil[2]	Master of Philosophy
MSc	Master of Science
MSEK	Million Swedish Krona
MTEC	National Metal and Material Technology Center
NARESA	Natural Resources Energy and Science Authority of Sri Lanka
NECTEC	National Electronics and Computer Technology Center
NGO	Non-Governmental Organization
NRC	National Research Council
NSD	Norwegian Centre for Research Data
NSF	National Science Foundation
NSTDA	National Science and Technology Development Agency

1 A pre-doctoral degree, including the required doctorate coursework and a dissertation equivalent to half a PhD dissertation.

2 An advanced postgraduate research degree, standing between an MSc- and PhD degree.

OAEP	Office of Atomic Energy for Peace
PhD	Doctor of Philosophy
R&D	Research and Development
SAREC	Swedish Agency for Research Cooperation
Sida	Swedish International Development Cooperation Agency
SRI	Sri Lanka
S&T	Science and Technology
THA	Thailand
ThEP	Thailand Center of Excellence in Physics
TRF	Thailand Research Fund
TTSF	Thailand Toray Science Foundation
TWAS	The World Academy of Sciences
UGC	University Grants Commission
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	United States Dollar
WHO	World Health Organization
WoS	Web of Science

Executive Summary

This book aims to gather experiences, developments and effects of the long-term support to chemistry- and physics research groups at universities in Sri Lanka and Thailand,[1] provided by the International Science Programme (ISP) at Uppsala University. It covers collaborating years 1978–2010, and includes tracer studies of former students as well as follow-up studies of involved research groups.

Tracing graduates

The tracer studies specifically focus on the experiences and whereabouts of former MPhil- and PhD students from ISP supported research groups in Sri Lanka and Thailand. The studies build on a data set of 53 former students from Sri Lanka and 17 former students from Thailand, responding to an online questionnaire. A number of which were strategically selected for in-depth interviews.

Main results indicate that both collaborations have been successful in retaining research capacity in the supported countries. A large majority of both the Sri Lankan- (87 %) and Thai (88 %) respondents are currently working in their home countries, most employed at universities as lecturers. This corresponds well to the general mobility pattern of graduates from ISP supported groups and networks, where a large majority (92 %) of the PhD students graduated between 2008–2013 have remained in their home countries and regions after graduation, employed at universities or research institutes (Andersson & Sundin, 2016).

Generally, Sri Lankan and Thai respondents are satisfied with their current employment position and believe it matches their academic qualifica-

[1] Sri Lanka: University of Colombo, University of Jaffna, University of Peradeniya, and University of Sri Jayawardenepura, supported 1978–2010.
Thailand: Chiang Mai University, Chulalongkorn University, and Prince of Songkla University, supported 1982–2007.

tions. Close to half of the Sri Lankan respondents, and one third of the Thai respondents, have been geographically mobile and worked abroad since graduation, while sectoral mobility has been low.

A majority of the respondents were trained on a sandwich basis, in general with a host university in Sweden and with degrees awarded from the home university. Most of the Thai respondents held a staff member position when starting training, while around one third of the Sri Lankan respondents were employed at the time they enrolled. The sandwich mode training is one of the main contributing factors to why many graduates have stayed in their home countries after graduation. The continued contact with the home institution throughout the training facilitated the start-up and continuation of graduates' research back home. These results confirm the positive retention effect of the sandwich model emphasized by ISP already in the late 1980s (Liminga, 1996), in a case study of ISP support to research groups in Bangladesh (Kuhn, 2012), and in the 2011 evaluation of ISP (GHD, 2011). The foreign exposure, the focus on local research problems, meeting experts in the field and getting access to advanced facilities were other positive features of the sandwich model experienced by Sri Lankan and Thai graduates.

In general, however, Thai respondents were somewhat less satisfied with the sandwich model than the Sri Lankan respondents, mainly due to the long completion time of degrees. Administrative- and teaching responsibilities at the home universities were the main reasons behind the extended time needed to complete degrees for sandwich graduates from both countries. The average completion time of PhD degrees, including all types of training, was slightly higher for Thai respondents (7 years) than for Sri Lankan graduates (6.4 years).[2]

Some of the Thai respondents would have preferred to do a full time PhD abroad, both to save time and to better be able to carry out natural science experiments. Further, local degrees awarded from the home universities in the sandwich program were, by some Thai and Sri Lankan respondents, experienced to have a relatively lower status than degrees awarded from universities abroad. Other negative features experienced with the model were too short and unfairly distributed sandwich stays abroad, and relatively low student allowances compared to the remuneration of Swedish PhD students. Insufficient monetary compensation for the supervision, both to the host supervisor

[2] To compare: the average completion time of PhD graduates from all ISP supported groups and networks 2008-2013, including both sandwich and local programs, was 4.9 years (Andersson & Sundin, 2016). The average completion time of a PhD degree in the natural sciences in Sweden has varied between 6.5 years in 1990 to 5.5 years in 2013 (SCB, 2002; SCB, 2014).

personally and to the host institution, was brought up by some of the Swedish host supervisors as a drawback of the model.

In Sri Lanka, the abroad training component in the sandwich model has worked differently between males and females, and between academic disciplines, with female and chemistry respondents having spent much shorter time abroad than male and physics respondents. However, the back and forth mode of the model together with ISP's family allowance seem to have facilitated female respondents choosing to pursue their PhD education with an abroad training component.

A great majority of the respondents from both countries are still actively conducting research to various degrees. However, finding time for research is described as difficult due to the priority given to teaching and administrative tasks at their universities. Web of Science data show that a majority of graduates have published papers after graduation, with several instances in highly ranked journals. The respondents are actively networking, both internationally and nationally. Co-publication with the former host institutions in Sweden is common.

Follow-up studies

The follow-up studies focus on ISP support to research groups in Sri Lanka and Thailand. The studies show that ISP support varies in nature, both between countries and between research groups within the same country. Hence, the support is adapted to the specific country context and to the individual needs of each respective group.

In general, Sri Lankan research groups have been more dependent on ISP funds than have the Thai research groups. ISP started support when many of the departments in Sri Lanka were very resource challenged, especially those in physics. Universities were mainly focused on teaching, PhD programs in physics were not available, and laboratories were in most cases lacking basic equipment and consumables. In all cases but one, ISP was the single, main financial contributor of the groups during the first 6–15 years of the collaboration. At this stage of development, the ISP support made a considerable difference in terms of improving the conditions for research and postgraduate training at the supported departments in Sri Lanka.

In Thailand, ISP served as the main donor to one research group, where research capacity had to be built up from scratch. In the other cases, basic capacity had already established before the start of the ISP collaboration. ISP instead served as a complementary donor to these groups and funds were used for things that were not provided from other funders, such as scientific contacts and research visits for staff and students.

In many research groups, in both Thailand and Sri Lanka, ISP funding has functioned as seed money enabling them to attract funding from other sources. All research groups have during the period of support received funding from other sources than ISP.

Positive features of the ISP support, as expressed by group leaders were the flexibility in the use of funds compared to other donors, the unique long-term and patient character of the support, and the personal relationship with ISP staff in Uppsala. Similarly, these features were also recognized to be important by group leaders, members, and students in the case study of ISP support to Bangladesh (Kuhn, 2012).

Overall, ISP support to Sri Lanka has made greater impact on the national level compared to the support provided to the Thai research groups. In Sri Lanka, universities and research was, and currently still is, less developed than in Thailand, and the relatively small amount money invested by ISP has had a larger impact regarding the number of both PhD graduations and of publications. ISP supported the initiation of the first PhD programs in physics in Sri Lanka, and the first ever Sri Lankan physics PhD student graduated from an ISP supported group. PhD graduates from supported groups in the country made up a notable share of the national number of PhD students annually graduating in the field of science during the mid/late-2000s. In Thailand, the national number of PhD graduates has increased rapidly during the past decade due to government efforts and investments. Graduates from ISP supported groups in Thailand therefore made out a very small share of the national graduation output during the collaborating years.

The pattern is similar regarding publications, where Sri Lankan ISP related authors[3] have contributed to a large number of the national annual publication output, compared to ISP related authors in Thailand. The publications of supported groups in both Sri Lanka and Thailand, all show instances of quality and high citation rates.[4]

Considering the efficiency of the ISP support in Sri Lanka and Thailand in terms of outcomes (graduations and publications) per million SEK spent over the period of support, the Sri Lankan and Thai research groups are more,

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3 ISP related authors are defined as persons listed in ISP records as having taken part of ISP support or ISP related activities in various ways and to various extents, i.e. fellows, students, graduates, staff members, or group leaders.

4 Similarly, the findings of the GHD (2011) evaluation of ISP concluded that publications coming from ISP supported groups in Ethiopia and Kenya had high or satisfactory quality and were cited above world benchmarks.

or similarly, efficient as overall ISP support. The Thai research groups also show a positive increase in efficiency of graduations and publications over the decades of support. This indicates increased capacity as well as improved conditions for PhD training in the groups gained over the years, although not solely as an effect of ISP support, because in most cases ISP only provided complementary funding to the Thai physics groups.

ISP supported groups in both Sri Lanka and Thailand have contributed to their respective societies in various ways. There are examples of group leaders and graduates being appointed to government committees, boards or working groups. Some of importance to the development of both physics- and chemistry education and research, as well as to national policy and strategy development. The university-industry collaboration stand out in Thailand, where some supported research groups actively and successfully have developed and improved technologies for industrial companies in the country. In Sri Lanka, there are examples of graduates using their knowledge to the benefit of the Sri Lankan society in terms of education of high school teachers, public awareness creating, and through consultancy services.

Overall, the continued activities of supported groups in Thailand and Sri Lanka can be considered successful. In Thailand, all research groups covered in the study have continued their activities to various degrees, and all former group leaders have successfully transferred leadership to younger colleagues. In Sri Lanka, most groups have continued. However, some groups there ended activities due to issues with replacements of retiring group leaders and due to lack of sufficient funding.

The way forward

No further ISP support is likely to be given to groups in Sri Lanka and Thailand, and the specific country contexts make it difficult to make general recommendations relevant to all countries where ISP provides support. However, based on the findings and experiences from respondents a number of possible improvements of the ISP support have been identified. ISP can consider to:

- Promote the awarding of Licentiate degrees from Swedish universities, in cases where relevant.
- Guide in potential buy-outs from teaching at the home university.
- Gather student experiences of the current allowance level in Sweden.
- Clarify the process and justification of new ISP support, and consider the sustainability of new projects.
- Take actions to improve gender equality in supported groups.

- Stress the importance of successors of retiring group leaders in supported groups.
- Improve communication and mentoring in the phase out of ISP support.
- Make better use of the competence gained in research groups after concluding support.

Part 1

Introduction

1. Introduction

The International Science Programme (ISP) at Uppsala University has supported the building and strengthening of capacity for research and higher education in chemistry and physics in Sri Lanka and Thailand for three decades. At first ISP provided fellowships to staff members at universities and national institutions, but later redirected support to institutionally based research groups.

ISP's long-term support was provided to research groups at four universities in Sri Lanka between 1978–2010; University of Colombo, University of Jaffna, University of Peradeniya, and University of Sri Jayawardenepura. In Thailand, ISP has supported research groups on a long-term basis at Chiang Mai University, Chulalongkorn University, and Prince of Songkla University from 1982 to 2007. In total, ISP support has amounted to 43.5 MSEK for Sri Lanka and 12.4 MSEK for Thailand during these periods.

The experiences, developments and effects of the ISP support according to graduated students, group leaders, and as shown by statistical data are gathered here in the form of tracer- and follow-up studies of both collaborations.

1.1 Purpose

The purpose of the tracer studies is to collect and analyze quantitative and qualitative data on mobility, career development, research outcomes and experiences of PhD-, Licentiate- and MPhil graduates of formerly ISP supported research groups in Sri Lanka and Thailand. This corresponds to a general need to follow up on the results of the ISP support, and to gain better knowledge of, and gather experiences from, ISP alumni in Sri Lanka and Thailand, and to account for their continued activities after the end of ISP support.

The purpose of the follow-up studies is to provide a historical overview of the ISP collaboration in Sri Lanka and Thailand and to analyze and assess the developments and effects of the ISP collaboration with research groups in chemistry and physics at universities in the two countries over the years of support. The evaluation covers areas of effectiveness, efficiency, impact, and sustainability, and the assessment and analysis are made in relation to the most recent goals and objectives of ISP as stated in the Strategic Plan 2013–2017 (ISP, 2013b):

1. The overall goal: *"to contribute to the strengthening of scientific research and postgraduate education within the basic sciences, and to promote its use to address development challenges."*

2. The general objective: *"to strengthen the domestic capacity of scientific research and postgraduate education, by long-term support to research groups and networks in these fields."*

3. The specific objectives:
   - *"Better planning of, and improved conditions for carrying out, scientific research and postgraduate training,*
   - *Increased production of high quality research results,*
   - *Increased use by society of research results and of graduates in development."*

1.2 Methodology

A combination of quantitative and qualitative data collecting methods has been used. Data for the tracer studies were collected through online questionnaires and semi-structured, in-depth interviews with questionnaire respondents. The tracer studies have also been complemented with the views and experiences of Swedish (and one Finnish) host supervisors, gathered via questionnaires. Data for the follow-up studies were mainly collected through interviews with former and current group leaders of supported groups, internal ISP records, as well as complementary data from the tracer studies. The Web of Science (WoS)[1] database has been used as a bibliometric source for both the tracer- and the follow-up studies.

The methodologic process of both studies was the same. The initial phase of the tracer- and follow-up studies consisted of descriptive desk studies of ISP reports. It provided the historical context of the collaborations, including both qualitative descriptions of groups and their activities and quantitative data reported over the years, such as number of graduates and publications of supported groups. Names of former students on the MPhil- and PhD level were identified through ISP records, and email addresses were obtained through contact with the former group leaders of the research groups, through the internal ISP database over visiting students and scientist, and through internet search. The online questionnaires were created using Uppsala University's internal system for web questionnaires "KURT"[2] and sent out to all traced students via email. The questionnaires included questions on personal data, questions regarding former students' participation in, and experiences of, research training and education in ISP funded research groups, mobility and career development since graduation, and on future plans. A questionnaire to host supervisors of Sri Lankan and Thai students were also developed during this initial phase, addressing their experiences of hosting sandwich students, communication challenges, other difficulties, and the development and improvement of students' capabilities. Names of host supervisors were found in ISP records.

Next, interview guidelines for the semi-structured interviews with former students and group leaders were settled. The interviews with former students intended to let the respondents deliberate and further develop the answers provided in the online questionnaire. The interviews with former and current

1 Web of Science (WoS) is a database maintained by Thomson Reuters, which covers 12,000 peer-reviewed international scientific journals.

2 KURT can be reached (in Swedish) through: https://doit.medfarm.uu.se/kurt/.

group leaders aimed to capture their experiences and views of the support provided and covered a historical and background overview, capacity building, relevance, funding, current situation, continued activities and their views of ISP as a donor. The design of the online questionnaires and the interview guides for former students are based on a previous tracer study carried out by researchers at the Nordic Africa Institute (Fellesson & Mählck, 2013).

The second phase involved field visits where semi-structured interviews with former students and group leaders were conducted. The Sri Lankan field study was carried out during a one week visit in September 2014 to University of Colombo, University of Peradeniya and University of Sri Jayewardenepura. Due to time constrains, University of Jaffna, located in the northern part of the country, was not visited. The field study of Thailand was carried out during two and a half weeks in June 2015, at Chiang Mai University, Chulalongkorn University and Prince of Songkla University. All interviews ranged from 45 minutes to 1.5 hours, all were recorded and major parts were transcribed.

The final phase involved summarizing and analyzing results, conducting additional desk studies and complementary bibliometric studies. Publication data (citations, venues of publications, impact factors, and authors) were collected through the WoS database.

1.2.1 Tracer studies

Online questionnaires and semi-structured, in-depth interviews with responding former students were the main data sources of the tracer studies. Full questionnaires and interview guidelines are found in Appendix 1 and 2. Complementary data was collected via questionnaire to host supervisors of the former students (Appendix 3), and publication data through the WoS database.

Questionnaires to former students

For Sri Lanka, an online questionnaire consisting of 62 questions was sent by email in May 2014 to 127 traced former MPhil and PhD students part of the ISP-Sri Lanka collaboration. In all, 53 responded (Table 1.1). The traced students received their research training through ISP supported research groups in chemistry and physics at four different universities in Sri Lanka; University of Colombo, University of Jaffna, University of Peradeniya and University of Sri Jayewardenepura. The questionnaire data were analyzed using the statistical software Stata. Cross tabulations were carried out together with Fisher's exacts test to determine whether there were significance differences between gender, discipline of science, as well as level of degree in relevant areas. The online questionnaire was followed up by semi-structured in-depth interviews during the field visit to Sri Lanka targeting 17 strategically selected respondents to the questionnaire. One interview was conducted via Skype shortly after the return to Sweden, making it in total 18 interviews.

For Thailand, an online questionnaire consisting of 74 questions was sent out via email in April 2015 to 23 traced former students, out of which 17 responded (Table 1.1). Questionnaire data were analyzed using Microsoft Excel. No comparisons between gender, discipline of science or level of degree was carried out, because of the homogeneity of respondents. In-depth, semi-structured interviews with 11 questionnaire respondents followed during the field visit to Thailand. Respondents were part of supported research groups at Chiang Mai University, Chulalongkorn University and Prince of Songkla University.

Table 1.1 Number of identified, traced, responding and interviewed former students.

	Identified	Traced and emailed	Answered questionnaire	Interviewed
Sri Lanka	170	127	53	18
Thailand	33	23	17	11

In both studies the interviewees were selected to obtain an as broad representation as possible with regard to university of graduation, discipline of science and gender. The interviews took place after the online questionnaire was closed and the preliminary results had been summarized.

Questionnaires to former host supervisors

For Sri Lanka 57 host supervisors were identified, out of which 26 were traced with email addresses. The questionnaire, consisting of eight qualitative questions was sent out via email to the traced supervisors in March 2014. The response rate was 62 % (16 out of 26 supervisors). Two of the respondents preferred to answer the questions through a face to face interview, conducted in April 2014, and one respondent answered the questions over the phone in June the same year.

For Thailand, the online questionnaire consisting of 18 questions was sent out to host supervisors in Sweden in May 2015. In total, 40 host supervisors were identified out of which 11 were traced with email addresses. Five supervisors answered the questionnaire.

Bibliometric data

In order to examine scientific productivity of responding graduates of the tracer studies, their scientific papers (refined to journal articles and full conference papers) in the WoS database were traced and analyzed. The search was based on respondents' full names. When the relevant articles had been identified, duplicates were removed and the year of funding, number of quotations, association of co-authors, journal name, and journal impact factors were noted. The data collected from this search was analyzed with help of Endnote and Microsoft Excel.

The quality of the journals was also considered using the Norwegian register for scientifically approved journals, series and publishers, provided by the Norwegian Center for Research Data (NSD).[3] The Norwegian register rating stretches from 0–2, where journals ranked with 0 are not classified as scientific publication venues, 1 are scientific publication venues and 2 stands for extra prestigious scientific journals (NSD, 2017). Journals of publication have also been checked against Beall's "blacklist" of publication venues, listing questionable and possible predatory open access journals.[4]

1.2.2 Follow-up studies

The follow-up studies focuses on ISP support to, and the achievements of, research groups in Sri Lanka and Thailand, and is mainly based on interviews with former and current group leaders of supported groups.

In-depth, semi-structured interviews were carried out in September 2014, with seven out of 15 identified current and former group leaders of supported groups in Sri Lanka (Table 1.2). A follow-up seminar for group leaders was held in Colombo, Sri Lanka at the end of the field visit week, attended by eleven group leaders. At the seminar, group leaders' experiences of the collaboration were presented, followed by a group discussion on possible improvements of the ISP support. Due to time constrains leaders of two research groups in chemistry were not interviewed, but did attend the seminar where they shared their experiences and thoughts. In Thailand, interviews with eight out of eight identified former and current group leaders (one skype interview) were carried out (Table 1.2). Full interview guidelines are found in Appendix 4.

3 Available at: https://dbh.nsd.uib.no/publiseringskanaler/Forside.

4 Available at: http://scholarlyoa.com/individual-journals/.

Table 1.2 Number of current and former group leaders identified, interviewed and attending seminar.

	Identified	Interviewed	Attended Seminar
Sri Lanka	15	7	11
Thailand	8	8	–*

* No group leader seminar was arranged in Thailand.

Bibliometric data

A bibliometric study in WoS was also carried out as a base for the follow-up studies, to gather, analyze and assess publication data of ISP related authors in relation to the publication activity at the respective departments, universities, and the national publication output. The database search focused on each university and department where research groups received support. The search was refined to only include journal articles and full conference papers, and covered longitudinal data including years before, during and after the ISP support. Each university and related department was searched separately, and the number of annual publications was noted. Publications from departments were reviewed to record number published articles by authors with ISP relation. ISP related authors are defined as persons listed in ISP records as having taken part of ISP support or ISP related activities in various ways and to various extents, i.e. fellows, students, graduates, staff members or group leaders. Results were analyzed by WoS own analysis- and citation report tools, as well as by using Microsoft Excel.

Even though the number of publications is a straight forward basic measure of productivity, it only measures the quantity and not the quality of the published articles. Citation counts are one measure of the latter, indicating the impact and influence of research papers. A citation count in WoS was carried out for each supported department in both the Sri Lanka and Thailand collaboration, later compared to the average citation for each field. The WoS database search also considered the quality of publication venues of the articles coming from each supported department, using the same ranking system as described in the tracer study-method above.

1.3 Limitations

The fact that the ISP collaboration with Sri Lanka and Thailand started a long time ago has posed some challenges. To find updated contact information, and to get in contact with graduates, group members and host supervisors have implied some difficulties. The limited time available in the field has also impaired the possibility to meet with all group leaders of supported groups. Furthermore, in two cases group leaders have either moved or passed away, therefore their experiences could not be covered.

It is important to emphasize that the tracer studies only reflects the experiences and activities of *respondents* to the online questionnaires and interviews, and that little is known about the identified and traced graduates that did not respond. A limitation specific to the Thailand collaboration is that the low number of identified and responding female and chemistry students of the tracer study has precluded any comparison between gender and field of study.

The studies have been carried out by social scientists, meaning that they do not include any scientific quality evaluation of the natural science research conducted in the groups. The studies do however include social science methods, through which the research groups, their activities and achievements have be assessed and analyzed.

Finally, it is important to state that it is hard to evaluate what would have happened in the absence of ISP support and to what degree outcomes can be attributed to the relatively small scale, however long-term, support that ISP has provided. Still, the accounts of the responding students and interviewed group leaders, together with the extensive desk studies, hopefully provide an adequate representation of the effects and impact of ISP's long-term collaboration in these countries.

1.4 Background

This section includes a brief overview of the development of research and higher education in Asia in general, and in Sri Lanka and Thailand in particular. In addition, it includes an overview of ISP and its developments.

1.4.1 Research and higher education in Asia

Over the past 20 years, higher education has been rapidly expanding in most parts of Asia. The UNESCO Institute for Statistics (UIS, 2014) and the Asian Development Bank (ADB, 2011) describe this as a success story in terms of the increase in opportunities to access higher education in the region. Today, Asia accounts for close to 50 % of the higher education enrolment in the world (UIS, 2014).

As a result of the increased undergraduate enrolment, the higher education systems in Asian countries have been "expanding out" in terms of building new universities, recruiting more instructional staff, and improving access. The expansion has also created a need for the higher education system to "expanding up" in terms of providing postgraduate training that meets the need of more and better qualified instructors. Today, most middle-income countries in Asia provide postgraduate education (UIS, 2014).

Many countries in Southeast and East Asia have moved from the so called "elite systems" of higher education where below 15 % of the relevant age group are enrolled, to the "massification stage" with a gross enrolment rate between 15 and 50 % (UIS, 2014). This massification of higher education has not come without challenges. The rapid expansion of student numbers has left universities without adequate financial resources to manage and absorb the growing student population, and has put an increased pressure on the governance and administrative systems. Maintaining the quality in times of financial constrains is one of the major challenges for Asia's higher education systems. Other challenges are improving the relevance of the curricula and instruction practices, increasing and better using the available financial recourses, and balancing the expansion of access to higher education with greater attention to equity and quality (ADB, 2011).

Governments in Asia have adopted similar strategies to cope with these challenges. One strategy is the privatization of the public higher education system, where public universities apply fee-based courses (ADB, 2011). Another strategy is to provide distance education. In Asia, more than 70 universities are providing distance education, which allows more students to access education at a lower cost (UIS, 2014). The most widely used strategy has been governments allowing and encouraging private higher education options as a way to expand and to improve access to higher education without putting constrains on the public funds. Private higher education institutions make up the fastest growing sector in the world. However, the share of private education enrolment varies widely across Asia. Traditionally it has been the dominant type of education in for example Japan, the Philippines and the Republic of Korea, all with a student enrolment rate in private colleges and universities at over 70 %, while only 1 % is enrolled in private institutions in, for example, Afghanistan (Altbach *et al.*, 2009; UIS, 2014).

While privatization is viewed as one of the solutions to increasing access to higher education, Shin & Harman (2009) points to the possible questionable quality. The privatization of higher education also tends to work against equity. The freedom of private higher education institutions to set their own tuition fees often result in these options being out of reach for students with less financial resources (ADB, 2011).

Women and higher education and research in Asia

Female enrolment rates in tertiary education vary widely in Asia. On one side, there is a group of countries including Bangladesh, Bhutan, Cambodia and Tajikistan having a Gender Parity Index (GPI)[5] below 1, indicating that fewer women than men are enrolled in tertiary education. On the other side, there is a group of countries in the region with far higher female than male enrolment rate. In the top of these countries we find Sri Lanka with a GPI of 1.8, followed by Brunei Darussalam (1.69), Mongolia (1.49), and Kazakhstan (1.44). Thailand also belongs to this group with a GDP of 1.31 (ESCAP, 2013).

Aggregated numbers for Asia show fewer females higher up on the academic ladder. In the region, 47 % of the students enrolled in Bachelor programs are females, compared to the 37 % females in doctoral programs (UIS, 2014). When looking at the headcount of fulltime equivalents of researchers employed in the Research and Development (R&D) sector, where postgraduate students are included, the share of females in the region falls to 18 %. This is the lowest percentage of female researcher of all regions in the world

5 GPI is defined by the United Nations as the "(…) ratio of the number of female students enrolled at primary, secondary and tertiary levels of education to the number of male students in each level. (…) A GPI of 1 indicates parity between the sexes; a GPI that varies between 0 and 1 typically means a disparity in favor of males; whereas a GPI greater than 1 indicates a disparity in favor of females" (UN, 2016).

(ESCAP, 2013).[6] However, several countries, such as Armenia, Azerbaijan, Georgia, Kazakhstan, Mongolia, Philippines, and Thailand have reached or are close to reaching gender parity, meaning that half of the research force employed in R&D is female. The percentage in the region is affected by the fact that the most successful countries in terms of highest number of full time equivalent researchers also has the lowest female representation; Japan and Republic of Korea are two of them, with 17 % and 14 % female researchers, respectively (ESCAP, 2013).

Mobility

Mobility in relation to tertiary education is something that is increasing worldwide. The Asia and Pacific region has had the most significant growth of student mobility of all regions in the world. It is estimated by the UNESCO Institute of Statistics (UIS) that in 2011, 60,000 students from East and South Asia were going abroad for a doctoral degree. In some countries the share of students going overseas for doctoral degree studies is higher than the share of students domestically trained. In 2011, this was the case for Brunei Darussalam and Nepal (UIS, 2014).

Consequently, one of the major challenges facing countries in South Asia is to keep researchers in their home countries. Besides the fact that highly skilled people are leaving to go abroad it also means that the benefits from the generously subsidized education in many south Asian countries in practice go to the countries receiving those students (UNESCO, 2010). However, there has also been a large increase in the inflow of students to Asia. The number of international students coming to East and South Asia to get a higher degree has doubled between 2005 and 2011, to 492,000 students (UIS, 2014). Graduate level students are estimated to be one quarter to one third of the total number of students coming to Asia from abroad. The expansion of graduate programs has most likely contributed to an increased quality of higher education, with more highly educated academic staff members with masters and doctoral degrees (UIS, 2014).

Research & Development in Asia

There are large differences in the government funding spent on R&D in the region. Some countries in Asia are among the top countries in the world in terms of expenditure on R&D as a share of GDP, while in some countries expenditure remains low. Sri Lanka and Thailand belongs to the latter group of

6 42.5 % female researchers are employed in the R&D sector in Latin America and the Caribbean, 39.2 % in the Pacific, 34.5 % in Africa and 34.0 % in Europe (ESCAP, 2013).

countries spending between 0.1–0.2 % of GDP on R&D, together with Azerbaijan, Indonesia, Kazakhstan, Kyrgyzstan, Mongolia, the Philippines, and Tajikistan. This low expenditure is lagging behind the target of 1 % of GDP set by many countries (ESCAP, 2013).[7]

Almost 30 % of all scientific researchers in the world are located in Asia. Many of the Southeast Asian countries, are working towards becoming knowledge based economies (Yousapronpaiboon, 2014), and their research is becoming more significant than ever. The leading nations in the ASEAN (Association of Southeast Asian Nations) region when it comes to number of researchers are New Zealand with 7,084 researchers per million inhabitants, Singapore (6,088), Republic of Korea (5,481), Japan (5,180), and Australia (4,231). Thailand is behind these nations with 311 researchers per million inhabitants, however with fast growing numbers. Lower numbers are found in Cambodia with 17, Philippines with 81, and Indonesia with 162 researchers per million inhabitants (UNESCO, 2010). Sri Lanka has approximately 103 researchers per million inhabitants (NSF, 2013).

Scientific output in terms of publications in international journals, however, still remains low in the region. Countries in South Asia contribute with only 2.7 % of the international publications found in WoS (UNESCO, 2010).

1.4.2 Research and higher education in Sri Lanka

Higher education in Sri Lanka has its roots in the ancient Buddhist monks training centers called Pirivenas. The modern higher education in Sri Lanka started with the establishment of the Ceylon Medical School in 1870, followed by Colombo Law College (1875), School of Agriculture (1884), the Government Technical College (1893) and the Ceylon University College (1921). Sri Lanka's first university, University of Ceylon, was established in 1942 (MHE, 2014).

By the late 1980s, eight universities and one University College had been established in Sri Lanka, together training more than 18,000 undergraduate and 2,000 postgraduate and certificate students (Savada & Ross, 1990). Over the past ten to fifteen years, the main policy priority of the government has been to expand the access to university education through creating new regional universities, at least one in each province (WB, 2009). There are currently 15 public universities in Sri Lanka under the responsibility of the Ministry of Higher Education. The University Grants Commission (UGC) organizes 16

7 There are five countries in Asia among the world's top 25 countries that spend the greatest share of their GDP on R&D: Republic of Korea (3.7 %), Japan (3.4 %), Singapore (2.4 %), and China (1.7 %) (ESCAP, 2013).

additional postgraduate institutions affiliated to the universities, eight other degree-awarding institutions, and the Open University. In addition to this there are two other universities under the responsibility of the Ministry of Defense and the Ministry of Vocational Technology, respectively (UNESCO, 2013).

As for many countries in Asia, Sri Lanka has experienced a substantial increase in enrolment rates during the past two decades. The higher education gross enrolment rate for the country has increased from below 10 % in 1990 to more than 21 % in 2007. The increase is attributed to both higher demand and to higher supply. The number of students coming from secondary education has increased, just like the ability and willingness of people to pay for higher education. On the supply side, the number and capacity of higher education institutions, both public and private, has grown substantially over time (WB, 2009). Historically, universities functioned as elite institutions, because exams were only conducted in English (Savada & Ross, 1990). In the mid-1960s, examination languages expanded to Sinhala and Tamil, which opened up higher education to a larger share of the population (ADB, 2016).

Access to higher education in Sri Lanka, however, still remains a challenge according to the World Bank (2009) and the Asian Development Bank (2016). Public universities are extremely competitive and open only to a minority of eligible secondary education graduates, due to the limited number of places available. The absorbing capacity of public universities 2007–2011 are estimated by the ADB (2016) to be about 16.2 % of the students qualified to enter university. Admission is based on merit and district criteria, the latter being a quite controversial policy established to create a positive discrimination to benefit students from poorer regions (ADB, 2016). Many students failing to get admitted to conventional degree programs try for external degree programs, i.e. distance education. These programs are established to provide broader access to higher education at a lower cost than what is possible through conventional degree programs. More than half of Sri Lanka's student population is enrolled in these programs, which indicated improved access but face challenges in form of poor academic standards, absence of academic support, and lack of organizational- and financial support (ADB, 2016; WB, 2009).

The limited intake at public universities in combination with the growing number of secondary graduates has led to the relatively recent (1990) development and expansion of private sector higher education institutions in Sri Lanka. This private sector consists of both degree awarding institutions and providers of alternative higher education qualifications such as professional certificates and diplomas. Most of the degree awarding institutions offers degrees through affiliation to foreign universities based in countries like

Australia, China, Malaysia, Singapore, the United Kingdom, and the United States. Around 15 % of the total number of Sri Lankan students are enrolled in private sector higher education institutions (WB, 2009).

Even though the expansion of higher education has provided increased access opportunities in the past decade, it is not equally available to all. For example, education in Sri Lanka is provided free of charge up to the undergraduate level, but the students enrolled are mainly from the highest economic classes in the country (Altbach *et al.*, 2009). Further, private institutions, professional institutes not located under the UGC, and foreign universities are all fee-based and hence favoring the high-income segment of the population (ADB, 2016).

Women in higher education and research

The UGC estimates that in 2012, 60 % of the enrolled undergraduate students were female. Factors believed to contribute to this high share of women in education include the fact that voting rights were granted to both men and women when introduced in 1931, to the provision of free primary, secondary, and tertiary education since 1945, and to the fact that 97 % of state schools are coeducational, i.e. mixed gendered (UNESCO, 2013; ADB, 2008).

Women outnumber men in many programs on the undergraduate level in Sri Lanka. Only in engineering and architecture degree programs, and in computer science and IT programs, male students are in majority. However, when moving up to the postgraduate level (Postgraduate Diploma, Masters, MPhil or PhD), the picture is different with more men than women enrolled in all programs except education, law, and indigenous medicine (UGC, 2013). Looking at fulltime equivalents researchers employed within the R&D sector in the country, 40 % were female in 2013 (ESCAP, 2013).

Mobility

Similarly to the general trend in Asia, many under- and postgraduate students in Sri Lanka are leaving the country to study abroad. In 2011, the top five destinations for Sri Lankan degree-seeking students were United Kingdom, Australia, United States, Malaysia, and India. At the undergraduate level most student pay for their own education, while at the postgraduate level students are normally funded by fellowships, scholarships, or research- and teaching assistantships abroad (UIS, 2014; WB, 2009).

There has been a substantial decrease in the total number of economically active scientists in Sri Lanka, from 13,286 in 1996 to 7,907 in 2006 (Anas & Wickremasinghe, 2010). The main reason for this decrease is believed to be an outflow of scientist from Sri Lanka to other countries. This migration of scientist could play a part in the difficulties Sri Lanka has faced in transitioning to a knowledge-based economy, since highly skilled and intellectual human capital is key in this transition. The National Science Foundation of Sri Lanka (NSF) reported a high outflow of engineers, as well as scientist in disciplines such as chemistry, agriculture and microbiology, biotechnology, and molecular biology. Anas & Wickremasinghe (2010) point to that scientists in chemistry are essential for the R&D activities of most industries and that the other disciplines mentioned are emerging fields in industrial development. Losing individuals specialized in those disciplines could negatively affect the R&D activities in several industrial sectors in Sri Lanka.

Research & Development in Sri Lanka

For many years, Sri Lanka was recognized as a provider of some of the best higher education in the region. The long period of civil war, however, has impaired the achievements, and expenditures on higher education and R&D could not be sustained (UNESCO, 2010). Sri Lanka's gross expenditure on research and development (GERD) has varied between 0.40 and 0.11 % of GDP over the past 40 years, with a negative development. The highest rates of GERD were in the 1960s and 1970s and the lowest one in 2008. In 2010, it was estimated to be 0.16 % of GDP (NSF, 2013).

The spending on R&D is correlated to the number of researchers in the country. According to the World Bank (2009), postgraduate studies are still underdeveloped in the country, and concentrated to only a few universities. In 2007, 61 % of all postgraduates were enrolled at two universities. In many Sri Lankan universities postgraduate students make up less than 5 % of the total enrolments. The small number of students continuing to postgraduate studies poses a real challenge for Sri Lanka in terms of preparing new generations of academics, researchers, and highly qualified individuals to fuel the knowledge economy (WB, 2009).

In 2010, the number of scientific researchers in Sri Lanka (full time equivalents) was estimated to be 2,140, corresponding to 103 researchers per million inhabitants (NSF, 2013).[8] In comparison, Iran had 1,491 and Pakistan 162 researchers per million inhabitants in 2009/2010. These numbers are low compared to countries like US and South Korea, in the same years with 6,253 and 5,481 researchers per million inhabitants, respectively (NSF, 2013).

8 It is worth noting that not all people employed in R&D hold a PhD degree. Of the 5,162 full- and part-time researchers involved in R&D in the country, 1,344 hold a PhD degree according to the Sri Lankan National Science Foundation (NSF, 2010).

The Sri Lankan government emphasizes the lack of human capital in the science and technology sector in its development policy framework "*Mahinda Chintana – Vision for the future*" (MFP, 2010). It is recognized that there is a need for increasing the intellectual and human capital in Sri Lanka in the transition to a knowledge economy, and to be competitive globally. Strategies include training more human resources in high-tech areas, as well as to attract senior researchers to the country through incentive schemes to reverse brain drain.

Scientific output

WoS data show an increasing number of indexed publications coming from Sri Lanka. Sri Lankan scientists published 126 papers in indexed journals in 1987, and 400 in 2010 (UNESCO, 2010). This is more than in most countries in Sub Saharan Africa, and it puts Sri Lanka among the top 20 in Asia and the Pacific. However, Sri Lanka has far to go to reach the level of the more developed countries in the region, with 3,000 to 36,000 annual indexed publications. Bangladesh, Indonesia, the Philippines, and Vietnam all have a higher annual publication rates than Sri Lanka; between 650–875 publications per year (UNESCO, 2010).

According to the National Research Council (NRC), Sri Lanka has established several incentive programs to encourage research and publishing. In 2001, the program of the President's Awards for Scientific Publications was started to honor Sri Lankan scientists whose work reached international standards and to increase national scientific production (NRC, 2011).

1.4.3 Research and higher education in Thailand

Substantial efforts from the Thai government in the past two decades have contributed to a large increase in tertiary education availability and a growing number of students. The number of public and private universities has expanded significantly. Only between 2003 and 2008 the number of tertiary institutions increased from 120 to 166 (UNDP, 2014), and in 2012 Thailand had 170 public and private universities (WENR, 2015). The leading institutions are Mahidol University ranked as the 40th best university in Asia, Chulalongkorn University ranked 48th, followed by Chiang Mai University (92), Thammasat University (134), and Prince of Songkla University (142) (QS, 2015).

Thailand is aiming to transform into a knowledge-based economy, and higher education has become a business (Yousapronpaiboon, 2014). Almost half of the universities are under private ownership. Out of the 170 existing universities in 2012, 79 were public universities, 71 were private and 20 were community colleges (WENR, 2015). In 2009, the Thailand Ministry of Education estimated that 11 % of all tertiary education students were studying at private universities (WENR, 2015). According to WENR, the involvement of foreign universities in Thailand is low compared to the surrounding countries. Every foreign university wanting to establish itself in Thailand has to enter into a partnership with a local Thai owned education institution where at least 51 % of the ownership must be Thai. A report from the British Council identified 128 such collaborative degree programs with international partners in 2011. This is a relatively low number compared to other countries in the region, and far fewer than largest transnational education (TNE) hosts Malaysia and Singapore. The top five TNE partner countries to Thailand in 2011 were China, USA, Germany, Australia and Canada (WENR, 2015).

In 2009, 56 % of Thai high school students choose to continue to tertiary education, which is a higher tertiary enrolment ratio than in any other ASEAN country, besides Singapore (UIS, 2014). The high and increasing tertiary enrolment rates show that the efforts of the Thai government to increase availability of the tertiary education have been successful. However, the quality of Thai education is still a concern. In the general rating of the quality of education systems in the World Competitiveness Report, Thailand was ranked lowest in the ASEAN community (UIS, 2014), and the Thailand Development and Research Institute (TDRI) expressed concerns about education quality, accountability of teachers, school directors, and administrators (UIS, 2014). In 2014, there were no Thai universities listed among the top 500 universities in the world on the Shanghai Jiao Tong list (2014). The concentration of leading universities in urban areas, particularly in Bangkok is another problem that the Thai government has been addressing through the creation of science centers in remote areas (MOST, 2011). In 2015, Thailand became a part of the Asian Economic Community (AEC), which opens up opportunities for internationalization of, among many other fields, education (Yousapronpaiboon, 2014). This also puts higher pressure on increased quality and competitiveness of Thai tertiary education.

Women in higher education and research

Thailand has a GPI above 1, indicating that more women than men are enrolled in higher education. The ratio of female to males also increases with level of education; female to male enrolment at primary education is 97, at secondary level it is 106, while at tertiary education level it is 131 female to 100 male students. In addition, 51.2 % of the researchers employed within the R&D sector in Thailand were female in 2013 (ESCAP, 2013).

Educational, social, political, and professional opportunities in Thailand have significantly improved during the last decades. Praparpun (2009), however, argues that women still face significant gender bias due to a culture that traditionally has treated women unequally. Females have historically had fewer opportunities to access education than males, because of the social pressure to get married at a young age. Literacy has therefore not been considered as important for females as for males. Buddhist monks, who were not allowed to be near females, provided the public education in the past. Year 2000 was the first year when the percentage of female students enrolled at Thai universities exceeded the percentage of males. However, several areas are still predominantly male, such as veterinary science, engineering and law (Vichit-Vadakan *et al.*, 2006).

Mobility

As the overall trend in Asia, student mobility in Thailand is growing. Between 2008 and 2010 the number of students abroad increased from 24,272 to 26,233. The top three destinations in 2010 were the US, the UK, Australia, Japan and Malaysia (UIS, 2012). In terms of funding, a great majority of students are self-funded (more than 70 %), while other students receive scholarships from Thai and international organizations. The most popular field of study for international students is business. Thailand hosted 19,052 foreign students in 2010, which was a large increase from 2009 when 16,361 foreign students studied in Thailand (UIS, 2012). Data from the former Ministry of University Affairs show that the top source-countries were China, Myanmar and Laos (WENR, 2015).

Research & Development in Thailand

Currently Thailand's spending on R&D is low (ESCAP, 2013). However, both households and government have made substantial investment in education and in the past decades, and the country is aiming at reaching an investment of 1 % of GDP on R&D (UIS, 2014). The Thai government has an ambition to form a strong and competent working force, which will attract investors from abroad, as well as strengthen domestic innovation in S&T and be able to serve as a Southeastern Center of Excellence. The Ministry of Science and Technology (MOST, 2011) stated in their research- and innovation document that:

> *"The country can no longer rely on its status as a cheap manufacturing base for exports; instead it must leverage its human capacity to become a center for higher value-added production, complete with a strong intellectual property pipeline."*

The role of education and research is shared between universities, research centers, and upcoming science parks. In 2011, the Thai Higher Education Commission identified nine academic institutions[9] to be upgraded to national research universities with a goal to improve the national research standard and output, and to promote international collaboration (WENR, 2015). These universities received between 3–15 million USD annually to further develop their R&D capacities (MOST, 2011).

There is strong focus on commercialization of research discoveries, both at universities and at industrial research clusters. The Thai public universities receive up to 40 % of their funding from the government. However, these funds cannot cover their needs, and therefore the universities are forced to look for additional funding such as scholarships, revenues from patents, and contributions offered by the private sector. Interaction and collaboration with the private sector is strongly encouraged, and the World Bank has estimated that 30 % of the food industry and 20 % of the car industry use public facilities, out of which some are university facilities, for their research activities. On average 45 % of all investments in R&D are public, while 55 % come from the private sector (MOST, 2011).

The Thai government is strongly encouraging foreign investment in research-based production in Thailand. Among incentives are corporate income-tax deduction for R&D spending, low interest loans, advisory and infrastructure support, coverage of business consulting, workshops, exhibitions, and grants. Several foreign companies are now coming to Thailand not only for manufacturing, but also for research. Among the largest investors are Japan and USA (MOST, 2011).

Scientific output

In the last two decades, the number of English language scientific papers by Thai authors in Web of Science journals has increased from 885 in 1998 to 4,134 in 2008. The number of patents has shown a 12 % increase between 2000 and 2007. A majority (57 %) of the published papers are written in collaboration with foreign co-authors. The most common countries of origin of co-authors are the US, Japan, and the UK (UNESCO, 2010). Overall, Thai papers published between 1999 and 2009 had on average 7.02 citations per paper. In the region, Australia (11.6), New Zealand (10.4), Papua New Guinea (9.88), and

9 Chulalongkorn University, Kasetsart University, Chiang Mai University, Khon Kaen University, Thammasat University, Mahidol University, the Prince of Songkla University, Suranaree University of Technology and the King Mongkut's University of Technology Thonburi.

Singapore (8.49) had the most, while Fiji (4.7), and Malaysia (4.4) had the least (UNESCO, 2010).

Although science and technology education and research is developing due to strong efforts by the government, Thailand is still lagging behind other nations in the region. The Ministry of Science and Technology has estimated that 30 % of graduates are from the fields of science, which is a far lower share compared to countries in the region, such as South Korea (70 %) (MOST, 2011). The share of publications in the field of chemistry was 11.9 %, in physics 5.9 %, while mathematics made out less than 2 % of all Thai publications in 2008 (UIS, 2014).

1.4.4 ISP over time

ISP started in 1961 at Uppsala University, Sweden under the name the International Seminar in Physics. In 1970, the International Seminar in Chemistry was established, based on the positive experiences of the Physics Seminar. A Mathematical Program was added in 2002. ISP assists lower-income countries to build and strengthen their domestic research capacity and postgraduate education in chemistry, mathematics and physics. ISP enters into long-term collaboration with institutionally based research groups and regional scientific networks in Africa, Asia and Latin America.

From fellowship program to research groups

In the beginning (1960s–1980s), ISP functioned as a pure fellowship program, providing fellowships to staff members from universities and research institutes in developing countries for research training at Uppsala University. There was a vision among the ISP initiators that the fellowship participants would return to their home countries and start research projects, however the means and experience to concretize the vision was missing at the time.

The fellowships were announced through Swedish Embassies in selected cooperation countries, who in turn notified institutions and universities. Selected applicants received a stipend and were invited to come to Uppsala for a standardized ten-month period of research training, typically when due for sabbatical leave. Each participant joined a Swedish research group and was trained under the guidance of a senior scientist. When the fellows returned home, the problem was actualized of how they would use the new knowledge obtained during training in Uppsala. The answer was to continue the support to the fellow also after returning home. The so called follow-up support was therefore introduced in 1967, consisting of a grant to be used to buy equipment, chemicals or to fund visiting scientists aiming to facilitate the continuation of research in the home country (Liminga, 1996; Lindqvist, 2001).

Another important policy change taking place in 1983/84, was to also accept students in the program. Sandwich postgraduate training was implemented with part of the degree work carried out at the home institution and part at the host institution abroad (Liminga, 1996). Both the sandwich program and the follow-up support was part of an action plan presented by ISP already in 1967 on how to develop into a capacity building program. The idea with the action plan was to strengthen the research capacity in cooperation countries through long-term collaboration between research groups in the same field, with staff members and students taking turns going back and forth between the host- and the home institution for research training, together with support to improve the local research environments (Lindqvist, 2001). It would take until the late 1980s to fully implement the action plan, and develop into supporting institutionally based research groups, and not individual fellows (Liminga, 1996; Lindqvist, 2001; Sundin, 2011).

Selection of collaborating partners

When support was redirected to research groups, ISP replaced the open call announcements through Swedish Embassies with an "application by invitation" system. Each project applying for support needed to have an identified group leader responsible for the application of funds and the activities of the project. This marked a period of change in the management of ISP's activities as the grant came under full control and disposal of the applying group leader in the collaborating country. This new mode of operation transferred more responsibility to the groups in terms of planning activities and handling funds, led to better and more advanced planning of activities in each project, and a more efficient use of funds (Liminga, 1996; Sundin, 2013).

Still today, ISP applies application by invitation where research group leaders and network coordinators are invited to apply for funding from ISP. During the transition period from the fellowship program, many of the previously participating chemistry and physics fellows were invited to apply for grants. In later years, the selection of new groups and networks was carried out through a scouting process, where ISP Program Directors invited qualified and competent scientists met during travel and conferences to apply for grants. This process was criticized by ISP largest donor the Swedish International Development Cooperation Agency (Sida) and in the evaluation of ISP in 2011 (GHD, 2011), for not being sufficiently transparent and open. ISP still applies the application by invitation process, however with some developments. When new research groups are to be identified, ISP aims to organize meetings at targeted institutions, and to invite research groups to apply for funding in competition. This process has been implemented in some, but not all, cases.

New groups and networks are invited to apply for 1–3 year grants, and existing groups and networks to renew their application every three years. Due to the long-term engagement, new support possibilities open up rather scarcely, and usually not every year. The applications sent in to ISP are, since the early 2000s, evaluated by a scientific reference group for each program, consisting of scientists in relevant scientific fields from the South and the North. Before the introduction of reference groups, applications were reviewed by the ISP Program Directors, sometimes in consultation with other scientific expertise. The allocations proposed by the Program Directors, following evaluation by the reference groups, are ultimately decided upon by the ISP board.

Collaborating countries

The initial scope of countries at the start of ISP was quite wide but was soon restricted to a limited number of countries with priority given to developing countries. From 1973 the support was mainly directed to least developed countries and primarily so called program countries selected by Sida. Following a policy adopted by the Swedish government in 2007, ISP support was decided by Sida to be permitted in twelve focus countries, namely: Bangladesh, Bolivia, Burkina Faso, Cambodia, Ethiopia, Kenya, Mali, Mozambique, Rwanda, Tanzania, Uganda and Zambia. ISP is currently (2017) following this policy and research group support is mainly directed to these countries with some exceptions.[10]

What the funding is used for

Applying research groups and networks send a budget together with the application to ISP specifying their activities and requested usage of funds for the coming year. Depending on the individual needs of the group, the grants can be used for purchasing equipment, spares, consumables, literature, attending conferences and organizing workshops, for research work and training for both staff and students, as well as exchange visits to and from collaborating groups.

Collaboration with host universities

Since the start of the program, one of ISP's core ambitions has been to facilitate contacts between researchers in the North or the South, working in the same field. In principle, ISP cooperates with all major Swedish universities, and in several cases also with institutions outside Sweden, including in

[10] See www.isp.uu.se/countries for further information on supported countries.

the regions of the supported activities. Normally the research group in the North serves as a host group for postgraduate students and research visits from group members, with the aim of establishing a long lasting collaboration beneficial for both parts. Regional South-South collaboration is also common, especially regarding network activities.

Governance

ISP is part of Uppsala University and its operation is defined in the instruction issued by the Vice Chancellor.[11] ISP is governed by a Board consisting of members from Uppsala University, other participating universities in Sweden, representatives from low-income countries and Uppsala University student- and personnel organizations. The members of the Board are appointed by the Vice Chancellor of Uppsala University. An Executive Committee is appointed by the Board and meets at least four times a year to review ISP's financial performance, to take decisions regarding the program development, and to prepare decisions for the Board. All members of the Executive Committee come from Uppsala University.

Donors

The main funding of ISP's core activities has always been from the Swedish government, presently through Sida. The government funding has increased from 250 KSEK per annum in 1961 to an annual allocation of 20–30 MSEK during the 2000s (Lindqvist, 2001). During 1989–1996 the Norwegian Agency for Development Cooperation (NORAD) supported ISP's physics program directly. The International Centre for Theoretical Physics (ICTP), the International Foundation for Science (IFS), The World Academy of Sciences (TWAS), the International Atomic Energy Agency (IAEA) and United Nations Educational, Scientific and Cultural Organization (UNESCO) have all historically contributed to ISP's operations in various ways. Besides government support through Sida, ISP currently receives important contributions from Uppsala University and, since 2011, from Stockholm University.

11 The latest instruction can be found via: www.isp.uu.se/digitalAssets/502/c_502288-l_1-k_ufv-2016-134-instruktionisp20160322.pdf.

Part 2

ISP in Sri Lanka

2. ISP in Sri Lanka

By *Rebecca Andersson*

This section consists of a tracer- and follow-up study of ISP's collaboration with research groups in Sri Lanka, in the fields of physics and chemistry. The focus is on ISP's support between 1978 and 2010, to research groups at four universities in Sri Lanka: University of Colombo, University of Jaffna, University of Peradeniya, and University of Sri Jayawardenepura.

Current and former research group leaders and ISP staff gathered in Colombo, 2014, for a follow-up seminar on three decades of research cooperation. From the left: I.M.K Fernando, K.P.S.C. Jayaratne, R. Andersson, T.R. Ariyaratne, M. Åkerblom, P. Sundin, K. Balasubramaniam, V. Arasaratnam, E. Karunanayake, M.A. Careem, B.S.B. Karunaratne, M.A.K.L. Dissanayake, K. Premaratne, K. Tennekoon, and S. Ekanayake. Photo courtesy: Rebecca Andersson.

2.1 Supported Sri Lankan research groups

Here follows a historical overview of the supported Sri Lankan research groups, including information about the start and development of the collaboration, the fields of research, challenges faced, outcomes, and the current situation and funding. It is based on interviews with group leaders in Sri Lanka, and on data from IPICS and IPPS project catalogues.

2.1.1 Overview

ISP has collaborated with scientists and groups of scientists in Sri Lanka between 1972 and 2010. During the first 16 years of the collaboration, support was provided to individual scientists. The Sri Lankan research groups were later built up around some of these fellows. Over the years, ISP has supported fellows and research groups at six different universities and one institute in Sri Lanka; University of Colombo, University of Jaffna, University of Kelaniya, University of Peradeniya, University of Sri Jayawardenepura, University of Ruhuna, and the Ceylon Institute of Scientific and Industrial Research (CISIR)[1].

The support to these institutions has been of various character. A project at Department of Chemistry at University of Ruhuna, got pilot support between 1986 and 1988 but did not receive any further funding after this. At University of Kelaniya, a person received fellowships and travel assistance from 1975 until the beginning of the 1990s for the purpose of studying aspects of chemical education on the high school-level in Sweden and to write general chemistry books in Sinhala. Neither of these two cases are included in the study due to the fact that they only received funding for a short period of time and never evolved to research groups. The collaboration with CISIR, which was ISP's initial contact with Sri Lanka in 1972, stayed at the fellowship stage. This was due to the fact that the institute came under a new ministry in 1990, with changed policies and chief executives, which lead to the end of the collaboration in the same year.

ISP has provided long-term support to eight research groups in chemistry and four in physics at University of Colombo, University of Jaffna, University of Peradeniya and University of Sri Jayawardenepura (Table 2.1 and Table 2.2), together using 43.5 million SEK over the years. These groups and universities are in focus in the follow-up study. The support has varied in nature, because

[1] Ceylon Institute of Scientific and Industrial Research (CISIR) is today called Industrial Technology Institute (ITI), organized under the Ministry of Technology and Research.

different groups had different needs depending on the situation at the respective university and department in question.

Table 2.1 Starting year and number of supported research groups in Sri Lanka.

University	Colombo	Peradeniya	Jaffna	Sri Jayewardenepura
Starting year	1978	1981	1985	1995
Chemistry	1	5	1	1
Physics	3	1	0	0

Table 2.2 Overview of supported research groups in Sri Lanka.

University	Period	Acronym	Name of research group
University of Colombo			
Chemistry	1979–2002	SRI:02	Biochemistry, molecular biology and gene technology
Physics	1978–2010	SRI:01/1	Atmospheric physics and lightning
Physics	1981–2010	SRI:01/2	Molecular desorption mass-spectrometry
Physics	2005–2010	SRI:01/3	Strengthening of the activities of the Centre for Instrument Development (CID)
University of Peradeniya			
Chemistry	1981–1993	SRI:03/1	Isolation and structural studies of polysaccharides from plant and microbial sources
Chemistry	1981–1993	SRI:03/2	Essential oils/insect related chemistry
Chemistry	1984–1991	SRI:03/3	Mineral chemistry
Chemistry	1983–1991	SRI:03/4	Sri Lankan plants for anti-tumor agents
Chemistry	1993–2002	SRI:03	Bioactive compounds in the control of plant diseases
Physics	1983–2010	SRI:02	Condensed matter physics
University of Jaffna			
Chemistry	1985–2006	SRI:04	Biotechnology of starch and sucrose (palmyrah) based products
University of Sri Jayawardenepura			
Chemistry	1995–2009	SRI:07	Nutritional biochemistry

University of Colombo

ISP has supported one group in chemistry and three research groups in physics at University of Colombo during the period 1978 to 2010 (Table 2.2).

IPICS SRI:02 Biochemistry, molecular biology and gene technology 1979–2002

The idea of the project, to set up a laboratory in molecular biology and gene technology and train students and staff in the area was initiated in 1979 by the Head of Department of Biochemistry at the time, Professor Balasubramaniam. He had received a fellowship sponsored by ISP's Chemistry Program, and had spent one year of his sabbatical leave at the Biomedical Center at Uppsala University. His idea was met with some hesitation at both University of Colombo and Uppsala University, due to the fact that molecular biology and gene technology was considered too advanced and expensive for a developing country. It was also not clear if it fell within the scope of the ISP Chemistry Program, which promoted fundamental chemistry. In due time, both sides got convinced to pursue the project. However, because of the civil disturbances in Colombo in the early 1980s Professor Balasubramaniam left University of Colombo to take a position at University of Jaffna.[2]

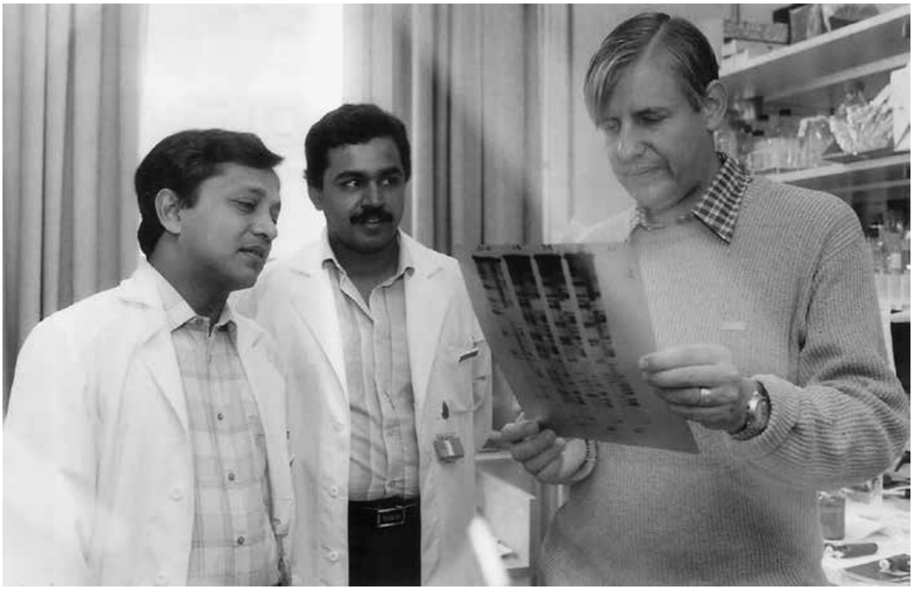
Despite the key person leaving, project discussions continued with University of Colombo and in 1984 it was settled that Professor Eric Karunanayake would take over the planning and set-up of a program in molecular biology at the department. After spending one year of research training in recombinant DNA-technology at the Biomedical Center at Uppsala University, he returned to Sri Lanka and managed to build up a well-functioning research laboratory in molecular biology and gene technology at Department of Biochemistry. This was the only laboratory of its kind in Sri Lanka in 1986, and Professor Karunanayake was one of few researchers in the country trained in this area (Karunanayake, 2005).

The first five years of the collaboration were focused on building capacity in biochemistry through the development of MSc- and PhD programs on a sandwich basis. Two junior staff members at Department of Biochemistry completed a sandwich type PhD during this period. They were the first two PhD students ever to graduate with a local degree from Department of Biochemistry, University of Colombo. After the laboratory had been established, the capacity building continued. The former one-year MSc in biochemistry was redesigned into a two-year MSc program in biochemistry, molecular biology and gene technology, starting in 1986 with 12 students. This was the only MSc program of its kind in Sri Lanka at the time.

By the end of 1987, the research group received its first three-year grant from the Swedish Agency for Research Cooperation (SAREC)[3], which secured the financial resources of the group for the coming years. A new wave of civil disturbances in the late 1980s did however delay the work and progress of the project. The Vice Chancellor of University of Colombo, late Professor Stanley Wijesundera, was tragically killed during these disturbances. As he

2 At a later time, the Chemistry Program reinitiated the contact with Professor Balasubramaniam and started collaborating with University of Jaffna.

3 During the collaboration period, SAREC was integrated as a unit under the Swedish International Development Cooperation Agency (Sida).



Professor Eric Karunanayake (left) together with Professor Ulf Pettersson (right) at the Biomedical Center, Uppsala University. Photo courtesy: IBMBB.

was a strong influential supporter of the project, it was further delayed and activities stalled.

The situation in Sri Lanka started to improve in the early 1990s and since MSc- and PhD students started to enroll, SAREC prolonged the funding of the project. The research areas were expanded further to include biomedical research and plant molecular biology in collaboration with the Tea-, Rubber- and Coconut Research Institutes of Sri Lanka. An external evaluation carried out of SAREC funded projects at universities and institutes in Sri Lanka (Sanderatne & Nilsson, 1996), considered Professor Karunanayake's project to be one of the most successful ones and recommended continued support:

> *"The small laboratory established in the Faculty of Medicine [University of Colombo] is claimed to be the best in the region and comparable to the best in the world. The contributions of the researchers at international conferences, the participation of foreign researchers at this laboratory and the recognition it has attained from WHO are proud achievements."*

The ISP Chemistry Program provided parallel support during this period and also administrated major parts of the SAREC grants through deposit of funds, purchasing of equipment and molecular biology reagents, finding host universities in Sweden for Sri Lankan students as well as administration of student stays in the host country in terms of housing and insurance. In 1996, ISP

The Institute of Biochemistry, Molecular Biology and Biotechnology (IBMBB) in Colombo. Photo courtesy: IBMBB.

started to phase out its own, relatively small, monetary support as it was no longer considered needed. The group was however provided with other types of support from ISP, and remained as a resource group until the mid-2000s, acting as a host laboratory to staff and students from other ISP supported groups in the region.

As research areas and manpower grew, the space in the current laboratory became insufficient. A proposal of building a research institute was submitted to SAREC in 1999. The building of an institute of biochemistry, molecular biology and biotechnology had been a dream and a vision of Professor Karunanayake since the inception of the collaboration. SAREC alone could not support a project of this size and therefore the Department for Infrastructure and Economic Cooperation at Sida was approached and later agreed to be a part of the project. A soft lone was granted, and in 2004 the Institute of Biochemistry, Molecular Biology and Biotechnology (IBMBB) was inaugurated. Professor Malin Åkerblom, who replaced the retired Professor Rune Liminga as Director of ISP's Chemistry Program in 1997, was the prime mover on the

Swedish side in the facilitation of the birth of IBMBB. She helped out with contacts at Sida, coordinated the necessary visits to laboratories in Sweden, and helped out in the planning and coordination of furniture- and equipment purchase. The Assistant Director to the ISP Chemistry Program, Dr Linnéa Sjöblom assisted in gathering quotations for equipment not available in Sri Lanka and facilitated procurement and transfers (IBMBB, 2014).

Hence, even though the monetary support to the research group ended in the late 1990s, ISP continued to support the group through mentoring and coordination for several years.

Objectives: The two objectives stated at the initiation phase of the collaboration were to build scientific capacity in the field by training students at the MSc- and PhD level and to establish research programs in biochemistry relevant to the development of Sri Lanka. The research of the group started with a focus on the biochemical evaluation of medicinal plants with antidiabetic properties, and studies of enzymology and drug metabolism. In the 1980s the project developed to focus on molecular biology related to tropical parasitic diseases and gene technology, including the establishment of DNA-based diagnostics techniques for the detection of genetic diseases. When the project expanded to include molecular biology and gene technology in the mid-1980s, so did the objectives. It now also aimed at developing the laboratory in molecular biology and gene technology into a center of excellence for training of personnel from other institutions in Sri Lanka, and from other countries in the region. An additional aim was holding regular workshops and seminars in Sri Lanka jointly with Swedish academics and other scientists.

Outcomes: The ISP support has over the period, 1979–2002, resulted in 10 doctoral graduations and 44 MSc- and MPhil graduations. The main collaborating host institution for staff and students has been Uppsala University, Sweden. Students have also received training at Stockholm University and at the Swedish University of Agricultural Sciences, both in Sweden, and at the Bangladesh Institute of Research & Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM), Bangladesh. During the time of ISP support, the group has published 21 papers in international journals, 9 publications in local and regional journals and made 32 conference contributions.

Funding: ISP started to support the research group in 1979, and the first grant from Sida/SAREC was approved in 1987. Compared to the latter funding, ISP's monetary contributions were relatively small in scale. In total, Sida/SAREC invested close to 26 million SEK while ISP invested 2.5 million SEK (specified in Appendix 6). ISP coordinated major parts of the Sida/SAREC contributions. Other sources of funding of the group during the collaboration period include grants from University of Colombo, IFS, NARESA and TWAS. However, year and amount is not available.

Current situation: The research group is still active. Since the inauguration of the institute in 2004, 75 MSc students and 17 MPhil- and PhD students have graduated. In 2014, 34 MSc students and 22 MPhil- and PhD students were pursuing their studies at IBMBB. Since the establishment of the institute, the group has had 43 publications in international journals and 7 publications in national journals.

IPPS SRI:01/1 Atmospheric physics and lightning group 1978–2010

The initial contact with the Department of Physics at University of Colombo was established through the fellowship program. ISP's Physics Program sent out brochures with information about the fellowship opportunities to the Swedish embassy in Sri Lanka, which in turn forwarded them to ministries and universities. The candidate M.L.T. Kannagara, now a retired Professor in lightning research, applied and got accepted for a fellowship in the late 1970s. He went to Uppsala University for training during his one-year sabbatical leave. Professor Lennart Hasselgren, former Director of ISP's Physics Program, was very impressed with his work and when Professor Kannagara returned to University of Colombo, a joint lightning research program was initiated together with the former Institute of High Voltage Research at Uppsala University. This was the first ISP collaboration with a research group at a university in Sri Lanka.

However, the formation of a research group did not go as planned. Both the first and second person receiving ISP fellowships stayed in Sweden. Despite this, the support from ISP continued, and the third person, Professor K.P.S.C. Jayaratne, returned to Sri Lanka and University of Colombo in 1992. He was the second person to ever receive a PhD in physics from a Sri Lankan university.[4] In turn, Professor Jayaratne recruited three PhD students who all completed their degrees on a sandwich basis and joined the group, one of who is the current group leader: Dr I.M.K. Fernando.

When ISP started the collaboration with the Department of Physics in the late 1970s undergraduate- and MPhil programs were conducted, but no PhD program in physics existed, neither at University of Colombo, nor anywhere

4 The first person to receive a local PhD degree in Physics from a Sri Lankan university was also an ISP-associated student, from University of Peradeniya.

else in Sri Lanka. The main function and focus of the university was teaching. Recourses and culture for research were limited, lacking equipment, literature and laboratory facilities in the area of atmospheric and lightning physics.

Objectives: From its inception in the late 1970s, the research activities of the group were focused along two main lines; weather atmospheric electricity and thunderstorm electricity. The aim of the research group was, and currently is, to study the physics of lightning and atmospheric physics in the tropics, as well as its direct and indirect effects on structures and humans.

The first two PhD students of the group conducted their studies entirely in Sweden, focusing on instrumentation development, use of various measurement techniques, and theoretical studies. A few measurements were conducted in Sri Lanka to compare the electromagnetic environment in tropical regions with temperate regions. Studies were however limited due to lack of manpower and instruments.

The thunderstorm electricity branch of the group intensified its studies in the late 1990s to understand lightning discharges in tropical and temperate regions, through improvement of both instruments and manpower. During the 1990s, publications of the group also started to rise gradually. During this period, a few WoS journal articles and a number of conference papers were published. Lightning awareness programs were also conducted to educate the public about mitigating lightning damages. At the end of the 1990s, the group started a project with funds from ISP to implement a lightning location system together with the Department of Meteorology and the Industrial Technology Institute of Sri Lanka. The project was initially successful, but due to malfunctioning instruments and too limited support by relevant authorities, it was later abandoned.

In the early 2000s, the group expanded its research into the lightning protection side. Before 2002, all lightning research of the group was based on electric field changes. In the latter part of 2000s, the group widened its measurements to thunder, optical changes, and high-speed photography. Further, the group has started a new project on understanding the attachment of lightning to telecommunication towers and its effects. The group was also planning to reinitiate the project on designing a lightning location system for Sri Lanka.

Due to lack of manpower, the group has only conducted limited research in the field of weather atmospheric electricity during the time of the collaboration. In the mid-2000s, the group initiated a new research program in collaboration with the Sri Lankan Meteorology Department and Uppsala University, to develop a mesoscale climate model to study pollution dispersion and weather forecasting for Sri Lanka. Currently, one PhD student has graduated

Members of Department of Physics after the awarding of an Honorary Doctorate to Professor Bo Sundqvist (Vice Chancellor of Uppsala University at the time) by University of Colombo in 2003. From left: Dr R.V. Cooray, Dr C. Gomes, Dr R. Lelwala, Dr. M. Edirisinghe, Prof B. Sundqvist, Prof T.R. Ariyaratne, Prof L. Hasselgren, Dr I.M.K. Fernando, and Dr D.D.N.B. Daya. Photo courtesy: Department of Physics, University of Colombo.

in the atmospheric modeling field, being the only researcher in the country with this specialization. The model is not being used for operational weather forecasting yet, but has been used to identify what influence the central mountain area in Sri Lanka has on local weather.

Challenges: One challenge the group faced over the years was to retain the best students at the university, and convince them to join the research group for a local PhD degree. The top class students usually go abroad, as they had no problem receiving fellowships from other countries. The attitude at the department towards local degrees has also been a major challenge, both for the group leaders and for the students. PhD degrees from universities abroad have a higher status and are viewed as better among the staff members. The group also faced other internal challenges. As the group received outside funding, the faculty funding was reduced. Related to this is the problem of getting internal funds to repair or modify instruments.

Outcomes: The main area of use of the ISP funding has been the provision of sandwich PhD training and supervision abroad, as well as purchasing instruments. The main collaborating host institution receiving students has been Uppsala University in Sweden, while periods of training have been spent also at University of Florida, USA, the International Centre for Theoretical Physics (ICTP), Italy, and the Finnish Meteorological Institute. Between 1978 and 2010 the collaboration has resulted in 12 doctoral degrees, 2 MPhil-, and 12 MSc degrees. The group has published 25 papers in international journals, has had 26 publications in local and regional journals, and has made 93 conference contributions.

Funding: Over the years of support, ISP has provided approximately 9.8 million SEK to the group. Other sources of funding have been University of Colombo, ADB, EU, JICA, NARESA, NSF, and UGC, as specified in Appendix 6.

Current situation: After the end of ISP support in 2010, the group has received both international and local funding. Currently, there are five PhD students enrolled, supported by university grants, NRC, and the World Bank. The group has published two to three papers per year in international, peer-reviewed journals after the ISP phase out. An ISP graduate started the first MSc program at the Department of Physics. By now, three batches comprising in total about 45 students have graduated and the program is still running.

IPPS SRI:01/2 Molecular desorption mass spectrometry (PDMS) 1981–2010
Similarity to the research group in atmospheric physics and lightning (IPPS SRI:01/1), the initiation phase and formation of a research group in mass spectrometry was a struggle, as the first staff member receiving a ISP fellowship left University of Colombo shortly after returning home from Sweden. To keep the collaboration alive, the current group leader, Professor T.R. Ariyaratne, was invited for a short-term fellowship. When returning to Colombo, he started the research group in collaboration with the Ion physics group at the Department of Radiation Sciences, Uppsala University.

At the start of the collaboration, there was no mass spectrometry instrumentation available at the Department of Physics, University of Colombo. When Professor T.R. Ariyaratne returned from doing his PhD in mass spectrometry in the UK in 1980, it was not possible for him to do anything related to instrumentation at the department. Some small-scale research projects in physics were ongoing and undergraduate and MPhil training in physics existed to some extent, but there were no PhD programs, neither at the department nor in Sri Lanka.

Objectives: The objectives of the research group was to develop mass spectrometry instrumentation, to carry out mechanistic studies related to ion desorption processes, to set up a research laboratory in mass spectrometry, and to develop human resources in the field. The final objective was to apply mass spectrometry in natural product chemistry and other related fields, aiming to provide service to the natural product chemists in the identification and quantitative determination of new molecules extracted from medicinal plants in Sri Lanka.

Shortly after the establishment of the group, in 1985, the first mass spectrometer (a Plasma Desorption MS) was constructed after repeated visits to the Ion physics group at Uppsala University. The first PhD- and MPhil students joined the group in 1987, two at each level. The construction of a second mass spectrometer using the "Matrix Assisted Laser Desorption/Ionization (MALDI)" technique followed, and later the group constructed an improved version of the secondly built one.

For the next step, the group wanted to do research application in natural product chemistry. The group did however encounter some problems because the mass spectrometers constructed were not working with the sufficient resolution needed. The instrumentation could not live up to the performance demanded by researchers nationally and internationally, and since data could not be obtain with the required accuracy the group faced problems getting results and papers published.

Outcomes: The main use of the funds from ISP has been to develop the mechanical workshop needed to support the group and build mass spectrometry instrumentation, as well as to train PhD students. The main collaborating host institution for PhD students has been Uppsala University, Sweden. In addition, students have also received short-term training at University of Southern Denmark and University of Manitoba, Canada. Over the years of support, 1981 to 2010, the group developed three mass spectrometers and has in total graduated five PhD's and four MPhil's. The group has published eleven papers in international journals, eight papers in local/regional journals, and has made 43 conference contributions.

Funding: In total, this group has received 8.8 million SEK from ISP. The main part of the funding to the research group has been provided by ISP, but funding has also been received from national sources such as University of Colombo, NARESA, NSF, TWAS and UGC. An overview of the funding is available in Appendix 6.

Current situation: The support to the research group ended in 2010. The group started to face challenges early in the collaboration because the building of instrumentation is very expensive and requires, besides substantial funding, technical staff trained on an advanced level to run and monitor the instruments. After the end of ISP support, it was hard to obtain a sufficient level of funding from University of Colombo. To obtain larger grants from government agencies requires evidence from the research, something that could not be reached with sufficient accuracy. It was therefore not possible for the group to keep in the frontline as needed in the field of instrumentation. Currently, the three mass spectrometry built are not in use, and there are no PhD students attached.

IPPS SRI:01/3 Strengthening of the activities of the Centre for Instrument Development (CID) 2005–2010

In 2000, the research group in molecular desorption and mass spectrometry (IPPS SRI:01/2) experienced a decline in activity. During this time, the same research group leader, Professor T.R. Ariyaratne, established a sub-group in instrumentation at the department. An application was sent to ISP and the group started to receive support in 2005. The group was established to promote the advancement of the technological standard and applied scientific research in Sri Lanka, to use the knowledge of building instruments obtained over the years to support national level research, and to solve problems of relevance to Sri Lanka.

Objectives: The focus of the group was on instrumentation and on building instruments locally for the specific needs in research and educational institutions, as well as in the industry. The group also aimed to undertake consultancies in instrument development, and for research and industrial applications related to instrumentation. Other general objectives were to transfer scientific research output to technology, to provide support to modernize indigenous technology and automate industrial plants, and to help innovative staff in their inventions. In terms of training of students and manpower in the field, the group aimed at conducting a wide range of training courses, seminars and workshops related to modern technology, to carry out industry oriented research leading to postgraduate qualifications, and to initiate new research programs leading to MPhil-, and PhD graduations in instrumentation, in collaboration with local and foreign counterparts.

The group started out in 2005 with the launching of a two-year MSc program in applied electronics, including a course in microcontrollers and their applications. The latter course targeted engineers, university lecturers, and other technical staff. In 2007, the group also launched a certificate course in electronics and automation technology for secondary school students. Through the courses, the group wanted to disseminate knowledge and train people in applied electronics and automation technology, while at the same time get additional funds to the research group through tuition fees.

During the period of support, the group focused on two projects related to post harvest technology and solar energy in Sri Lanka; the packing and transportations of fruits and vegetables by trucks, and the drying of agricultural products and materials using solar energy. In addition, the group successfully applied GASMAS (Gas in Scattering Media Absorption Spectroscopy) technology to monitor the oxygen content in a polluted lake in the city of Colombo. The applied molecular spectroscopy research group at the Atomic Physics Division, Lund University, Sweden, was assisting the group in acquiring this emerging technology. The group also undertook a project on the automation of water purification and processing plants, maintained by the Sri Lankan National Water Supply and Drainage Board.

Challenges: The major difficulty facing the group during the time of the collaboration was the lack of technical staff, and the fact that the mechanical workshop did not have all the facilities needed. There was also a lack of manpower to carry out research because of the time required for teaching and other obligations of the academic staff. The group also encountered, and still encounters, difficulties of attracting students for locally conducted research programs, as first class students from the undergraduate levels normally apply for foreign fellowships and disappear abroad.

Outcomes: Over the short period of support, 2005–2010, one MPhil student has graduated, and two publications have been made in international journals and six in national and regional journals. In addition, the group has made sixteen conference contributions. The main collaborating host institution has been Lund University, Sweden.

Funding: ISP supported the group with approximately half a million SEK between 2005 and 2010. During the support period, the group received funding also from Sri Lankan public sources such as NSF and NRC. The group is also self-funded through fees from the MSc course in applied electronics. The support received from other agencies is approximately equivalent to the amount of ISP support over the years (as specified in Appendix 6).

The in-house built linear parabolic convertor being repaired outside the Department of Physics, University of Colombo, 2014. Photo courtesy: Rebecca Andersson.

Current situation: The research group has since the phase out of ISP support converted to working solely on solar energy. The new projects are focusing on harnessing solar energy using in-house built linear parabolic convertors for 1) power generation, 2) purification of seawater, and 3) the drying of agricultural produces and other materials. The reason for this is that the government is currently supportive of projects in the field of energy. There is a great need for an alternative energy source and there is a lack of good drinking water in the central part of Sri Lanka.

At the moment, there are two PhD students involved in the solar energy project, one of which has recently graduated. One problem facing the group today is, however, finding financial resources to support the postgraduate students who chose to do research locally. The MSc program in applied electronics is still running.

University of Peradeniya

ISP has supported one research group in physics and in total five groups in chemistry at University of Peradeniya between 1981 and 2010 (Table 2.2).

IPICS SRI:03/1, SRI:03/2, SRI03/3, SRI:03/4 and SRI:03, 1981–2002

The support to Department of Chemistry at University of Peradeniya was channeled to five different research groups in chemistry over the years of collaboration: Isolation and structural studies of polysaccharides from plant and microbial sources (IPICS SRI:03/1); Essential oils and insect related chemistry (IPICS SRI:03/2); Mineral chemistry (SRI:03/3), and Sri Lankan plants for anti-tumor agents (IPICS SRI:03/4), all started between 1981 and 1983. The group Bioactive compounds in the control of plant diseases (IPICS SRI:03) was created in the mid-1990s through a merge of two groups (IPICS SRI:03/1 and SRI:03/2). By that time, the ISP support to the Anti-tumor agents research group and the Mineral chemistry research group (IPICS SRI:03/4 and SRI:03/3) had ended.

Professor Nimal Savitri Kumar, now retired group leader of IPICS SRI:03/1 and SRI:03, was in the beginning of the 1980s, working on seaweed polysaccharides at University of Peradeniya. She had a PhD and Postdoc from University of London, but in Sri Lanka her research field was an unfamiliar and unexplored topic. The lack of facilities for research in polysaccharides chemistry at University of Peradeniya posed a problem for the progress of her research. The first active group in polysaccharide chemistry at the university could, however, be established after one of her students returned from an ISP fellowship at the Swedish University of Agricultural Sciences, combined with small equipment support.

Before the start of the ISP support organic chemists at the department only worked with natural product chemistry. All spectroscopic data, however, needed measurements abroad, which usually took between three and six months to accomplish. The facilities available at the department were only suitable for students at the MSc level. However, many of the staff members at the department did have a PhD degree obtained from universities abroad, and had research grants from the National Science Foundation and the International Foundation for Science. Research was going on to the extent possible with the available facilities.

In 1981, Professor Vijaya Kumar, retired group leader of the research group IPICS SRI:03/2 and SRI:03, was awarded the first ever regional fellowship from the ISP Chemistry Program to Mahidol University in Bangkok, Thailand. During the following years, two of his students were granted ISP fellowships and went for research training in Sweden, as there was an identified need to train students in this area and to access mass spectrometers to study essential oils. Upon their return to Sri Lanka, a group started to form in Essential oils and insect related chemistry.

ISP expanded support to also include groups in Sri Lankan medicinal plants and in mineral chemistry in 1983 and 1984, respectively. Support to these groups were, however, short lived and ended in the late 1980s and the beginning of the 1990s.

The two groups in Polysaccharide chemistry and Essential oils and insect related chemistry, under the leadership of Professors Savitri and Vijaya Kumar, remained supported. During this period, in the beginning of the 1990s, the Coconut Research Institute and the Tea Research Institute in Sri Lanka recognized the expertise of the groups and began collaborative research on some of the insects attacking coconut and tea. A project on the Shot-hole borer beetle of tea, involving the study of an associated fungus and its polysaccharides, gave the two Peradeniya groups an opportunity to work together. The joint research worked well, and the two groups were therefore merged into one group in 1993, named Bioactive compound in the control of plant diseases (SRI:03). In 1993, ISP sponsored an insectary at University of Peradeniya, which improved the capabilities for research work in the area at the department.

The ISP support ended in 2002 due to the fact that the group came to received substantial support from Sida/SAREC.

Challenges: The major challenge facing the group was to get the best students from the undergraduate programs to stay at the university and continue on the postgraduate level instead of going for studies abroad. According to the former group leaders, at least 75 % of the special degree students went, and are still going, abroad. The quality of the students was therefore a challenge during the period of collaboration, and sometimes undergraduate students were recruited to the groups to do research.

Outcomes: The ISP collaboration with all research groups at the Department of Chemistry between 1981 and 2002 resulted in 13 PhD graduations and 14 MSc- and MPhil graduations. Students from the groups have been sent to several host institutions in Sweden, namely: Karolinska Institutet, the Mid Sweden University, the Royal Institute of Technology, Stockholm University, the Swedish University of Agricultural Sciences, and Uppsala University. In addition, students have also been trained at the City of Westminster College, UK, the Bhabha Atomic Research Centre, India, and the International Centre for Insect Physiology and Ecology, Kenya. The groups have together published

68 papers in international journals, 5 articles in local and regional journals, and have produced 113 conference contributions.

Funding: Besides ISP, the largest funder of the research groups over the years has been the Swedish Government through Sida/SAREC. ISP facilitated the group application for support in 1993, and between 1994 and 2004 Sida/SAREC supported the *"Biochemical Pest Control Project"* involving the research group (IPICS SRI:03), the Institute for Fundamental Studies, and the Tea Research Institute, all in Sri Lanka. ISP took on the role to be the coordinator of the collaboration. In total, the Sida/SAREC funding add up to approximately 13.7 million SEK and has enabled the group to equip the laboratory. ISP has contributed with 2.8 million SEK, as specified in Appendix 6. Additional funding has in the beginning of the 1980s come from IFS, NARESA, NSF, TWAS and the multinational pharmaceutical company Ciba Geigy Ltd (today named Novartis). Amounts and specific years are however not available.

Current situation: From 1993, ISP supported one of the four initially supported groups, SRI:03, headed by Professors Savitri and Vijaya Kumar. Both group leaders retired from the university in 2007 and 2008, respectively. The research group did not continue after their retirement, mainly due to the fact that there was no one to take over and keep it going. There are, however, currently two staff members in organic chemistry at the Department of Chemistry, and research is still ongoing. Funding is received from the World Bank and there are four PhD students enrolled.

IPPS SRI:02 Condensed matter physics 1983–2010

The support to the Department of Physics at University of Peradeniya started in 1983 with a one-year fellowship awarded to Dr M.A. Careem, who later became one of the research group leaders. During his one-year sabbatical leave in 1984, he went to Chalmers University of Technology in Gothenburg, Sweden, and started to work on a research project on lithium sulphate under Professor Arnold Lundén. The fellowship was followed by a visit by the former ISP Physics Director, Professor Lennart Hasselgren, in 1984.

The following year it was time for Dr Careem's colleague, Dr M.A.K.L. Dissanayake, to go on sabbatical leave. He was a bit hesitant to apply for a fellowship from ISP's Physics Program due to the low financial benefits compared to fellowships offered in the United States. However, Dr Careem convinced him to pursue the fellowship through ISP because of the long-term benefits it would yield to the department.

From the left: M.A.K.L. Dissanayake, L. Hasselgren, B.S.B. Karunaratne and K. Premaratne at the Peradeniya Botanical Garden during Professor Hasselgren's first visit to the Department of Physics at University of Peradeniya in 1984. Photo courtesy: Department of Physics, University of Peradeniya.

In the beginning of the 1980s, the research activity in physics at University of Peradeniya was close to zero. There were three senior academics at Department of Physics, none of whom were actively conducting research. The research culture and research tradition at the department were close to non-existing and material wise there were no research laboratories or equipment, journals, or research funds available.

Upon the return of Drs Careem and Dissanayake from Sweden in the mid-1980s, they submitted an application to ISP for long-term research support. When the application was accepted, they started by ordering an HP Impedance Meter and a few essential chemicals. Their collaborating partner and research host from Chalmers University of Technology, Dr Bengt-Erik Mellander, made a two-week visit to the Physics Department in 1986 to set up the instrument and initiate basic research work on Lithium Sulphate (Li_2SO_4) based Solid Electrolytes. The instrument is still being used at the department today, mostly for undergraduate research.

In 1986, the first "entirely home grown" research paper from Department of Physics, University of Peradeniya was presented by Drs Careem and Dissanayake at the first Asian Solid State Ionics Society Conference (ACSSIS-1986)

M.A. Careem (left) and M.A.K.L. Dissanayake (right) at the First Asian Solid State Ionics Society Conference in Singapore in 1986 talking to late Professor Takahashi from Japan, the "father" of Solid State Ionics. Photo courtesy: Department of Physics, University of Peradeniya.

held in Singapore. In the same year, the first research student, Kumara Bandaranayake, was registered for a PhD degree at the department. After years of alternating research training at University of Peradeniya and Chalmers University of Technology, he became in 1991 the very first PhD graduate in Physics from a Sri Lankan university.

The group continued to publish around three to four papers in international journals each year and in 1989 Professor Lennart Hasselgren suggested that the research activities at Peradeniya should be expanded to semiconductors and ceramics. Dr K. Premaratne and Dr B.S.B. Karunaratne were appointed to lead the respective areas. Later, also the solid-state ionics program was split into two programs, one on polymer electrolytes and one on conducting polymers. Hence, since the early 1990s there were four subgroups under the common name IPPS SRI:02. The overall goal of the research group was to understand the fundamental physical processes in several technologically important novel materials with potentials for new devices and applications.

Challenges: Like the groups in physics at University of Colombo, the physics research group at University of Peradeniya faced problems with attracting undergraduate students to pursue higher studies and research locally. The group leaders estimate that around 80 % of the physics special degree students graduating from the university every year, leave for postgraduate studies abroad, mainly to the US, and many do not return.

Outcomes: Over the years of support, 1983 to 2010, the group has graduated 18 PhD students, and 60 MSc- and MPhil students. The main collaborating host institutions have been Chalmers University of Technology and the Royal University of Technology, both in Sweden, and the Technical University of Denmark. The group has published 108 papers in international journals, 79 papers in national and regional journals, and has made 278 conference contributions.

Funding: During the years of support, the group has received 13 million SEK from ISP. In addition, the group has received around 1.6 million SEK from other sources, mainly from University of Peradeniya and the connected Post Graduate Institute of Science, and from NSF. The group has also received competitive grants from EU. The funding of the group is specified in Appendix 6.

Current situation: At the moment, three out of four subgroup leaders has retired from University of Peradeniya. Two of them have continued to work at University of Malaya, Malaysia and the Sri Lankan Institute of Fundamental Studies, respectively, where they have continued research collaboration with the former physics department at University of Peradeniya and the former host group at Chalmers University, Sweden. One group leader is still active at the department, supervising the only PhD student, and a young staff member has taken over as the leader of another subgroup, supervising two MPhil students. PhD graduates from the US has also returned to start new research programs, supported by the NSF.

The challenge remains to attract students to pursue a local PhD after their undergraduate studies, in particular after the end of ISP support because the opportunity of sandwich type PhD programs with abroad components no longer remains. However, possibilities for students to receive local government grants for PhD studies, with a short-term overseas training component, are increasing.

University of Jaffna

Between 1985 and 2006 ISP has supported one chemistry research group at University of Jaffna, located in the northern part of Sri Lanka (Table 2.2).

IPICS SRI:04 Biotechnology of starch and sucrose (Palmyrah) based products 1985–2006

The initial contact with ISP started in 1979 through the awarding of a fellowship to Professor K. Balasubramaniam to work on neurotoxin at the Biomedical Center at Uppsala University, Sweden. Professor Balasubramaniam was working at Department of Biochemistry, University of Colombo at that time and was the initiator of the molecular biology and gene technology collaboration established there (IPICS SRI:02). Due to civil disturbances in Colombo the same year, Professor Balasubramaniam left Colombo to instead join University of Jaffna. The contact with ISP was resumed in 1985 when Professor Balasubramaniam established collaboration between his new university and Department of Biotechnology, Lund University, Sweden.

It was decided that the research at University of Jaffna should focus on biotechnology, due to the fact that it could be carried out with less capital and less equipment than molecular biology, and therefore was the more realistic choice in the then war-struck Northern Province where the university is located.

When the ISP collaboration started, Professor Balasubramaniam was the only person holding a PhD at the department, as the other two staff members with PhD degrees had left the country. The department had the bare minimum of facilities, and one PhD student and one MPhil student were enrolled at the time. The first years of the collaboration therefore focused on building up the most important resources lacking, namely scientific manpower in the field. The group started by establishing a MSc course in biotechnology in 1986. With the help from ISP, and through the links with Lund- and Uppsala University, sandwich MPhil and PhD programs were also initiated. In 1992, the group started regional collaboration with Mahidol University, Thailand, where students were sent for research training.

Objectives: To educate staff in biotechnology has been one of the major objectives of the group from the start. The second objective was to develop fermentation and enzyme engineering technologies. The research group broadly consisted of two subprojects. The first project was involved in the conversion of rice, corn and manioc starch to glucose, and the usage of glucose and sucrose from the palmyrah fruit in the fermentation processes to produce organic acids and alcohol. The second project focused on producing enzymes by microbes, necessary for the production of glucose from starch and on the immobilization of these enzymes for repeated use.

Challenges: The Northern Province of Sri Lanka was completely cut off from the rest of country in the late 1990s. Most of the resources at the university were destroyed in the war during 1995 and the group had to start over from scratch. ISP provided the group with a lump sum to start working from the basal level.

Another consequence of the war was the lack of continuous electricity supply in Jaffna between 1987 until 2012. The group had to work with electricity generated from their own generators, which also were interrupted from time to time. The group developed alternative measures to deal with the lack of energy. Instead of liquid fermentation, which is dependent on electricity, the group instead carried out solid-state fermentation, which only requires a maintained temperature. To keep the required temperature, non-electricity measures were invented, for instance using old fridges filled with hot water as incubators. This work in 1990 laid the foundation for the development of the solid-state fermentation technology, and contributed to the take-off of research activities in the group. With this technology the group produced enzymes required for the production of liquid glucose using corn starch. The group supplied this liquid glucose to the confectionery industries in the region. Later on, liquid glucose was imported from China and there was no need for the group to continue the production.

Due to the war, ISP staff did not have the possibility to visit Jaffna until in 2007. The support continued based solely on the reporting from the research group.

Outcomes: The group managed to maintain the quality and publish papers in international journals despite all challenges. During the period of collaboration between 1985 and 2006, five PhD students graduated as well as eight MSc and MPhil students. The group had 30 publications in international journals and 12 in national and regional ones. In addition, the group has made 130 conference contributions.

Funding: Up to year 2000, the main source of funding to the research group was from ISP. ISP helped to facilitate the application to Sida/SAREC in 2000, which resulted in a large grant for the project "Thermostable depolymerase from thermophiles", which continued until 2010. ISP has contributed with approximately 2.5 million SEK while Sida/SAREC has contributed with 8 million SEK. After 2010, funding has been provided from Fonterra-Sri Lanka and NRC. An overview of the funding of the group is given in Appendix 6.

Professor Balasubramaniam (left) and Professor Malin Åkerblom (right), former Director of the ISP Chemistry Program, reunited in Colombo, Sri Lanka 2014. Photo courtesy: Peter Sundin.

Current situation: The group leader Professor Balasubramaniam retired in 1997, and the first PhD student to graduate from the group, Professor Vasanthy Arasaratnam, took over as group leader. She is currently the Vice Chancellor at University of Jaffna, and is still actively doing research at the department. As Jaffna was severely affected by the civil war, which lasted during the whole period of the collaboration, most of the students who graduated from the group have left Sri Lanka to seek opportunities abroad. Professor Vasanthy Arasaratnam and Dr S. Balakumar (the present Dean of the Faculty of Medicine) are the only ISP-associated staff members left at the university. The Department of Biochemistry is however maintaining its strengths in research and publishing. Since the phase out of ISP support, they had about ten publications and two PhD and MPhil students enrolled, respectively. There is still no master program at the department.

The group has established collaboration with the Central Food Technological Research Institute in Mysore in India, and is continuing the collaboration with Mahidol University in Bangkok, established in 1992. The group has maintained the collaboration with their host group at Lund University, where MPhil- and PhD students are sent for training.

University of Sri Jayewardenepura

ISP has collaborated with one chemistry research group at University of Sri Jayewardenepura, supported between 1995 and 2009 (Table 2.2).

IPICS SRI:07 Nutritional biochemistry, 1995–2009

The initiation of the research group in nutritional biochemistry at University of Sri Jayewardenepura started through links established in the early 1970s with the Ceylon Institute of Scientific Industrial Research (CISIR). ISP had a good relationship and collaboration with the Director of the Institute, Professor Errol Jansz, but as the institute came under another ministry in the 1990s the executive directors were replaced and the collaboration could not continue as before. Professor Jansz subsequently left the institute and joined the newly established Faculty of Medical Sciences at University of Sri Jayewardenepura, as the Head of Department of Biochemistry.

The cooperation with CISIR was viewed as successful from ISP's side and great potential was therefore seen in continuing the collaboration from University of Sri Jayewardenepura. After a visit by the ISP Chemistry Director, Professor Rune Liminga, and a proposal from Professor Jansz, it was concluded that the department was in great need of training staff members and students. Professor Jansz was given a small pilot grant for the academic years 1994/95 to 1995/96. The pilot support was viewed as successful and long-term funding continued until the phase out of support in 2009.

The work of the group was divided into different subprojects. The major focus of the group was nutritional and bioactivity studies of underutilized indigenous plant foods and food materials such as the sword bean, the velvet bean, palmyrah fruit pulp and shoot flour. Research on carotenoids of Sri Lankan fruits and vegetables was another aspect that was studied in detail. On the bioactivity front a variety of plant sources were studied with respect to ingredients responsible for hypoglycaemic, hypocholesterolaemic, cytotoxic and neurotoxic activities. From 2005, the major focus was on the study of glycemic indices (GI) of typical Sri Lankan foods with the intention of providing the GI data to physicians, dieticians and nutritionists. The final year of support in 2009 was mainly devoted to a study on hypercarotenaemic children. The group has now established a database of GI values of Sri Lankan food.

The Medical Faculty and the Department of Biochemistry at University of Sri Jayawardenepura was established in 1993. The group had to start from

Felicitation of Prof Errol Jansz (left) organized by his postgraduate students on his day of retirement in 2007. Photo courtesy: Sagarika Ekanayake.

scratch with limited resources. They lacked basic instruments such as analytical balances for measuring quantities of chemicals, and facilities to keep animals involved in project trials. No MSc program was available at the time and the first MPhil student at the department was registered in 1997.

Outcomes: During the years of collaboration, the group has graduated six PhD students out of which all are still in the country and employed in academic institutions. Twelve MPhil students have graduated over the years of support, all except two have remained in Sri Lanka. The first ever MPhil of the faculty graduated through ISP support. The main collaborating host institutions for training of sandwich students and staff members have been Lund University, the Royal Institute of Technology, and Chalmers University of Technology. In addition, training has also taken place at Mahidol University, Thailand, the Bangladesh Institute of Research & Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM), and the H.E.J. Research Institute of Chemistry, Karachi University, Pakistan.

The research work was mainly conducted on foods or raw materials specific to Sri Lanka, and as a consequence the group faced difficulties in publishing in international journals. It was argued that the content did not cover a wide

Equipment donated by the ISP Chemistry Program to the laboratory at Department of Biochemistry, University of Sri Jayewardenepura. Photo courtesy: Rebecca Andersson.

enough range of readers. Despite this, the group has published 16 papers in international journals, 28 papers in regional and national journals, and made 31 conference contributions. The first ever paper in an international WoS-listed journal of the faculty came through ISP support.

Funding: During the period 1995–2009, ISP has supported the group with approximately 3.4 million SEK. Other sources of funding have been University of Sri Jayewardenapura, IFS, NRC, NSF and the Sri Lankan Government initiative "Improving Relevance and Quality of Undergraduate Education", adding up to approximately 0.3 million SEK. An overview of the funding is given in Appendix 6.

Current situation: The group leader Professor Jansz retired in 2007 and was succeeded by Professor Sagarika Ekanayake, who received her PhD training through ISP. Additionally, two former ISP students are working at the Department of Biochemistry at the moment, one of who is currently Head of Department. Research is still ongoing and all three have their own research teams with PhD- and MPhil students funded by the NRC, NSF, UGC, and World Class University Grants. No master program is conducted at the department.

The Department of Biochemistry is the most productive department at the faculty publication wise (SCI journals) and in terms of number of MPhil- and PhD students. Since the phase out of ISP support in 2009, the group has published 35 papers in international and regional journals, had 7 publications in national journals and made 120 national and international conference contributions. Most of the equipment obtained through ISP funding is working, and additional equipment has been bought through Sri Lankan grants after the end of ISP support. Beside PhD- and MPhil students from the department, undergraduate students and staff from other faculties are utilizing the laboratory.

2.2 Tracer Study Sri Lanka

This tracer study specifically focuses on former MPhil and PhD students part of ISP supported research groups in Sri Lanka between 1978 and 2010. The aim is to collect and analyze quantitative and qualitative data on their mobility, career development, research outcomes and experiences.

Based on ISP internal records, 104 PhD and 66 MPhil students were identified as having started training in supported research groups during this period.[5] Of these 170 identified, email addresses were traced to 127 former MPhil and PhD students, provided by group leaders of supported groups, the ISP internal database over visiting students and scientists and through internet search. The traced former students were invited to fill out an online questionnaire sent out by email in May 2014, which received 53 responses (42 %).[6] The online questionnaire was followed up by semi-structured, in-depth interviews with 18 of the 53 respondents of the questionnaire, during a one week visit to Sri Lanka in September 2014. A questionnaire was sent via email also to host supervisors of Sri Lankan sandwich students. Furthermore, a basic bibliometric study was conducted in WoS to follow up on the publication data of former students.

The study is divided into four areas;

1. Characteristics of former students,
2. The period of research training,
3. Career development and mobility after graduation, and,
4. Research results and collaboration.

Characteristics of former students provides an overview of the former students in terms of gender, academic discipline, level of degree, age when starting training, and duration of the training period.

Period of research training covers both information about the organization of the research training, and the training experiences of former students. This area aims to answer the questions: Where did students go for research training

5 This is an approximate number as the internal records do not fully cover all years of support. The Sri Lanka collaboration reaches over a period of time when ISP was a fellowship program providing fellowships to staff members and not to postgraduate students. It is therefore possible that some of the people included in the count are staff members at exchange visits. The distinction between staff members and postgraduate students is not made in the ISP internal database, because higher degree students are often staff members.

6 This can be considered an above normal response rate for emailed questionnaires which according to Bernard (1994) typically is between 20–30 %.

and for how long? How did students experience the research training at home and abroad? What factors have contributed to good and bad experiences?

Career development and mobility after graduation focuses on the post training period, including current employment position and experienced working conditions, as well as patterns of mobility and career development since graduating. Questions to be answered here are: Where are the former students today and where have they been since graduation (geographically and employment wise)? What are the underlying factors for their decisions regarding mobility and career development? How do they experience their current employment position?

Research outcomes and collaboration focuses on research activities since graduation and aims to answer: To what extent are graduates still actively conducting research? How much have they published since graduation and where? Are they still publishing papers and collaborating nationally and internationally?

Differences related to gender, academic discipline and level of degree will be considered in all areas.

2.2.1 Characteristics of former students

In this section an overview of the traced and responding former students is presented regarding gender, academic discipline and level of degree. Age and position at the start of the training, and time to finalize degrees is also reported here. Data regarding all traced students are obtained from ISP records while information about the respondents comes from questionnaire answers.

Former student statistics

Based on ISP internal documents, 104 PhD- and 66 MPhil students were identified as having started training in supported research groups during this period considered. Of the 170 identified students, 127 were traced with email addresses. The distribution of the traced students between the two disciplines chemistry and physics are nearly equal (Table 2.3). About one third of the traced students are female, and a majority of them are found within the Chemistry Program. A PhD degree was obtained by 68 % of the traced students, and the PhD holders are equally distributed between chemistry and physics.

Table 2.3 Distribution of the 127 traced students by field of science, gender, and degree.[7]

Field	Women	Men	Total	PhD	MPhil	Total
Chemistry	30 (48 %)	32 (52 %)	62 (100 %)	40 (75 %)	13 (25 %)	53 (100 %)
Physics	13 (20 %)	52 (80 %)	65 (100 %)	40 (62 %)	25 (38 %)	65 (100 %)
Total	**43 (34 %)**	**84 (66 %)**	**127 (100 %)**	**80 (68 %)**	**38 (32 %)**	**118 (100 %)**

Out of the 127 traced students, 53 (42 %) responded to the questionnaire. Similarly to the total sample of traced students presented above, the 53 respondents of the questionnaire are also relatively evenly distributed between disciplines; 24 in chemistry and 29 in physics. The overall gender distribution of the respondents also corresponds to the one found in all traced students with 66 % being male, a majority of which are found in the Physics Program (Table 2.4). When it comes to level of degree, 39 respondents (78 %) hold a PhD degree and 11 respondents an MPhil degree, the 3 remaining have not entered their degree in the questionnaire. Respondents come from the supported research groups in chemistry and physics located at four universities in Sri Lanka: University of Colombo, University of Peradeniya, University of Jaffna and University of Sri Jayewardenepura.[8]

Table 2.4 Distribution of the 53 questionnaire respondents by field of science, gender, and degree.[9]

Field	Women	Men	Total	PhD	MPhil	Total
Chemistry	14 (58 %)	10 (42 %)	24 (100 %)	16 (73 %)	6 (27 %)	22 (100 %)
Physics	4 (14 %)	25 (86 %)	29 (100 %)	23 (82 %)	5 (18 %)	28 (100 %)
Total	**18 (34 %)**	**35 (66 %)**	**53 (100 %)**	**39 (78 %)**	**11 (22 %)**	**50 (100 %)**

Student and staff gender balance

The gender distribution among the traced and responding MPhil and PhD students is quite similar to the general picture of ISP supported research groups; with more female students in the chemistry- than in the physics program. The average percentage of female PhD students in all ISP supported research

7 Information about level of degree is missing for nine students.

8 The supported groups, by university, are: University of Colombo: IPPS SRI:01/1, IPPS SRI:01/2, IPPS SRI:01/3 and IPICS SRI:02. University of Peradeniya: IPPS SRI:02, IPICS SRI:03/1, IPICS SRI:03/2, IPICS SRI:03/3, IPICS SRI:03/4 and IPICS SRI:03. University of Jaffna: IPICS SRI:04. University of Sri Jayewardenepura: IPICS SRI:07.

9 Three of the respondents have not filled out their level of degree in the questionnaire.

groups and networks between 2003 and 2010 was 39 % in the Chemistry Program and 11 % in the Physics Program (ISP, 2013b).

Records over the gender distribution among staff members in ISP supported groups have been kept since 1999. The distribution of gender among staff in Sri Lankan groups is also similar to the distribution of students, with more female staff members involved in the chemistry program. In the physics groups the number of female staff members (including both academic staff and technicians) has varied between 0 and 23 % at the most, between 1999 and 2009. For the chemistry groups the share of female staff members is higher, ranging between 33 and 60 %.

Starting age and duration of training

Most women responding to this questionnaire are born in the 1970s or later, and are in general younger than the male respondents. The majority (58 %) of all respondents were 25–29 years when starting their training. A larger share of the female respondents started training at ages 25–29 than the share of the male counterparts (Figure 2.1). On average, female respondent started training at 28.5 years and male respondents at an average age of 30.2. The average starting age of all respondents was 29.6 years. There appears to be no significant difference in age between students in different disciplines of science or regarding level of degree. Around one third of the respondents held a staff member position when they started training.

On average it took 6.4 years for the responding PhD students and 3.7 years for the MPhil students to finalize their studies. Number of years to finalize degrees is calculated based on available data, which is year of graduation minus starting year of the postgraduate training. An additional 0.5 years has been added to compensate for not knowing at which date each student started and graduated. No difference was found between female and males, or between chemistry and physics students regarding time to complete the training. Six MPhil students graduated within 3.5 years or less, and the remaining five students took 4.5–6.5 years to complete their studies (Figure 2.2). Regarding the PhD students, 26 finalized their degrees in 6.5 years or less and 12 students took 7.5–11.5 years to complete.

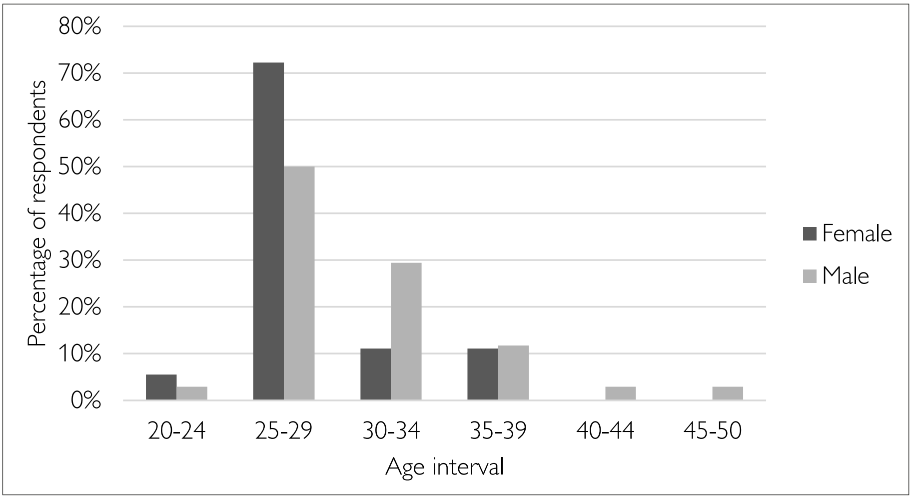


Figure 2.1 Age when starting postgraduate training (%), by gender.[10]

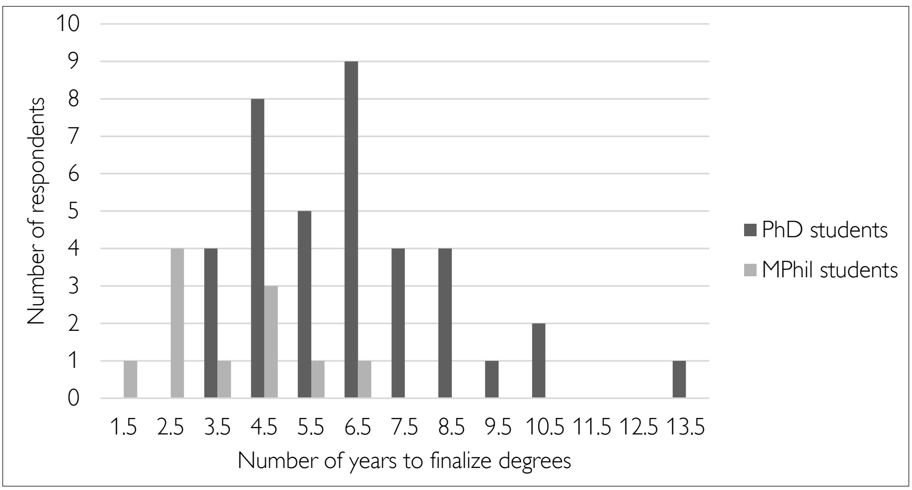


Figure 2.2 Number of years respondents took to finalize degrees.[11]

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10 52 persons (18 female and 34 male) responded to questions relevant for this figure, e.g. year of birth (q5), year of starting training (q12) and gender (q1). Questions are found in Appendix 1.

11 Number of years to finalize degree is calculated as year of graduation (q13) minus year of starting postgraduate training (q12) + 0.5 years to compensate for not knowing when during the year the student started or graduated. Questions are found in Appendix 1. 49 persons responded to these two questions.

2.2.2 The period of research training

In this section factors related to respondents research training in Sri Lanka and abroad are presented. This includes an overview of where students went for training and for how long, as well as positive and negative experiences of the research training.

The sandwich program

Through the ISP collaboration, postgraduate students on the PhD-, MPhil- and MSc level have received training on a sandwich basis or to a full extent locally in Sri Lanka depending on the field of study and the capacity of the department in that specific field. Sandwich model training means that students spent part of their research training at their home university in Sri Lanka and part at a host university abroad, alternating between these institutions.

A majority of the respondents (79 %) underwent this sandwich model training. The remaining respondents (21 %) did their postgraduate training entirely at their home university in Sri Lanka, without any period abroad. Most of the sandwich students (73 %) spent all, or a part of, their abroad training in Sweden. The remaining respondents went to host universities located in Bangladesh, Brazil, Denmark, Germany, India, Kenya, Norway and Pakistan. A few of these students spent training in Sweden combined with another of the mentioned host countries. A list of all host institutions is found in Appendix 5.

There was no variation regarding gender or level of degree between students who underwent sandwich training. The latter indicates that also a majority of the MPhil students have undergone sandwich based research training. Regarding sandwich students in the two disciplines of science, a significantly higher proportion of the physics (90 %) than the chemistry students (65 %) underwent sandwich model training ($p<0.05$).

Time spent abroad

The time that sandwich students spent abroad was also significantly different ($p<0.05$) between respondents from the two academic fields (Figure 2.3). The responding chemistry graduates spent shorter periods of total time abroad compared to graduates that were part of the Physics Program.

There are also gender related differences. According to the questionnaire results, females tend to have spent shorter periods of time abroad than males (Figure 2.4). Close to 40 % of the female students state that they spent 0–6 months abroad during the whole period of training in relation to only 12 % of the male respondents. The total stay rates of men are more equally spread among the longer periods of stay abroad. One female who chose not to do a sandwich type PhD describes the cultural problems Sri Lankan women might face when going abroad for research training:

> *"As long as you are not married it is easy [to go abroad]. Otherwise when you have family commitments it is extremely difficult. We have a culture where it is not highly encouraging for women to leave the family and go out. But nowadays a lot of people go out, leaving their families and kids. So it is very common, but still it is not very much encouraged. If you can get a fellowship where you can go with the family it is much more appreciated than if you go without the family".*

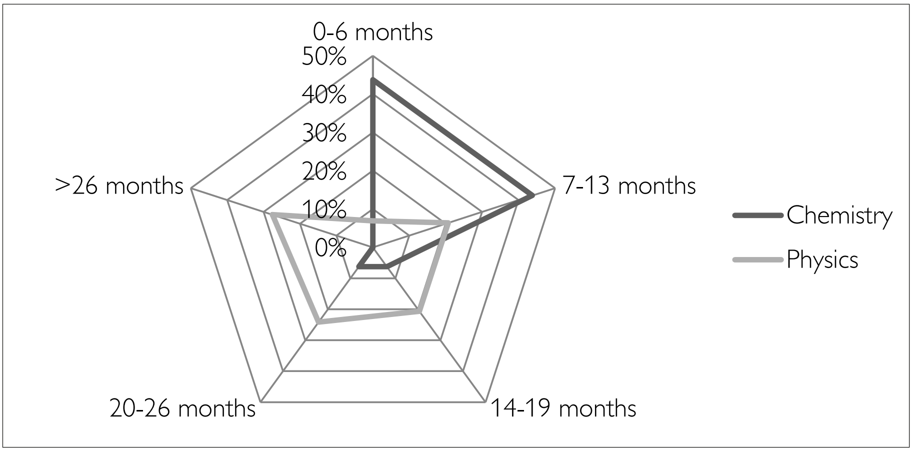

Figure 2.3 Total length of stay abroad of sandwich students (%), by discipline.[12]

[12] 45 persons responded to questions relevant to this figure, e.g. discipline of science and total stay rates abroad. Answers are presented as share of respondents within the Chemistry Program (16) and share of respondents within the Physics Program (29) respectively, not as percentage of total number of respondents.

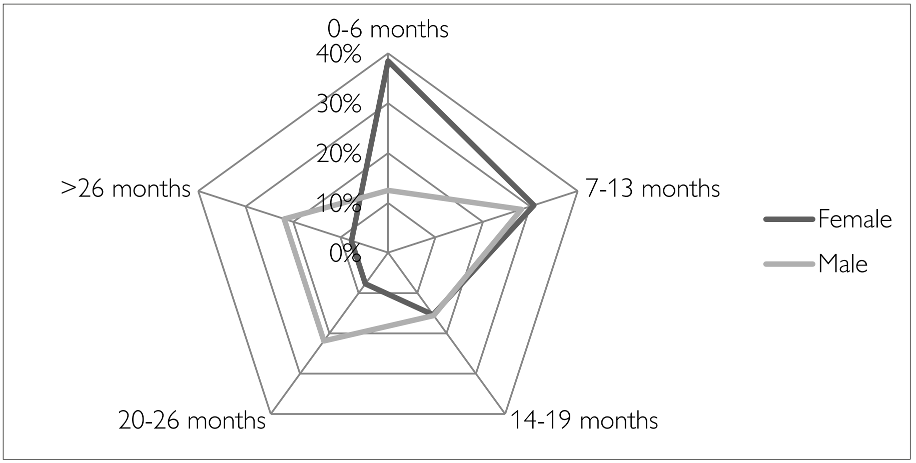

Figure 2.4 Total length of stay abroad of sandwich students (%), by gender.[13]

Experiences of the sandwich model training

Positive features

When interviewees were asked why they chose to stay in Sri Lanka and pursue the sandwich type or local PhD degree instead of going for postgraduate studies abroad, family reasons related to caring for parents or not wanting to leave husbands were the most common explanation among interviewed females. One significant reason given by many respondents were that they wanted to continue to do research when coming back to Sri Lanka, something that otherwise is considered hard after having pursued a full time PhD abroad. The sandwich students are never disconnected from their home universities and therefore have the possibility to continue their research when returning home. Two respondents explain:

> *"I got a place in the US. Sri Lankan always wants to go to US. But then there were other factors. I had a job so I had to leave that position at the university. Looking back I am happy for the simple reason that I could come back and continue my research. It is very different for the other students [who go abroad]. For the ones who come back it is very difficult to set-up and start research back in Sri Lanka". (Male)*

13 45 persons responded to questions relevant to this figure, e.g. gender and total stay rates abroad. Answers are presented as share of female respondents (13) and share of male respondents (32) respectively, not as percentage of total number of respondents.

> *"I planned to go to the US but got an ISP fellowship. At ISP we can do a project according to our requirements. It is more flexible (…). US people will get a PhD but they don't know where their findings will be applied. Here it goes back to the local scientific community". (Male)*

This feature of continuation of research was also emphasized in interviews with group leaders of the supported research groups, both by the ones with degrees obtained from abroad and by the ones with sandwich degrees. Two group leaders with foreign degrees explain:

> *"The sandwich model is good because you can keep people here (…). I like the sandwich model because when I came back from [doing my PhD in] the UK I had nothing to do here, no research and no support. When the sandwich students come back they can continue their research work here. They can do that. That was not here earlier". (Male)*

> *"With the sandwich model we don't lose the young intelligent people. Whereas if we send ten students to America one might come back. Even if they come back there is no guarantee that they will start some research. Once you are trained in a very advanced environment and then put back here, that person is lost. We had that problem all of us who did our PhD in US. This model has many positive features and retains the trainees in Sri Lanka, contributing to the socio-economic development of the country". (Male)*

The ISP provision of equipment also seems to have facilitated the continuation of research in the home country, according to interviewed respondents:

> *"We were not disoriented from home. One other thing is that we can gradually we got instrumentation to develop our research also. I thought it was a very good thing instead of being isolated for five to six years abroad". (Male)*

One person stated that he felt that he, through the sandwich program, could give something back to his country by studying things of importance to Sri Lanka. Another respondent pointed to the positive feature of host supervisors adapting the research to the situation in Sri Lanka, for instance in terms of only using low-cost materials. Other positive things brought up were the foreign exposure, meeting experts in the field, and getting access to advanced facilities.

Negative features

Regardless of being sandwich- or local students, the great majority of respondents graduated from their home universities in Sri Lanka. Only two respondents graduated in another country, both in Sweden. In countries where universities are certified to grant postgraduate degrees, students in ISP programs generally get their degrees from the home university. In the questionnaire and in interviews some respondents stressed the relatively low status of PhD degrees awarded at Sri Lankan universities compared to foreign degrees, especially from universities in the US or the UK. One respondent who lacked a permanent position when starting the PhD training described the risk he was taking when joining the ISP program instead of accepting a fellowship in the US. He felt that his local degree would not be valued as high as a foreign PhD degree when applying and competing for jobs after graduation in Sri Lanka. Another respondent describes a similar experience in terms of low status:

> *"[A negative feature of the sandwich model is] the extreme psychological stress from senior staff members, even highly respected, who used to degrade the sandwich type PhD". (Male)*

A few respondents argued that the sandwich model delays the completion of the PhD. Many respondents also brought up that they wanted longer periods of abroad stays, that the time in the host country was not sufficient. One interviewee pointed out that people did not want to join the (IPICS) program due to the low allowances provided, instead they went to the US where the economic benefits were better.

One respondent would have preferred to have a more organized rotating scheme regarding attendance to conferences. The person experienced that only one or two people in the group got to attend conferences, and suggested a rotating policy to create incentives for people to stay and do good work. Another respondent had similar opinions regarding who gets to go abroad for training and how often:

> *"The period of the foreign visit didn't have criteria. Some are getting more while others getting less. It should be better to give on a performance basis. There should be minimum three short visits for a person. There was no proper plan in the program. There need to be proper activity plan for the selected time (four to five years) maximum". (Male)*

Related to the host university, a few respondents brought up that communication between the host and local supervisor could be improved to make it easier for students, for instance regarding integrating the research work in both countries.

Views of host supervisors

Supervisors at host institutions (mainly in Sweden) were also generally very positive to the sandwich model and to receive students. The main benefits brought up were that the sandwich students widen perspectives, both culturally and regarding research. E.g. staff got in contact with other cultures, expanded their views, established valuable international contacts, and increased the diversity in the laboratories. The sandwich students developed and widened the research through new research ideas, new problems, and new angles and approaches. One supervisor pointed to that students coming from other countries often are more ambitious than Swedish students, due to their strong motivation and the high pressure they put on themselves to stand out from the crowd.

The limited monetary compensation for the supervision at the collaborating host institution was brought up as the main drawback, both to the host supervisor personally and to the host institution as a whole. Supervisors stress that supervision is time consuming and that the compensation given does not reflect the real costs of supervision. The sandwich collaboration was pointed out to be a financial burden for the research group since the faculty grant is based on the number of graduations in Sweden. Furthermore, because (most) sandwich students are registered, and receive degrees, from their home universities, no reward or compensation is given to the research group in Sweden.

Difficulties in relation to the training at home and abroad

In the questionnaire, respondents were asked to rate their experiences of their training situation with regard to five aspects, at both the host and home universities, on a scale comprising "mostly very good", "mostly good", "mostly difficult" and "mostly very difficult".

All but one respondent experienced the research training, the supervision, resources for research, the access to information, and the collegial support at the host universities, in Sweden and elsewhere, as mostly very good, or mostly good. A majority was also satisfied with the conditions and aspects for research training at universities in Sri Lanka. However, more dissatisfaction was expressed in relation to the training at the home universities than at the host universities. Most dissatisfaction was expressed regarding resources available for research at their home universities, in terms of both time and equipment, followed by the nature of the research training, the access to information on administrative rules and regulations of the department, collegial support and research networks at departments of training, and supervision in Sri Lanka.

Figure 2.5 shows a summary of research training-aspects experienced as mostly difficult and mostly very difficult, by gender. The experiences of females and males are similar. To a degree, however, males seem to be somewhat more dissatisfied with the research training (25 %) and the access to information and informal networks (15 %) in Sri Lanka than females. Females, on the other hand, experienced supervision (22 %), resources for research (40 %), and collegial support and access to networks (20 %) in Sri Lanka as a bit more difficult than males.

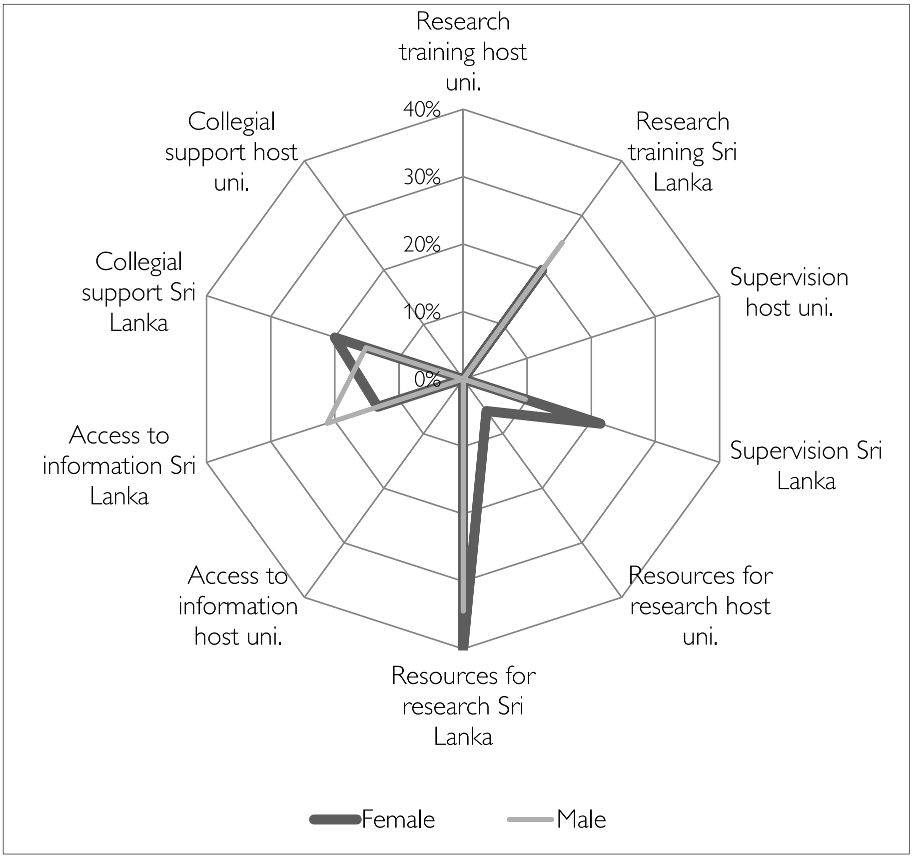

Figure 2.5 Share of respondents (%) expressing difficulties with the training situation, by gender.[14]

Significant differences are found in the experienced difficulties between chemistry and physics students regarding resources for research training ($p<0.05$) and concerning the research training itself ($p<0.05$) at the home universities (Figure 2.6). More than half (52 %) of the responding physics students were dissatisfied with the resources for research in terms of time and equip-

14 In the questionnaire respondents were asked to rate their experiences of their training situation in regards to the five aspects shown in the figure, at both host and home universities, on a scale comprising "mostly very good", "mostly good", "mostly difficult" and "mostly very difficult" (Appendix 1, q28). Figure 2.5 show a summary of respondents' answers "mostly difficult" and "mostly very difficult", presented by gender. 46–48 people answered the different aspects of this question, 13–15 females and 31–33 males.

ment at the physics departments in Sri Lanka and 33 % were dissatisfied with the local research training in general. This compared to 15 % and 12 % of the responding chemistry students. Physics students were also more dissatisfied with collegial support and research networks at the home university (22 %) compared to the chemistry students (10 %). Chemistry students, on the other hand, showed greater dissatisfaction than the physics students with access to information at the home university, with resources for research at the host university and the Sri Lankan supervision.

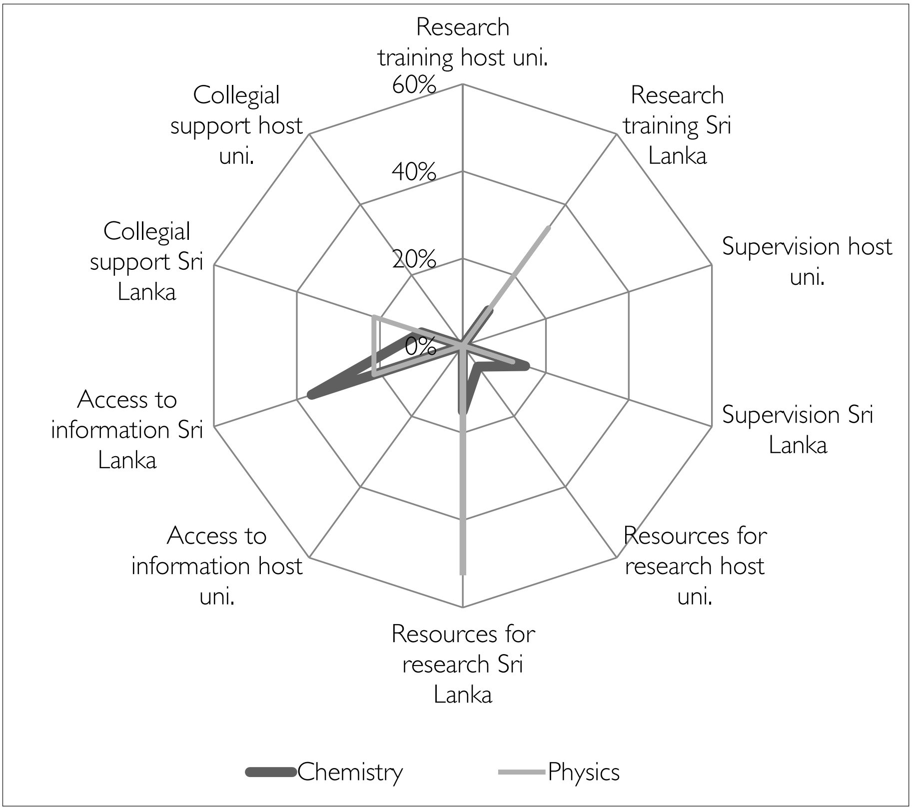

Figure 2.6 Share of respondents (%) expressing difficulties with the training situation, by discipline.[15]

[15] In the questionnaire respondents were asked to rate their experiences of their training situation in the five aspects shown in the figure, at both host and home universities, on a scale comprising "mostly very good", "mostly good", "mostly difficult" and "mostly very difficult" (Appendix 1, q28). Figure 2.6 show a summary of respondents' answers "mostly difficult" and "mostly very difficult", presented by field of science. 46–48 people answered the different aspects of this question, 17–20 chemistry respondents and 25–29 physics respondents.

When interviewed respondents were asked about experienced difficulties in relation to the training, poor facilities in Sri Lanka was brought up as a problem. Most mentioned that the lack of access to internet and journal articles made communication with others hard, and that it delayed research work back home. The difficulty to access online journals is still remaining at universities in Sri Lanka today.

> *"We were very poor at the time here. I cannot compare it to today. Now you have internet everywhere. We did not have all the research papers in the library. We were hundred percent dependent on our visit to bring it back from Sweden. We collect all the things and bring here for us and for our future students. We took photocopy and collected as much as possible. ISP allowed us 80 kg of shipping. When you visit our lab you can see all the papers collected by us". (Male)*

One person mentioned that the period in Sri Lanka was not as fruitful as the time spent in Sweden, because he could spend full time on his research in Sweden whilst he had to spend about 50 % on teaching in Sri Lanka. One external factor outside the universities causing difficulties for students was the civil disturbances, resulting in the closing of universities for long periods of time.

Integration at host universities

The interviewed former students felt well integrated and included in the host research groups when visiting. Many answered that it was thanks to their supervisors. Most interviewed students were also positive towards their daily life in Sweden. Again, the supervisors seem to have contributed to this social life outside the university for some of the students, combined with the fact that the students could bring their families along. Some interviewed respondents also describe a community of Sri Lankan people in Sweden who contributed a lot to their social life. Three interviewed respondents describe their social interactions outside the university:

> *"Over the weekend people in the group they did something special or some arrangements for us. Some type of social activities were always there". (Female)*

> *"There were 10–12 families from Sri Lanka there (in Sweden) at the time. They helped us a lot. They had a Sri Lankan community. They got information if new students were coming. My earlier seniors were there before me. Not very much Swedish contact actually. Although group members invited us for dinners and things and people in our own age invited us to parties and so on". (Male)*

"I was there with my family so there was a lot of playing outside. We had a lot of friends, both Sri Lankan and Swedish. We used to meet during the weekends or get invited to their houses so that was the social interactions. When we were there were a lot of Sri Lankans there doing research but since my kids were there they had friends and we became friends with their parents". (Male)

Most of the host supervisors also experienced that the students became well integrated into the research groups at the departments and that no discrimination has occurred against Sri Lankan ISP students during their visits. One supervisor did, however, point to that students from Sri Lanka had experienced unpleasant situations outside the university, with hard degrading looks. Even though none of the interviewed former students explicitly answered that they had experienced any negative treatment during the period of training in the host country, two interviewees, told stories that indicate a (Swedish) society not free from discrimination:

"We heard that about some skin headed young people that on Fridays smashed street lights and bus places. We heard that one student in Uppsala was attacked by those people. Not a Sri Lankan student, it is rumors right? But we were afraid to go out in the evening especially on holidays. So that problem was there". (Male)

"No discrimination at all. Some people said black heads, but that was for Arabic people not for us. We had an experience with a drunk person one time, but that was a drunk person, not a normal person". (Male)

The latter person also stated that:

"People were very friendly and happy because they knew that we came for educational purposes. We were educated people who came for education and not for refugee status. We are not going to stay, we are going back. So the feeling was very good". (Male)

2.2.3 Career development and mobility

This section covers the post training period, including graduates current employment position and working conditions. The geographical- and sectorial mobility of graduates is also presented here.

Current employment position and conditions

At the time of this study, 64 % of the respondents were working in the university sector in Sri Lanka. Of them, 39 % were employed at their university of graduation while 25 % were employed at a different academic institution in the country (Figure 2.7). Respondents in the latter group expressed in interviews that it was the lack of employment positions at their university of graduation that forced them to seek opportunities elsewhere. This mobility of graduates within the university sector does seem to have had advantages. Graduates from one of the physics research groups, now working at different universities and institutes, are still in contact with each other and are collaborating by sending students from more recently established, less equipped universities to established universities and institutes, with more facilities.

Outside the academic sector, the largest employers of responding graduates are governmental- and public agencies or organizations (15 %, 8 people). Respondents in this sector are employed at the Sri Lankan Institute of Nanotechnology, the Institute of Fundamental Studies, the Palmyrah Research Institute, the Central Bank of Sri Lanka, and the Ministry of Defense & Urban Development. The three first mentioned institutes are all research institutes where respondents spend close to full time on research, unlike most positions held by respondents employed at universities. One responding graduate is employed in the private sector in Sri Lanka.

In terms of geographical mobility, 13 % of the respondents currently work outside Sri Lanka. Five are working in the university sector in Canada, Malaysia, New Zeeland and USA,[16] and two are working in the private sector in Australia and Canada.

There were no significant differences in current sector of employment in relation to field of science, level of degree, or gender.

[16] Respondents are employed at University of Manitoba, Canada; University of Toronto, Canada; Lincoln University New Zealand, University of Illinois, USA and Putra University, Malaysia.

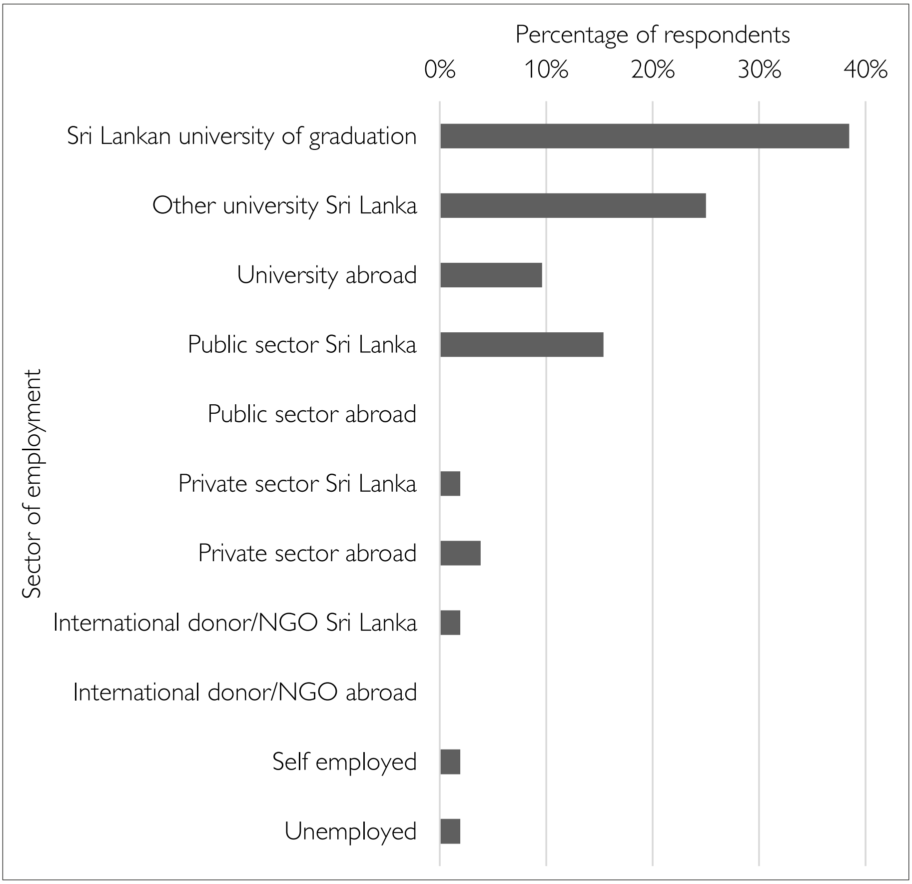

Figure 2.7 Current sector of employment of respondents (%).[17]

The most common position at universities among responding graduates is lecturer, held by 29 respondents (Figure 2.8). Among the respondents are also one Vice Chancellor, one Dean, eight Professors, two Associate Professors, and six Heads of Department.

In relation to the relatively low number of female respondents to the questionnaire (18 out of 52 respondents to this question), the female representation in academic positions can be considered quite high. One of the interviewed respondents believes that the high number of females in academia in Sri Lanka is related to the relatively lower income in science:

> *"In Sri Lanka there are more women in academy than men. In the Global Academy we talk a lot about getting the women in science but that has never been an issue for Sri Lanka. If you take our special degree programs 70 % are girls and*

17 52 respondents answered this question (Appendix 1, q38).

> *30 % are boys in science. Even if you take the academic staff you will find more women than men. So there has been no problem. Men prefer high salary jobs. That is why they don't want to move into the science field". (Female)*

Under the category "Other" there is one Principal Research Scientist and one Research Officer working at research institutes, one Science Librarian at a university, and one Scientist working for a pharmaceutical company, all females.

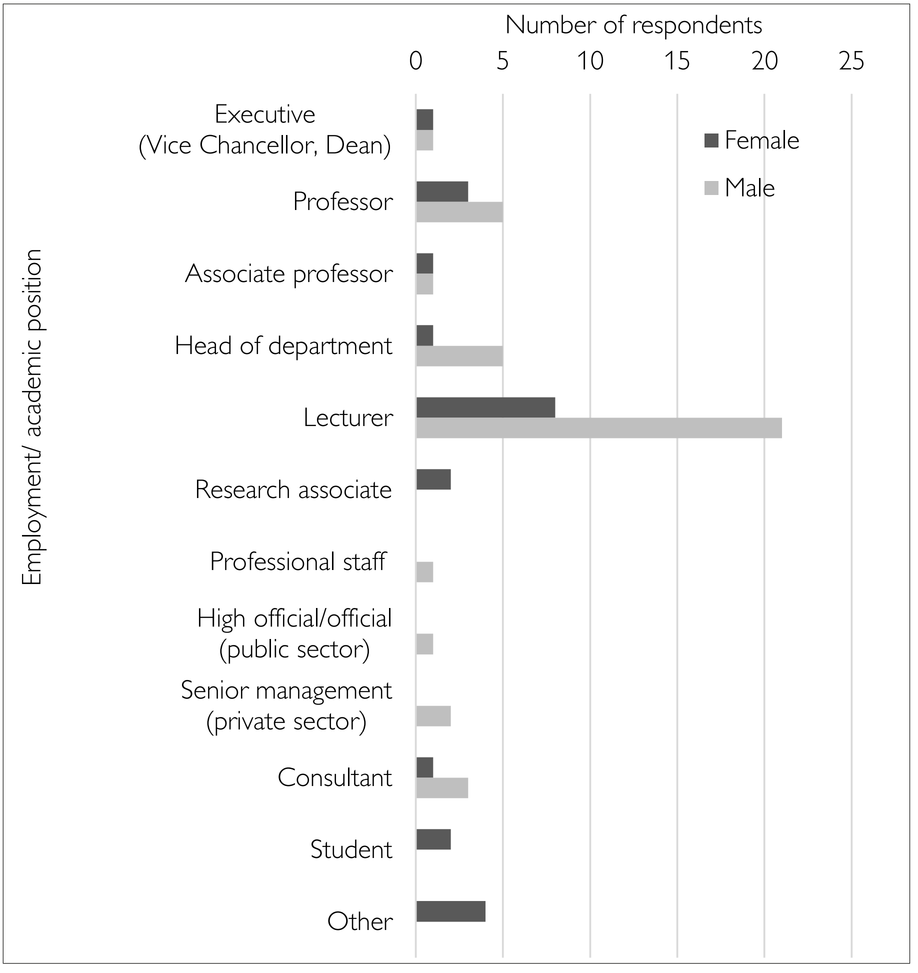

Figure 2.8 Current employment/ academic position of graduates, by gender (multiple positions may be held).[18]

[18] 52 people respondents to this question (Appendix 1, q39), 18 females and 34 males. Respondents could choose multiple positions.

Satisfaction with current employment

The great majority (96 %) believe that their current employment position correspond to a large or a very large degree to their academic qualifications, regardless of gender, field of science, or level of degree. In addition, all but four respondents express that their MPhil or PhD degree has contributed "very much" to their current position.

In general, the respondents seem very pleased with the situation at their current work place. When it comes to overall satisfaction with their work tasks, 90 % stated that they are satisfied or very satisfied (48 % and 42 %, respectively). This is also the case for specific areas related to their current work place, with 80–90 % stating satisfaction with their working conditions, job security, intellectual challenge, level of responsibility, degree of independence, contribution to society, as well as social status of their current position. Salary stands out as the one area where respondents are dissatisfied or very dissatisfied (Figure 2.9). Opportunity for career advancement and intellectual challenges followed as the second and third area, respectively, of experienced dissatisfaction at the current employment position.

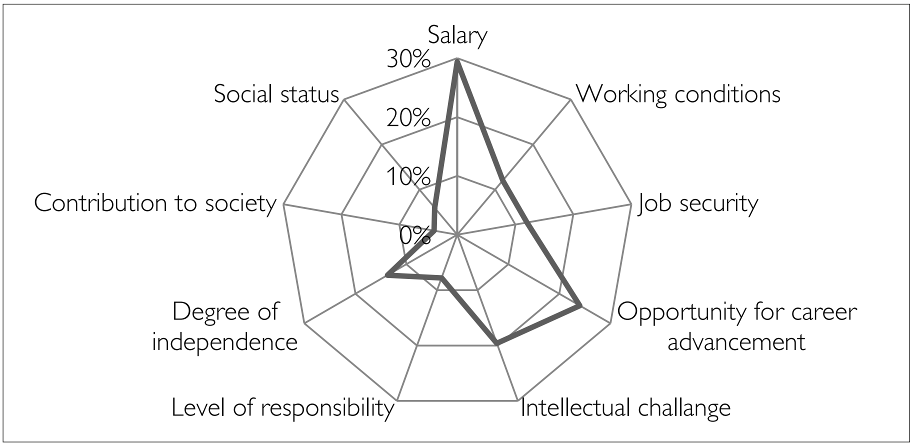

Figure 2.9 Share of respondents (%) expressing dissatisfaction with aspects of current employment position.[19]

19 In the question respondents were asked to rate their satisfaction with their current employment position ranging from "very satisfied", "satisfied", "dissatisfied" to "very dissatisfied" (Appendix 1, q45). Figure 2.9 presents a merge of respondents' answers "dissatisfied" and "very dissatisfied" in aspects related to their current position. 50–51 people answered the different aspects of this question.

Yet, only 29 % of the respondents expressed dissatisfaction with salary, meaning that a majority expressed that they are satisfied or very satisfied with what they are paid today. This is also found when asking respondents about supplementary income. A majority (77 %) of the respondents stated in the questionnaire that they only have one income generating employment. In interviews many respondents point to that the university salaries are satisfactory today compared to other positions in Sri Lanka, and that there has been an increase over the past years. However, university salaries are lagging behind the ones in the private sector, and some point to that although one can manage through the month, saving money is very difficult.

> *"Salaries are ok compared to other people. And they are better now, they have improved. Compared to the expenditures here it is not enough though. You can manage. But during the past few years people resigned [to go abroad] and they don't come back. PhD's leave because salary is five to ten times higher abroad". (Male)*

Females and males are equally satisfied/dissatisfied with their salaries. However, more males than females are dissatisfied with their career advancement opportunities and level of responsibility, and more females than males with the working conditions, the intellectual challenge, degree of independence and contribution to the society (Figure 2.10).

In all, it should be emphasized that 70 % or more of both females and males reported that they are satisfied or very satisfied with all of the areas related to their current employment position.

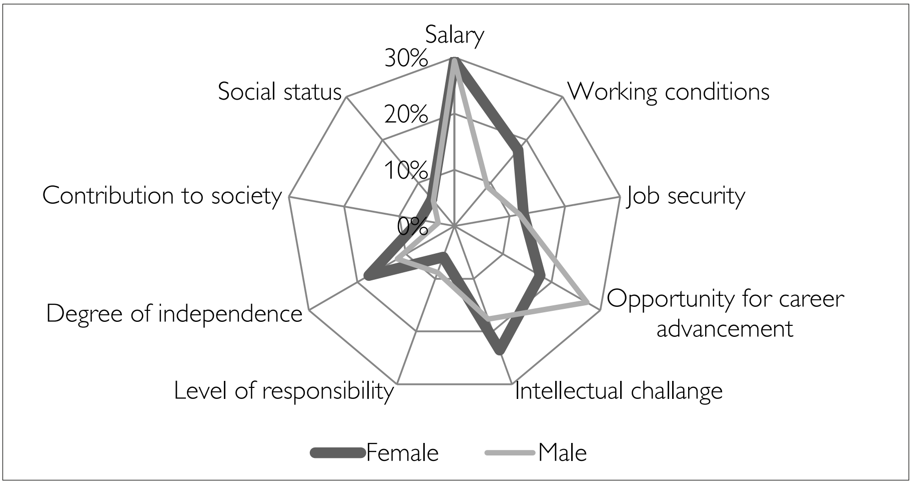

Figure 2.10 Share of respondents (%) expressing dissatisfaction with aspects of current employment position, by gender.[20]

Geographical and sectorial mobility

A majority of the respondents have since graduation held no more than 1–2 positions. Close to 30 % have had 3–4 positions, and 8 % have had 5–6 positions or more.[21] No significant difference where found regarding academic field, level of degree or regarding gender (Figure 2.11).

Geographical mobility among the respondents can generally be considered quite high, with close to half of the respondents having worked abroad after graduation, males to a slightly larger extent than females. Altogether, respondents have worked in many countries in Europe, Asia and the Pacific, America and Africa.[22] Most of these respondents (23) held positions abroad as researchers, four persons were employed in the private sector, four were lecturers and

[20] In the question respondents were asked to rate their satisfaction with their current employment position ranging from "very satisfied", "satisfied", "dissatisfied" to "very dissatisfied" (Appendix 1, q45). Figure 2.10 presents a merge of respondents' answers "dissatisfied" and "very dissatisfied" in aspects related to their current position, by gender. 50–51 people answered the different aspects of this question, 16–17 females and 33–34 males.

[21] The bias of when people graduated has not been considered here. A person graduating in the 1990s or earlier of course has had the chance to have more employment positions than someone graduating in the late 2000s.

[22] *Europe*: Finland, France, Germany, Italy, Portugal, Sweden, Switzerland
Asia and the Pacific: Australia, Fiji, India, Japan, Malaysia, New Zeeland, Pakistan, Thailand
America: USA, Canada
Africa: Nigeria

one person was consulting. Importantly, 87 % of the respondents to the online questionnaire have returned to Sri Lanka, living and working in the country at the time of the study.

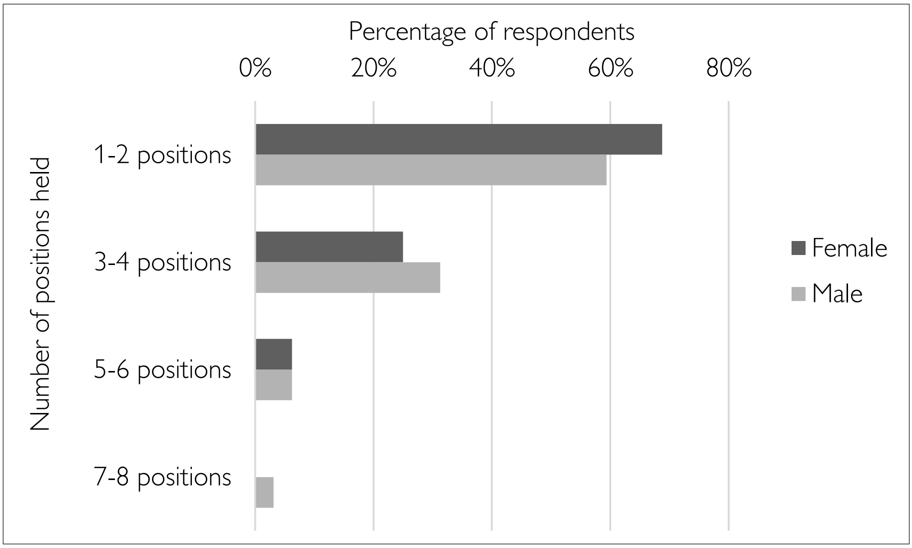

Figure 2.11 Number of positions held by respondents (%) since graduation, by gender.[23]

Group leaders of supported groups do estimate similar numbers. The physics group leaders state that approximately 71–95 % of the PhD- and MPhil graduates have stayed in the country while chemistry graduates seems to have migrated abroad to a slightly larger extent. Most of the chemistry MPhil- and PhD graduates from University of Sri Jayewardenepura (88 %) has stayed in Sri Lanka, while a similar share of the graduates from University of Jaffna have left to go abroad. Furthermore, it is estimated that 50–60 % of the graduates from the chemistry groups at University of Peradeniya and University of Colombo currently are working in Sri Lanka. In conclusion, a majority of the PhD- and MPhil graduates are still in Sri Lanka today.

The potential benefits of graduates migrating abroad is not to be neglected. A graduate from the atmospheric physics and lightning group at University of Colombo has been working at Uppsala University, Sweden since he graduated in the 1980s. He has functioned as the main collaborating partner and host supervisor to students from the Sri Lankan research group he left, and is still co-supervising most of the students in the group. On 2 December 2015, he was awarded an Honorary Doctorate by University of Colombo, Sri Lanka.

[23] 48 people answered this question, 16 females and 32 males (Appendix 1, q47).

2.2.4 Research results and collaboration

In the previous section we learned that a majority of responding graduates are working at universities and research institutes in Sri Lanka. This section focuses on the research activities and collaboration: Are respondents still actively conducting research? How much have they published since graduation and where? Which are the opportunities for research funding? Are they collaborating with other scientists, nationally and internationally?

Research activity

The questionnaire showed that a large majority (93 %) of the respondents holding positions where research can be carried out, are still actively conducting research to various degrees. About half of these respondents (48 %) stated spending 25 % or less of their time on research, while the second half (45 %) spend 50 % or more of their time conducting research. 7 %, all female, stated not spending any time on research at all.

Regarding gender, a larger share of the male than female respondents spend 25 % and 75 % of full time on research, respectively (Figure 2.12). While a larger share of the female than male respondents are represented in the remaining categories: full time, 50 % of full time, less than 25 % of full time and not at all. A similar variation is shown regarding discipline of science (Figure 2.13). A larger share of the physics respondents than chemistry respondents spend 25 % and full time on research, while a larger share of the chemistry respondents are represented in the other categories.

Most of the interviewed respondents employed at universities, describe research work as supervision and doing research project work with PhD-, MPhil-, Master- and undergraduate students. The limited time available for research was expressed as a problem by respondents employed at universities. The main reason given was the large focus on, and tradition of, teaching at universities, in combination with the high administrative burden. More than half of respondents are devoting 50% of their time on these tasks.

> *"University of Peradeniya is a teaching university (…). It is a traditional university, mainly used for teaching. But the research culture has also now developed. Compared to early days a lot of research groups are here now". (Male)*

> *"At the moment I don't have time to do research. At conventional universities there is a three months research period but at this university no. That is the problem. (…) I am writing one research paper. After 12 o'clock at night I do it. (…) My university is very focused on open distance learning, so we have to spend a lot of time on making materials for the students. That is why I don't have much time for research". (Female)*

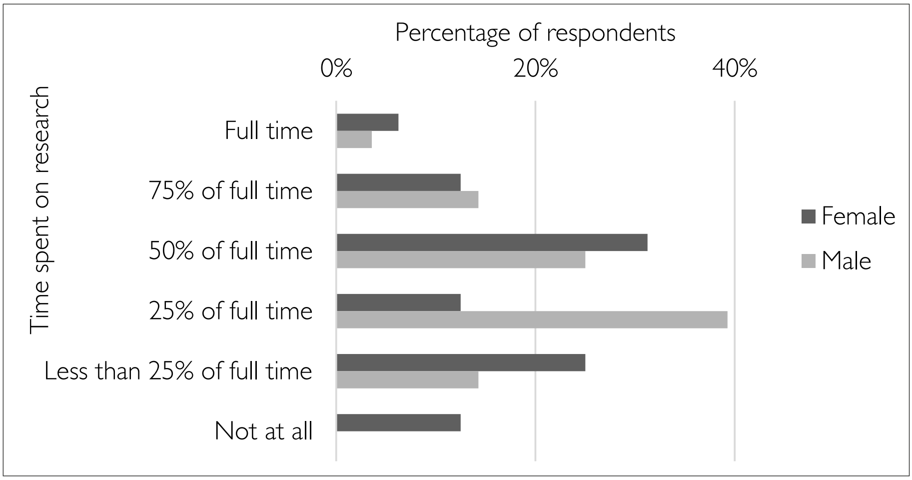

Figure 2.12 Share of respondents (%) currently actively conducting research, to different degrees of full time, by gender.[24]

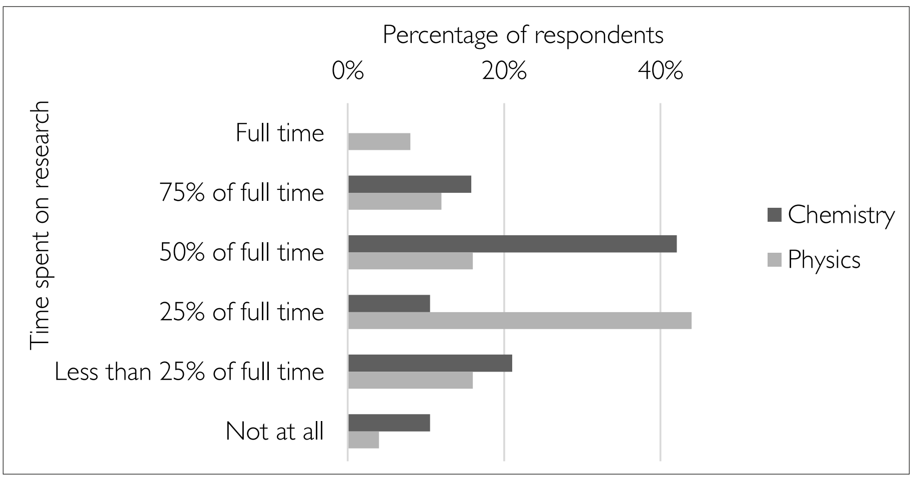

Figure 2.13 Share of respondents (%) currently actively conducting research, to different degrees of full time, by discipline.[25]

Interviewed respondents who are not employed at universities have a lot more time to dedicate to research. Three respondents working at a department located under a ministry, at a public/private research institute, and at a private

[24] 44 people (16 females and 28 males) answered this question (Appendix 1, q54), all assumed to hold positions where research work can be carried out, i.e. universities, research institutes or companies.

[25] 44 people answered this question (19 chemistry graduates and 25 physics graduates) available in Appendix 1, q54.

company spend close to full time on research. However, the latter person is restricted from publishing his result because he is doing commercial product research in the private sector.

Research funding

Most (60 %) of the funding of current research activities of respondents comes from the Sri Lankan government, followed by private funding, international donors and international research funds (Figure 2.14). One person sometimes uses private money for purchase of consumables (represented under "Other"). This is related to the heavy administrative- and time consuming task of buying equipment, consumables or other things for the university, that according to interviewed respondents, take anywhere from three to eight months from order to delivery. By using private money to buy smaller equipment or chemicals through for instance e-bay, the price is better and delivery times shorter than when procured in the university system.

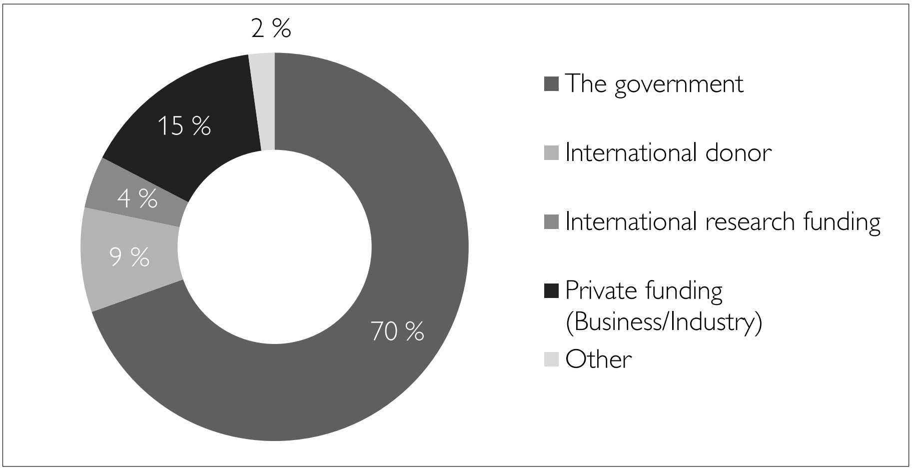

Figure 2.14 Share of respondents (%) receiving funding for current research activities, by source of funding (respondents could choose multiple options).[26]

Most of the interviewees express that the development of higher education and research in Sri Lanka is moving forward and improving, with increasing opportunities for funding and a greater focus on, and recognition of, scientific

[26] 38 people answered this question (Appendix 1, q55). Respondents could choose more than one option.

research. Something that also can be seen through the large share of the respondents research grants coming from the Sri Lankan government.

The major government funding agency supporting responding graduates is the National Science Foundation. The grants from the foundation are described as highly competitive and small in scale, but most of the time enough to support students, to buy consumables and in some cases also equipment.

> *"You can maintain with local money but you cannot develop with that money. You don't get a lot of money to buy equipment. Only for chemical consumables you get money usually less than 3 million Sri Lankan Rupees [approximately 170,000 SEK] for three years". (Female)*

> *"It is limited. We can get research funding but not in large scale. We can support student salaries and buy instrumentation. But we cannot establish a top class lab, which can live up to developed countries' labs". (Male)*

One problem brought up by one respondent is the lack of proper evaluation system for grants:

> *"It is a small country, therefore if applicants are friends with people on the board [at the grant giving agency], they will get it. They don't evaluate the project, they give it to friends without evaluating it properly. No proper evaluation panel. I applied earlier a few times, but I didn't get it. And it is only money for research students not for other things like conferences". (Male)*

Two respondent express concerns about the increased demand of product based research:

> *"Now the government is going for applied research and not basic research. In that case we are facing some problems because we are doing basic research. The administration and new government are thinking that without having to producing something doing research is nonsense. They ask us why we cannot produce a product like a battery. They are asking for the end product in the application. Each application we send there is a separate column for that. What is the end product of our research? We should produce something that has a marketing value, something that can be put into the market without any difficulties". (Female)*

> *"We are asked to go for product based project at the university but also nationally. I want to develop a teabag where we have this herbal preparation but finding money to do that is hard. You have to find a pharmaceutical company to get the teabag produced. We have no way of getting it done. Even though we are under pressure to be more productive, which we actually want to be, this barrier of getting grants is the biggest problem. And companies are important if you are product based, because the university cannot produce the tea bag. So you need either a state pharmaceutical corporation or another private collaboration, which is very difficult". (Female)*

Publications and journals

To encourage researchers to publish in scientific journals, the Sri Lankan government is giving incentives in the form of research allowances, and through the President's Awards for Scientific Publication. The latter is aiming to recognize Sri Lankan scientists whose work reached international standards and to increase national scientific production (NRC, 2011). Everybody is not positive to these incentives and mean that the Sri Lankan government has to raise the bar for allowances and awards so people don't just publish to get the allowance:

> *"Here you become a professor after you have had a certain number of publications, people don't have to do anything else. They cannot reach higher up [than professorship] so they get uninterested in research after becoming a professor. That mindset has to be changed. The government is giving certain research allowance for publishing paper. So people publish something somewhere just to get research allowance. I think the government has to change that to be in international high impact journals". (Female)*

According to the questionnaire answers and the WoS search, a majority of the respondents (74 % according to questionnaire answers and 68 % according to the WoS search) have since graduation published at least one paper in WoS journals. Some graduates have been more active than others publication wise. According to the WoS search, 32 % have not published any papers in WoS journals while 17 % have published more than 13 papers (Figure 2.15).[27] The average number of publications after graduation by respondents is, according to what is found in WoS, five publications.

The journals where graduates published were also considered in the bibliometric search. According to what was found in WoS, responding graduates have published 261 papers in 136 WoS peer-reviewed journals. The quality of journals are considered using *t*he Norwegian list for evaluating academic venues (NSD). The NSD ranking of the 10 most common journals of publications among graduates in chemistry and physics, respectively, are summarized in Table 2.5 and specified in Table 2.6.

Overall the 116 published articles in the 10 most common journals for chemistry and physics listed in Table 2.6 indicate that graduates publish in quality, peer-reviewed scientific journals. According to the NSD ranking most papers (69 %) are published in journals ranked to level 1 (Table 2.5), i.e. classified as scientific publication venues. 23 % of the papers are published in journals ranked to the highest level by NSD (level 2), meaning they are extra prestigious scientific journals (NSD, 2017).

27 What year respondents graduated has not been taken into consideration here.

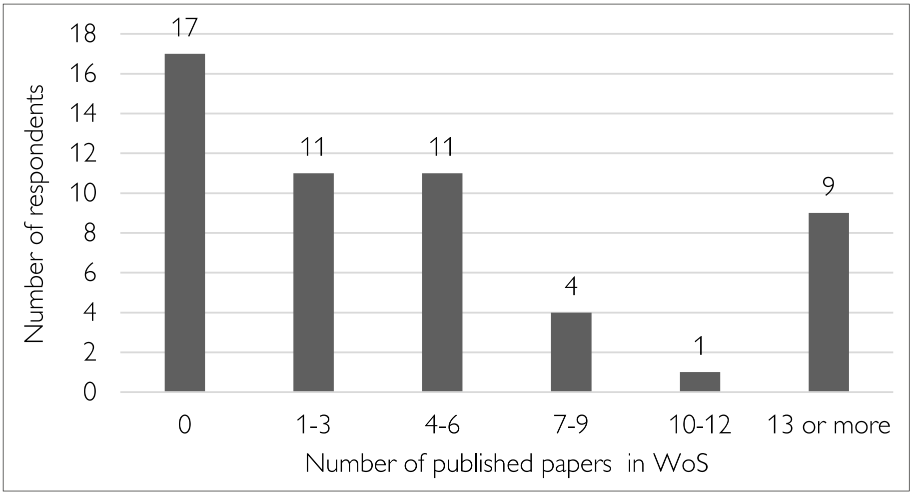

Figure 2.15 Number of respondents having published papers in WoS journals after graduation, by number of publications.

One of all the 136 journals where graduates have published, *The International Journal of Electrochemical Sciences*, is found on Beall's famous "blacklist" of publication venues, listing questionable and possible predatory open access journals. Publications in these types of journals are the opposite of a merit to the researcher and the university. Among graduates there was only one instance of publication in this journal.

Table 2.5 Ranking of the top 20 most common journals of publication of graduates, aggregated.

NSD rank*	Number of publications	% of publications
Level 2	27	23 %
Level 1	80	69 %
N/A	9	8 %
Total	**116**	

* The Norwegian NSD list stretches from 0–2, where 2 is the highest rank.

Table 2.6 The 20 most common journals of publications, by number of publications and field of research.

Chemistry Journals	No. of publications	NSD rank
Phytochemistry	11	2
Journal of the National Science Foundation of Sri Lanka	9	N/A
International Journal of Food Sciences and Nutrition	6	1
Starch-Starke	6	1
Biochemistry	5	1
Journal of Photochemistry and Photobiology A: Chemistry	5	1
Journal of Biological Chemistry	4	2
Natural Product Research	4	1
Journal of the Science of Food and Agriculture	3	1
Journal of Thermal Analysis and Calorimetry	3	1
Physics Journals	**No. of publications**	**NSD rank**
Solid State Ionics	15	1
Journal of Atmospheric and Solar-terrestrial Physics	12	1
Progress in Electromagnetics Research	7	1
Electrochimica Acta	6	2
Current Science	5	1
Journal of Applied Electrochemistry	3	1
Journal of Electrostatics	3	1
Journal of Power Sources	3	2
Journal of Solid State Electrochemistry	3	1
Solar Energy Materials and Solar Cells	3	2

Dissertation type

The standard format of a doctoral dissertation at universities in Sri Lanka is a monograph, which is one single piece of book type work, which normally does not include previously published material. Results from the tracer study shows that 84 % of the responding graduates did their theses in form of monographs. Despite this, 51 % of the responding graduates (both MPhil and PhD) in the tracer study have published results in international peer-reviewed journals before graduating according to what is found in WoS.

Interviewed graduates mentioned that the good thing with the monograph is the fact that it improves the writing ability and that all results can be represented. On the negative side it was brought up that it is a very time consuming model and that people can graduate without publishing anything. In the multi-paper thesis format you have to publish articles to get your degree, which is an indication of the quality of the work. However, it was mentioned that trying to get papers published is a time consuming task, which might delay the degree.

Research collaboration

Collaboration and networking is an essential part of scientific work and contributes to increased quality (UNESCO, 2010). The bibliometric search in Web of Science shows that after graduation 24 of the respondents (45 %) have published altogether 63 papers with co-authors at universities, institutes and private companies in Sri Lanka. About half (52 %) of the publications after graduation by responding graduates have been with co-authors outside Sri Lanka, mostly in Europe and Asia. Sweden is the most common collaborating country for publications with European colleagues, with most papers published in collaboration with the former host institutions. In Asia, most publications have been co-authored with researchers in Japan.

Questionnaire answers show that research collaboration in form of joint publications, joint research projects, and joint applications are most prominent with collaborators in Europe and Asia (Figure 2.16). To some extent, Sri Lankan graduates collaborate also with scientist in Latin- and North America, and in Africa.

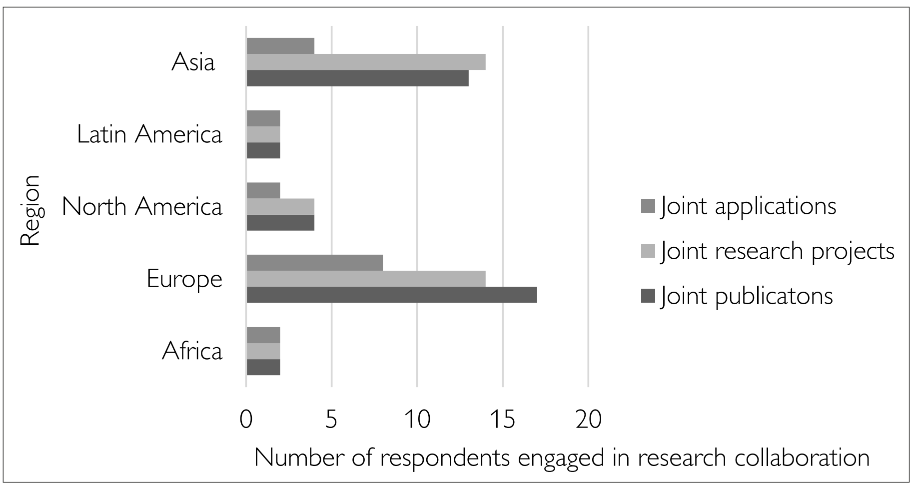

Figure 2.16 Number of respondents engaged in research collaboration with scientific partners, by continent and type of collaboration (respondents could choose multiple options).[28]

When interviewed respondents were asked if it is hard to establish collaboration outside Sri Lanka, the problem emphasized was how to contribute from

[28] The figure shows a combination of question 41 – type of collaboration, and question 42 – region of collaboration, found in Appendix 1.

the Sri Lankan side. The lack of available funding and equipment restricts collaborating opportunities according to two respondents, since they feel that they do not have much to offer. One person explains:

> *"Always in a good relationship you have to spend something. You have to spend your knowledge and your resources. That is how a good link will develop. For example in recent years a Malaysian group wants to develop their relationship with us. They facilitate me when I visit; they have accommodation, food and money. But when they come here we don't have any money to give back to facilitate them. [There is] no way to spend money on them. You have to use your own money. From university money we cannot spend a cent. We cannot invite guest to come to the university". (Male)*

A majority (59 %) of respondents state that they are still in contact with their collaborating department from the time of ISP support. The collaboration is mostly in form of research cooperation, joint research projects, and co-publishing (Figure 2.17). According to what is found in WoS, 18 of the respondents have co-published in total 62 papers in international journals after graduation with their host institution. To a small extent, there is also collaboration in terms of supervision of students, lecturing, and administrative collaboration. In some cases the contact is purely of personal character. Advice for ongoing research is also mentioned, as well as postdoctoral training and financial support for conferences, which is grouped under "Other".

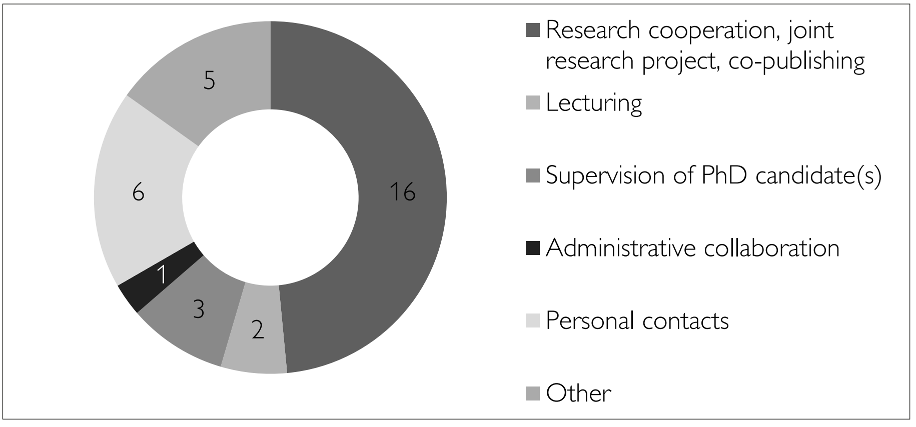

Figure 2.17 Number of respondents collaborating with former host departments, by type of collaboration (respondents could choose multiple options).[29]

29 29 respondents answered this question available in Appendix 1, q37. Respondents could choose multiple options.

Future plans

When asking respondents about their future plans, many expressed the intention to stay at their current workplace and continue with their research. Some are aiming at becoming professors and some to go on sabbatical leave to update their knowledge. A physics respondent expressed the intention to start up a research institute or a business in lightning protection, to help the government assist the scientific community. One chemistry respondent expressed her future intention in terms of what she wants to achieve with her research:

> *"I just want to synthetize one drug that is coming from Sri Lanka. Any compound that can come from Sri Lanka. Still we have not produced anything from here. Hopefully I will be the first one to do it". (Female)*

Another graduate could see herself at her current position also in the future:

> *"I think this [position] is enough. If we can do good research while teaching at the university we are serving the country. What they have provided to us we give back in return. We got the free education from Sri Lanka. That is why after finishing the PhD we didn't think about leaving the country. We [me and my husband] wanted to stay in the country and serve it". (Female)*

2.3 Follow-up study Sri Lanka

While the tracer study focuses on former students part of ISP supported groups, this section focuses on the research groups as such. The purpose of the follow-up is to analyze and assess ISP's collaboration with Sri Lankan research groups in chemistry and physics in relation to ISP's most recent goals, and the objectives stated in ISP's Strategic Plan 2013–2017 (ISP, 2013b).

This part covers areas of effectiveness, efficiency, impact, and sustainability. To the extent applicable, the Results Based Management Logical Framework established by ISP in 2013 serves as a base for assessment (Available in ISP, 2013b).[30] The focus is on research groups located at four universities in Sri Lanka; University of Colombo, University of Peradeniya, University of Jaffna and University of Sri Jaywardenepura, and supported by ISP during the period 1978–2010.

The quantitative data is provided from ISP's internal records (IPICS and IPPS Project Catalogues and Annual Reports) and the online questionnaire sent out to traced graduates from ISP supported research groups. In addition, publication data has been obtained from the WoS database. The qualitative data comes from interviews with group leaders and graduates from supported research groups, and from CVs of graduates.

2.3.1 Training and publication outcomes

The major focus of ISP's operation since the start has been to contribute to the strengthening of scientific research and postgraduate education within the basic sciences in low-income countries. Scientific research training with ISP support has been ongoing for over 30 years in Sri Lanka. The most basic and measurable outcome of the provision of research training has been postgraduate degrees and publications. Therefore, this section will focus on research and capacity building of the supported groups, measured by training outcomes and publication activity, including quality of publications and journals. Efficiency of the support in terms of training and publication outcomes is also presented here.

30 When ISP was evaluated in 2011 (GHD, 2011), the evaluators observed the lack of a program logic and clear linkages between different levels of result. Based on their recommendations, and as required by Sida, ISP developed a Results Based Management Logical Framework, which to the extent possible will serve as reference to this evaluation report. Despite of the fact that the collaboration reaches over 30 years back in time the Logical Framework is relevant because the main objectives of ISP have been based on essentially the same core values since the beginning of the 1970s.

In this respect, the annual activity reporting from ISP supported research groups has been consistent since the beginning of the support period, meaning that extensive longitudinal records are available. WoS has been used to provide supplementary information, and has served as a platform for looking further into the effects of ISP support at this fundamental level of capacity building.

Training outcomes

When ISP started support to Sri Lanka the opportunities for PhD training in chemistry and physics were scarce or non-existent. ISP helped to establish PhD programs in both fields at several departments, via research collaboration and exchange with host research groups mainly in Scandinavia. The first PhD graduation in physics from a Sri Lankan university was in 1991, by a sandwich student from an ISP supported research group at University of Peradeniya. The second physics PhD graduated shortly thereafter from an ISP supported group at University of Colombo.

At this stage of development it was not anticipated that groups would generate a significant number of graduates, but the aim was rather to increase the capacity of the staff to be able to carry out research and to train others. However, in many research groups the building of scientific capacity was closely linked to the training of PhD students. Naturally, this capacity building was a gradual process, taking many years. In due time, local PhD programs were established at all supported departments, where students were trained without any period abroad. Sandwich model training still continued, however, in parallel with the local programs. MPhil- and MSc students were also trained in supported groups.

The number of students groups graduated over the years of support depend on factors such as number of years of support, funding received, capacity, and number of supervisors. Aggregated, ISP supported groups have over the years graduated 69 PhD students and 157 MPhil and MSc students (Table 2.7).

Table 2.7 Number of graduations, expenditures and number of years of support, by research group.

Research group/University	Graduations PhD	Graduations MPhil/MSc	Exp. SEK	Years of support	
University of Colombo					
IPICS SRI:02	10	44	2.5M	1979–2002	24 years
IPPS SRI:01/1	12	14	9.8M	1978–2010	33 years
IPPS SRI:01/2	5	4	8.8M	1981–2010	30 years
IPPS SRI:01/3	0	1	0.5M	2005–2010	6 years
University of Peradeniya					
IPICS SRI:03, 03/1, 03/2, 03/3 & 03/4	13	14	2.8M	1981–2002	22 years
IPPS SRI:02	18	60	13.1M	1983–2010	28 years
University of Jaffna					
IPICS SRI:04	5	8	2.5M	1985–2006	22 years
University of Sri Jayewardenepura					
IPICS SRI:07	6	12	3.4M	1995–2009	15 years
Total	**69**	**157**	**43.5M**	**1978–2010**	**33 years**

National impact

Overall, a significant number of PhD students have been trained in ISP supported research groups, in relation to the number of doctoral students annually graduating from Sri Lankan academic institutions during the years of collaboration, and the initial capacity level of departments when starting support. When comparing the number of graduates from ISP supported research groups at the PhD level to all doctoral students graduating from Sri Lankan universities in the area of science, 10–50 % of the number of graduates between 2004 and 2010 are from ISP supported groups (Table 2.8).

Table 2.8 Number of PhD graduations in Sri Lanka in science and overall, number of PhD graduations (grad.) in ISP supported groups, and share of graduations from ISP supported groups in relation to the national graduation output, by year.[31]

Year	Number of PhD grad. in science	Number of PhD grad. in total	Number of PhD grad. in ISP groups	% PhD grad. in ISP groups of science PhD grad.	% PhD grad. in ISP groups of total PhD grad.
2004	4	9	2	50 %	22 %
2006	21	26	2	10 %	8 %
2008	10	24	4	40 %	17 %
2010	19	31	2	11 %	6 %

Completion time of PhD degrees

The 53 Sri Lankan graduates responding to the online questionnaire in the tracer study took on average 6.4 years to finalize PhD degrees and 3.7 years to finalize MPhil degrees. The average number of years for respondents to complete their doctoral degree is higher than the average completion time of graduates from ISP supported groups and networks between 2008 and 2013, which is 4.9 years (Andersson & Sundin, 2016). Still, it is within the same range as the average Swedish completion time of a PhD degree in the natural sciences, which has been reduced from 6.5 years in the beginning of the 1990s to 5.5 years in 2013 (SCB, 2002; SCB, 2014). A completion time similar to that of Swedish graduates can be seen as a good result, considering that the majority of respondents underwent sandwich programs which in general is more time consuming than local degree programs. Factors that have impacted on the completion time of degrees include the closing of universities for long periods of time in the late 1980s due to civil disturbances, and the high teaching and administrative burden at home universities, combined with limited resources for research.

Publication activity

The production of research results by supported groups is strongly related to the long-term process of building human capacity. In the beginning of the ISP collaboration, departments did not only lack researchers to carry out the research and training of postgraduate students, but also adequate facilities. At some departments, there were some research activities also before the ISP collaboration started, but in most groups there were no equipment available to carry out experiments. Through ISP grants, and funding from other sources,

31 Sri Lankan statistics over postgraduate graduates are scarce. Available data found only covers years 2004, 2006, 2008 and 2010, and is provided by the National Science Foundation (NSF, 2009; 2010; 2013).

groups gradually built up their facilities and human capacity and could start to publish "home grown" results.

Aggregated, the Sri Lankan groups have published 281 articles in international journals, 173 in national or regional journals and made 736 contributions to conferences (Table 2.9).

Table 2.9 Number of publications, expenditures and number of years of support, by research group.

Research group/ University	Publications			Exp. SEK	Years of support	
	International Journals	Nat./reg. journals	Conference contributions*			
University of Colombo						
IPICS SRI:02	21	9	32	2.5M	1979–2002	24 years
IPPS SRI:01/1	25	26	93	9.8M	1978–2010	33 years
IPPS SRI:01/2	11	8	43	8.8M	1981–2010	30 years
IPPS SRI:01/3	2	6	16	0.5M	2005–2010	6 years
University of Peradeniya						
IPICS SRI:03, 03/1, 03/2, 03/3 & 03/4	68	5	113	2.8M	1981–2002	22 years
IPPS SRI:02	108	79	278	13.1M	1983–2010	28 years
University of Jaffna						
IPICS SRI:04	30	12	130	2.5M	1985–2006	22 years
University of Sri Jayewardenepura						
IPICS SRI:07	16	28	31	3.4M	1995–2009	15 years
Total	**281**	**173**	**736**	**43.5M**	**1978–2010**	**33 years**

* ISP defines conference contributions as papers published in conferences proceeding, not merely presentation abstracts.

National Impact

The number of publications coming from Sri Lankan universities has increased considerably from the late 1970s until the end of ISP support in 2010. The recent annual indexed publication output for Sri Lanka is higher than most countries in Sub Saharan Africa, and puts Sri Lanka among the top 20 in the Asia and Pacific region. However, Sri Lanka has far to go to reach the level of the more developed countries topping the region rankings with 3,000 to 36,000 annual indexed publications (UNESCO, 2010).

In total, Sri Lankan scientists have published 5,428 articles (in English) in WoS journals during 1978–2010 (time span of the ISP collaboration). Articles from ISP supported groups are estimated to account for approximately 5 % (279 articles), of the national publication output found in WoS during these

Table 2.10 Number of publications by Sri Lankan authors in WoS journals, number of publications by ISP supported groups, and share of publications from ISP supported groups in relation to the national publication output, by year.

Publication year	Number of publications by Sri Lankan authors in WoS	Number of publications by ISP supported Sri Lankan groups	Share of publications by ISP supported Sri Lankan groups of total number published by Sri Lankan authors, in WoS
1978–1985	649	27	4 %
1986	63	9	14 %
1987	126	12	10 %
1988	155	20	13 %
1989	122	3	2 %
1990	135	5	4 %
1991	104	14	13 %
1992	112	5	5 %
1993	113	7	6 %
1994	113	19	17 %
1995	119	19	16 %
1996	111	12	11 %
1997	99	12	12 %
1998	145	8	6 %
1999	153	10	7 %
2000	166	12	7 %
2001	155	5	3 %
2002	191	11	6 %
2003	275	9	3 %
2004	233	9	4 %
2005	284	6	2 %
2006	271	6	2 %
2007	312	9	3 %
2008	413	13	3 %
2009	409	11	3 %
2010	400	8	2 %
Total	**5,428**	**281**	**5 %**

years (Table 2.10).[32] In the late 1980s and the late 1990s, publications from ISP supported groups are estimated to account for 10–17 % of the national publication output in WoS journals. With the increased number of Sri Lankan publications, naturally there has been a decrease in the share of publications coming from ISP supported groups. In the 2000s, numbers varied between 2–7 % at the most.

Publication activity at supported universities and departments

To get additional information about the publication activity of ISP supported departments a database search of published articles was done in WoS.[33] The number of articles published by ISP related authors over the years has been counted in the search, to give an indication of the effect the support have had on the supported departments and universities. ISP related authors are defined as persons listed in ISP records, i.e. fellows, students, graduates, staff members or group leaders, having benefited from ISP support or ISP related activities in various ways and to various extents.[34] This does not necessarily mean that the author have had support at the time of the publication date, but basically that that person is listed in ISP records as having received ISP supported training at some point, or been involved in activities in various ways. This search is different from the one in the tracer study in the way that it is more comprehensive and includes all ISP related persons at the department, i.e. not only former students.

The database search reveals that the number of WoS publications has increased steadily at University of Colombo and University of Peradeniya between 1978 and 2014. University of Jaffna and University of Sri Jayewardenepura also show a rising publication trend, however more modest (Figure 2.18).

32 The number is an estimate because the publication records of supported research groups are divided in international and national journals and not number of publications in indexed or peer-reviewed journals. There might therefore be an overestimate of ISP's contribution.

33 The numbers in this section are based on data from the Web of Science (WoS) database, only considering "document" type articles, written in English. The publication activity on the national-, university-, department- and ISP-related levels are all based on articles having at least one Sri Lankan author from the category of consideration.

34 This method of ISP related authors have been chosen instead of looking at acknowledgements. Authors can acknowledge funding agencies in articles, but far from all do, making it a poor data material for analysis. Of the publications, only 25 have emphasized ISP, IPICS or IPPS as a donor (42 if including Uppsala University), which is not likely to reflect the real number of articles produced with direct, or indirect support from ISP.

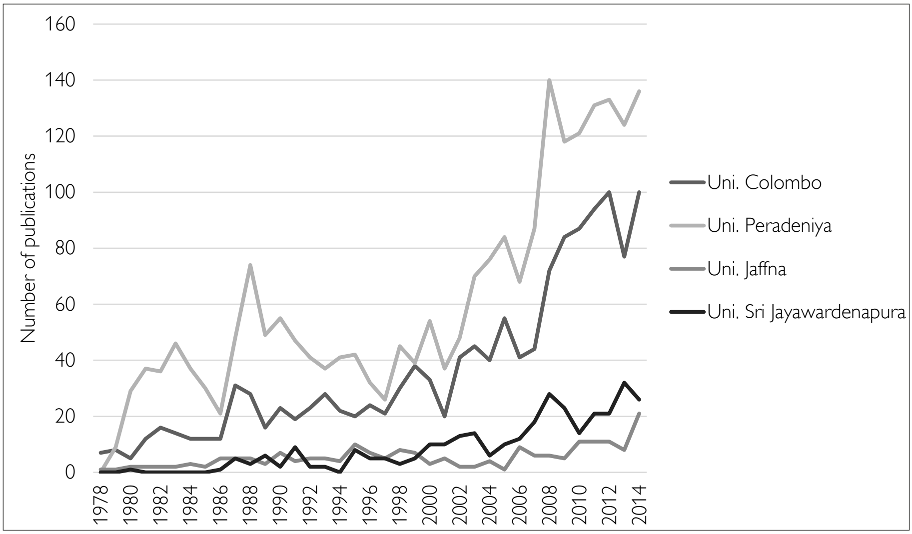

Figure 2.18 Publication activity at supported universities 1978–2014.

ISP supported departments at these universities have, according to what is found in WoS, accounted for 11–19 % of the total WoS publication output at the respective universities. In all, 9–16 % of the WoS publications from each university has an ISP related author. Looking at specific years (1994, 1998 and 2001) it is worth noting that ISP related authors from the Department of Biochemistry at University of Jaffna accounted for more than 50 % of the WoS publication output from the university.

As much as 83 % and 86 % of the publications coming from Departments of Physics at University of Colombo and University of Peradeniya, respectively, have had at least had one ISP related author. At the supported Biochemistry and Chemistry Department of these universities the share was lower, with 56 % and 60 % of the department publications, respectively, coming from ISP-related authors. At the Departments of Biochemistry at University of Sri Jayewardenepura and University of Jaffna, almost all publications (98 % and 95 %, respectively) found in WoS had one ISP related author.

At all supported departments, ISP graduates and fellows have continued to contribute to the publications of articles after the phase out of ISP support.

University of Colombo

At University of Colombo, the number of WoS publications has steadily increased from 7 publications in 1978 to 100 in 2014 (Figure 2.18). There, ISP has supported three research groups at Department of Physics between 1978 and 2010 (IPPS SRI:01/1, SRI01/2 and SRI:01/3). ISP has also supported one group at Department of Biochemistry between 1979 and 2002 (IPICS SRI:02), later establishing the Institute of Biochemistry, Molecular Biology and Biotechnology (IBMBB). Altogether, publications from the supported departments account for 13 % of all (1,354) WoS publications coming from University of Colombo, as found in the WoS database between 1978 and 2014. Publications from ISP related authors make out 8 % of the total university publication output these years.

Considering the total publication output from the Physics Department it comprises 4 % of the total WoS publication output of University of Colombo over the years. However, a great majority of the publications from the Physics Department found in WoS has at least one author with relations to ISP. Out of the 57 WoS publications found, 48 papers was published by at least one author associated with ISP (84 %). For many of the given years, ISP students, graduates, staff members, fellows, or group leaders have been authoring all publications coming from Department of Physics that specific year, according what is found in WoS (Figure 2.19).

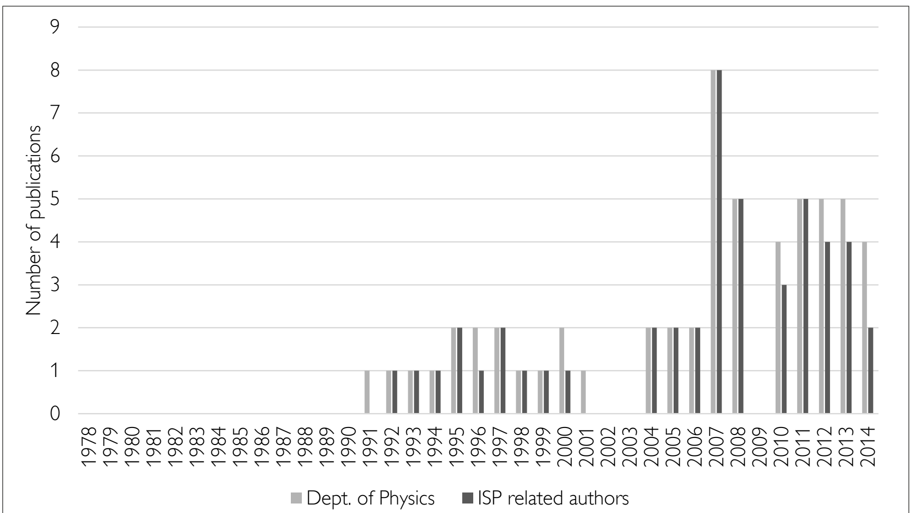

Figure 2.19 Publication activity at University of Colombo, at Department of Physics and by ISP related authors, over time.

Department of Biochemistry, and later also IBMBB, account for 9 % of all publications from University of Colombo over the years. Little more than half (56 %) of the publications coming from Department of Biochemistry and/or IBMBB are from ISP related authors (Figure 2.20).

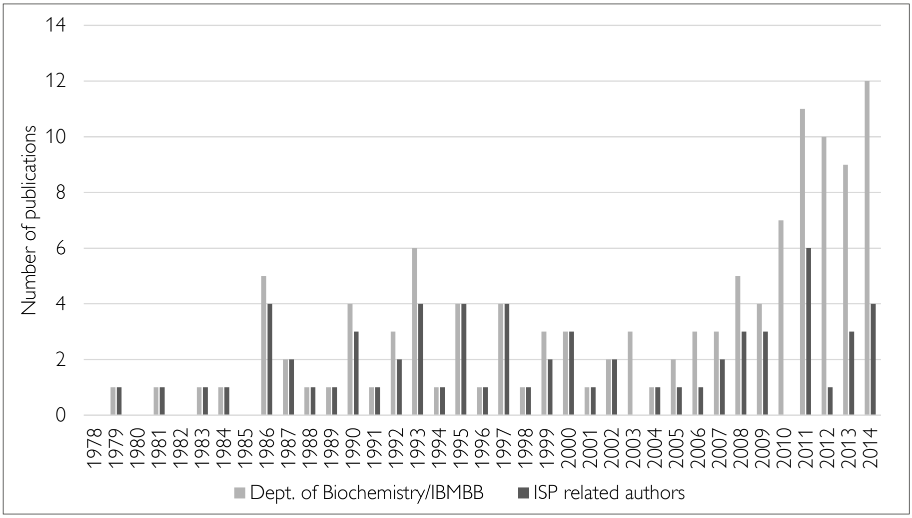

Figure 2.20 Publication activity at University of Colombo, at Department of Biochemistry/ IBMBB and by ISP related authors, over time.

Department of Biochemistry had publication activity already at the beginning of ISP Support (1979). The Physics Department devoted the first decade of support to capacity strengthening and started to publish papers in WoS-listed journals from the 1990s and onwards. Both supported departments has continued to publish also after the phase out of ISP support in 2002 and 2010, respectively.

University of Peradeniya

The number of WoS publications from University of Peradeniya has increased from 9 publications in 1979 to 136 publications in 2014 (Figure 2.18). ISP has supported in total five groups in chemistry during the period 1981–2002 (IPICS SRI:03/1, SRI:03/2, SRI:03/3, SRI:03/4 and SRI:03), and one group in physics between 1983 and 2010 (IPPS SRI:02). The supported departments account for 19 % of the 2,210 papers in WoS coming from the university between 1979 and 2014. Of all WoS publications coming from University of Peradeniya 13 % have at least one author with relations to ISP.

On the physics side, 86 % of all publications from Department of Physics found in the WoS database have at least one author associated with ISP. On the chemistry side, the corresponding number is 60 %. As can be seen in Figure 2.21 and 2.22, respectively, the Chemistry Department was active in research before the start of the ISP collaboration (1981) in contrast to the Physics Department (1983). At both departments, ISP related authors have been active in research during the period of collaboration, and have also continued to contribute to the publication output of departments after the end of support in year 2002 and 2010, respectively.

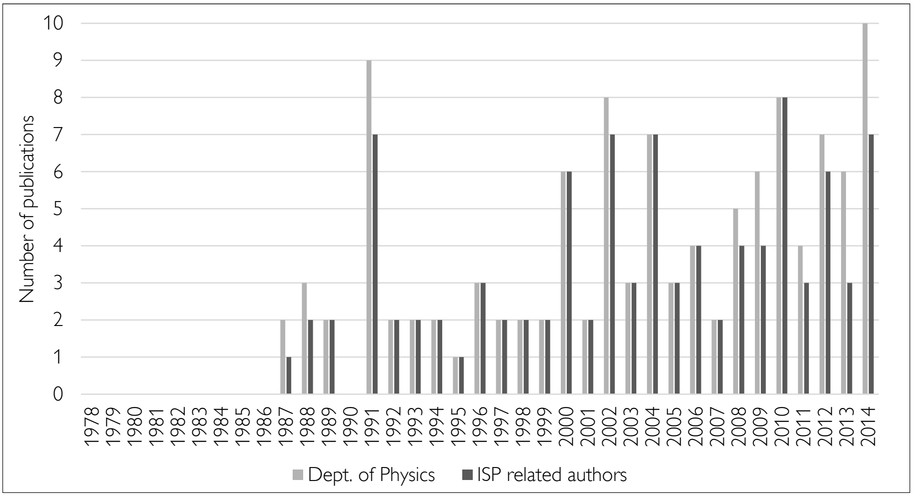

Figure 2.21 Publication activity at University of Peradeniya, Department of Physics and by ISP related authors, over time.

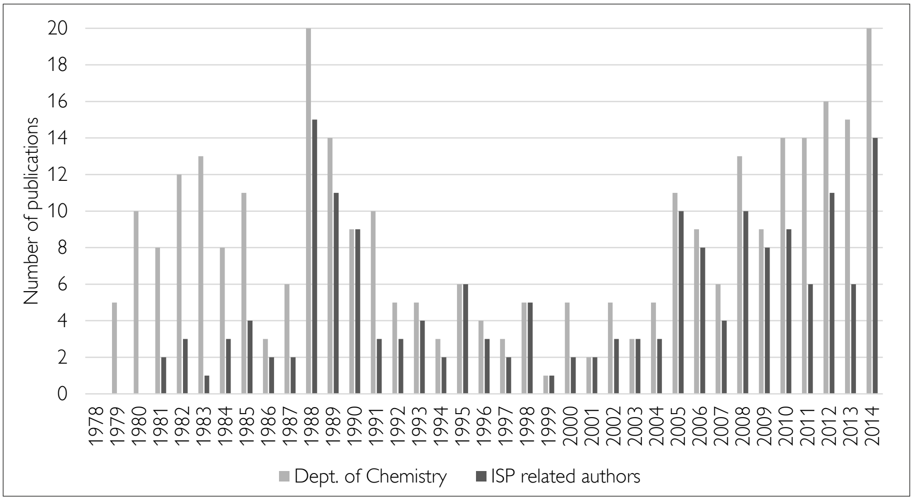

Figure 2.22 Publication activity at University of Peradeniya, Department of Chemistry and by ISP related authors, over time.

University of Jaffna

The number of WoS publications coming from University of Jaffna has varied between 1–10 during the 1970s and the 2000s. In 2014, 21 publications were recorded (Figure 2.18). ISP has supported one chemistry group at Department of Biochemistry between 1986 and 2006 (IPICS SRI:04). The department has accounted for 11 % of the 200 WoS recorded publications coming from University of Jaffna between 1978 and 2014. Almost all (95 %) of the publications found in WoS coming from the department have at least one author associated with ISP. It should be noted that in specific years (1994, 1998 and 2001) ISP related authors accounted for 50 % or more of the university publication output. No WoS publications have come from Department of Biochemistry before the start of the ISP collaboration in 1986, but the activity has continued after the phase out of support in 2006, all produced by ISP related authors (Figure 2.23).

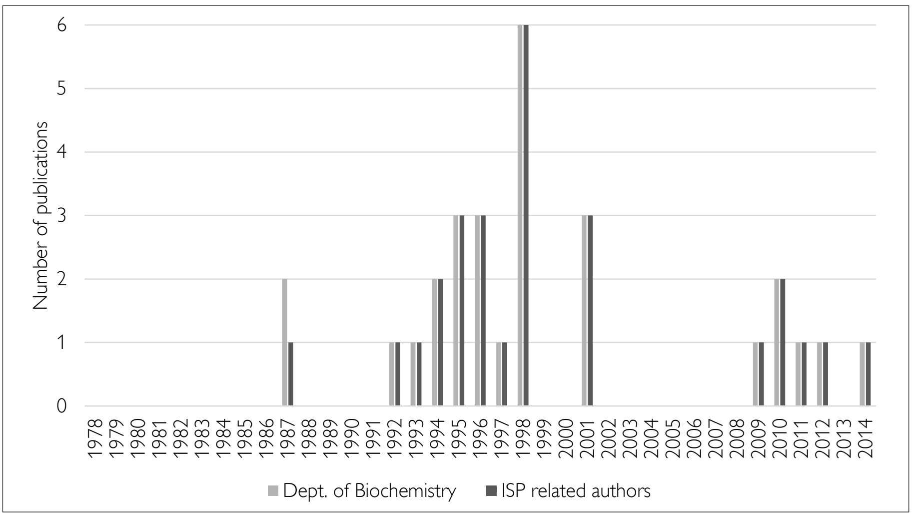

Figure 2.23 Publication activity at University of Jaffna, Department of Biochemistry and by ISP related authors, over time.

University of Sri Jayewardenepura

University of Sri Jayawardenepura shows an increasing number of published papers in WoS-listed journals from 0–6 papers during the 1980s, to 26 publications in 2014 (Figure 2.18). ISP has supported one chemistry research group at Department of Biochemistry between 1996 and 2009 (IPICS SRI:07). The department has accounted for 15 % (47 papers) of the total university publication output (315 publications) between 1978 and 2014. In 2000, 2001 and 2009, 40 % or more of the total output of publications from University of Sri Jayewardenepura came from Department of Biochemistry. A large majority of the papers from Department of Biochemistry are produced by ISP related authors (Figure 2.24). No WoS-listed publications have come from the department before the start of the ISP collaboration in 1996, which is not surprising considering that the department was established in 1993. The publication activity from the department, as well as from ISP related authors, has continued after the end of support in 2009.

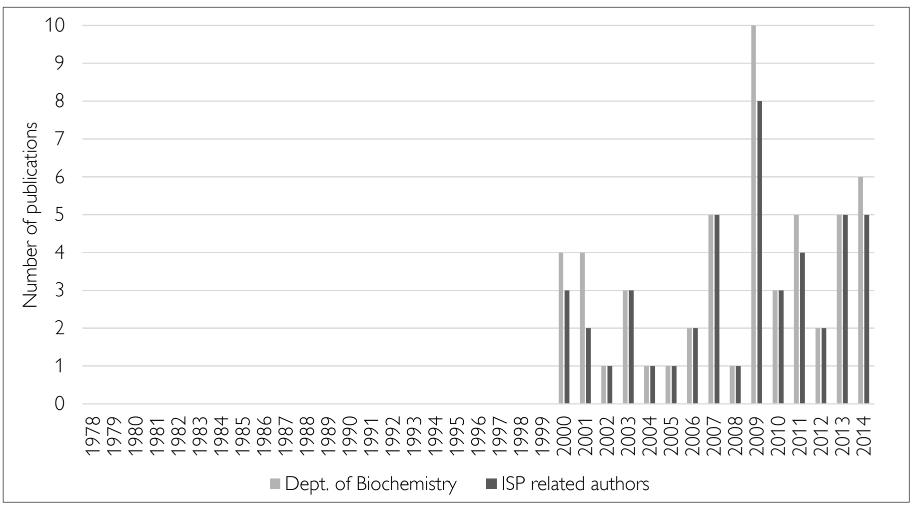

Figure 2.24 Publication activity at University of Sri Jayewardenepura, Department of Biochemistry and by ISP related authors, over time.

Quality of publications – citation and journals

Citations

Even though the number of publications is a straight-forward basic measure of productivity, it only indicates the quantity and not the quality of the disseminated work. One measure of the latter is citation counts, which indicates the impact and influence of research papers. The top three most cited publications in WoS coming from ISP related authors at the four universities was reviewed. These citations have also been compared to the average citation rates in respective fields for given years, provided by the Thomson Reuters (TR) Essential Science Indicators database (Table 2.11). The top cited articles are specified in the footnotes, with ISP related author(s) underlined.

A closer look at the citation rates show that all departments have examples of articles with above average citation rates in the respective fields for given years. All top three most cited articles coming from Departments of Physics and (Bio)Chemistry at University of Peradeniya, University of Colombo and University of Jaffna, respectively, are all cited highly above the averages. One out of the top three articles from Department of Biochemistry at University of Sri Jayewardenepura has above average citations.

Averages are however only accessible for 2000–2010. Therefore, articles published before that period is compared to the overall citation average for that period.

Table 2.11 Top three most cited articles published by ISP related authors, by departmental affiliation, and average citation data (rounded to integer) from the Thomson Reuters (TR) Essential Science Indicators database.

Ranking	1	2	3
University of Colombo, Department of Biochemistry/IBMBB			
Number of cites	106[1)]	96	42
Year of publication	1984	1986	1986
TR Citation average Biochemistry, 2000s	15	15	15
University of Colombo, Department of Physics			
Number of cites	66[2)]	49	35
Year of publication	2000	1995	1995
TR Citation average Physics, year 2000 and average 2000s	16	9	9
University of Peradeniya, Department of Chemistry			
Number of cites	48[3)]	44	43
Year of publication	2004	2001	2005
TR Citation average Chemistry, given years	15	18	13
University of Peradeniya, Department of Physics			
Number of cites	115[4)]	74	68
Year of publication	2002	2003	2002
TR Citation average Material science, given years	11	11	11
University of Jaffna, Department of Biochemistry			
Number of cites	50[5)]	35	22
Year of publication	1987	1996	1996
TR Citation average Biochemistry, 2000s	15	15	15
University of Sri Jayewardenepura, Department of Biochemistry			
Number of cites	37[6)]	13	12
Year of publication	2003	2000	2006
TR Citation average Biochemistry, given years	25	32	14

1) 106 citations: Karunanayake, E.H., Welihinda, J., Sirimanne, S.R. & Sinnadorai, G. (1984). Oral Hypoglycemic activity of some medicinal plants of Sri Lanka. Journal of Ethnopharmacology, 11(2), pp. 223–231. DOI: 10.1016/0378-8741(84)90040-0

2) 66 citations: Hakansson, K., Coorey, R.V., Zubarev, R.A., Talrose, V.L. & Hakansson, P. (2000). Low-mass ions observed in plasma desorption mass spectrometry of high explosives. Journal of Mass Spectrometry, 35(3), pp. 337–346. DOI: 10.1002/(SICI)1096-9888(200003)35:3<337::AID-JMS940>3.0.CO;2-7

3) 48 citations: Punyasiri, P.A.N., Abeysinghe, I.S.B., Kumar, V., Treutter, D., Duy, D., Gosch, C., Martens, S., Forkmann, G. & Fischer, TC. (2004). Flavonoid biosynthesis in the tea plant Camellia sinensis: properties of enzymes of the prominent epicatechin and catechin pathways. Archives of Biochemistry and Biophysics, 431(1), pp. 22–30. DOI: 10.1016/j.abb.2004.08.003

4) 115 citations: Jayathilaka, P.A.R.D., Dissanayake, M.A.K.L., Albinsson, I. & Mellander, B.E. (2002). Effect of nano-porous Al2O3 on thermal, dielectric and transport properties of the (PEO) (9) LiTFSI polymer electrolyte system. Electrochimica Acta, 47(20), pp. 3257–3268.
DOI: 10.1016/S0013-4686(02)00243-8

5) 50 citations: Sundström, L., Vinayagamoorthy, T. & Sköld, O. (1987). Novel type of Plasmid borne resistance to Trimethoprim. Antimicrobial Agents and Chemotherapy, 31(1), pp. 60–66.

6) 37 citations: Chandrika, U.G., Jansz, E.R., Wickramasinghe, S.N. & Warnasuriya, N.D. (2003). Carotenoids in yellow- and red-fleshed papaya (Carica papaya L.). Journal of the Science of Food and Agriculture, 83(12), pp. 1279–1282. DOI: 10.1002/jsfa.1533

Quality of journals

The WoS database search also targeted the top three most common journals of publication of each supported department (Table 2.12 and Table 2.13). Applying the Norwegian NSD list for evaluating the quality of the journals, supported departments have published most papers (47 %) in journals ranked at level 1, indicating they are scientific publication venues. 32 % of the publications are published in journals ranked as extra prestigious scientific journals at level 2. Many publications (21 %) are published in the *Journal of the National Science Foundation of Sri Lanka*, which is not found in the ranking, but also not on Beall's black list of predatory journals.

Table 2.12 Ranking of the top three most common journals of publication of ISP supported departments, aggregated.

NSD rank*	Number of publications	% of publications
Level 2	73	32 %
Level 1	110	47 %
N/A	49	21 %
Total	232	

* The Norwegian NSD list stretches from 0–2, where 2 is the highest rank.

Table 2.13 Top three publication venues of ISP supported departments.

University/Department	No. of publications	NSD rank
University of Colombo, Department of Biochemistry/IBMBB		
Journal of Ethnopharmacology	12	1
Journal of the National Science Foundation of Sri Lanka	6	N/A
International Journal of Food Sciences and Nutrition	5	1
University of Colombo, Department of Physics		
Journal of Atmospheric and Solar Terrestrial Physics	10	1
Journal of the National Science Foundation of Sri Lanka	10	N/A
Journal of Electrostatics	5	1
University of Peradeniya, Department of Chemistry		
Phytochemistry	61	2
Journal of the National Science Foundation of Sri Lanka	29	N/A
Tetrahedron Letters	17	1
University of Peradeniya, Department of Physics		
Solid State Ionics	25	1
Electrochimica Acta	12	2
Ionics	6	1
University of Jaffna, Department of Biochemistry		
Starch – Stärke	5	1
World Journal of Microbiology and Biotechnology	5	1
Process of Biochemistry	3	1
University of Sri Jayewardenepura, Department of Biochemistry		
International Journal of Food Sciences and Nutrition	12	1
Phytotherapy Research	5	1
Journal of the National Science Foundation of Sri Lanka	4	N/A

Cost and efficiency of training and publication outcomes

Together, the research groups have over the years 1978–2010 used 43.5 million SEK of ISP funding, which has resulted in 69 PhD degrees, 157 MSc- and MPhil degrees, 454 scientific publications and 736 conference contributions.

Besides postgraduate training and publications, the 43.5 million SEK has also been used for institutional resource development in terms of expenditures for items such as equipment, instrumentation, maintenance costs, and consumables, as well as staff training and exchange visits, and conference attendance. At many departments there were no available instrumentation at the start of support, and ISP helped in this initial phase to develop laboratories and facilitate the start-up and continuation of research. Immaterial wise, the support also contributed to the building of individual researchers' scientific reputation, the provision of collaborative links, and the establishment of postgraduate programs. The value of such development is hard to capture, but is still important to consider when assessing the efficiency of the support.

It should also, however, be emphasized that it is not possible to say to which share publications have been produced thanks to ISP support and to which share thanks to contributions from elsewhere, and to what extent the graduates have been directly or indirectly supported by the ISP funding. Many students who have not received funded training through the ISP support may have benefitted indirectly or partly, by using ISP funded equipment and consumables or received support for conference attendance or similar. ISP relies on the group leaders and network nodes to report on the number of graduates and publications that has resulted from the ISP support, directly from utilizing the funding, as well as indirectly, fully or partly. When measuring efficiency in terms of graduates and publications this complication needs to be considered, but the results still give an indication of the efficiency of ISP's support in Sri Lanka compared to the efficiency of ISP support in general, measured in the same way.

In comparison to the total outcome of each million SEK spent by all ISP-supported research groups and networks, the Sri Lankan groups have been more, or as efficient, as the overall ISP support when it comes to number of PhD graduations and to dissemination of scientific results, and slightly less efficient in terms of other postgraduate degrees (Figure 2.25).

Per million SEK spent, the Sri Lankan groups were most efficient in producing PhD graduates and conference contributions during the 1990s, compared to the other centuries of support. Publications in international journals has been highest, per million spent, in the beginning of the collaboration (in the 1980s).

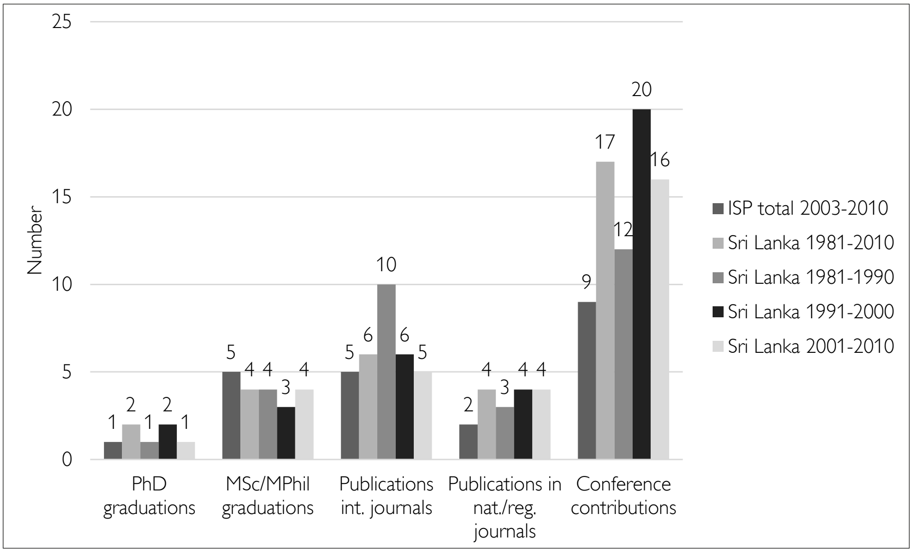

Figure 2.25 Outcomes of each million SEK spent by Sri Lankan research groups and the total average of all ISP groups and networks, by type of outcome and time period.

2.3.2 Societal impact

The number of trained students attending conferences and the number of published papers have, as mentioned, been recorded and reported since the start of the ISP collaboration. What has been lacking is the follow-up: have graduates reached any relevant positions, and are the research results and skills acquired being used by the society in any way? This section addresses these questions.

In addition to the internal ISP records, information in this section is provided by questionnaire answers and interviews with respondents of the tracer study, interviews with group leaders, as well as by reviewing CVs of graduates.

Appointments and honors

One effect of the ISP support, according to group leaders, have been the national and international recognition as researchers that they have gained by the scientific community, as a result of international collaboration, conference attendance, and increased number of publications and PhD supervision. Many have, for instance, been appointed to committees and boards of government institutions relevant for the development of S&T in the country.

At Department of Physics, University of Peradeniya, one of the research group leaders was appointed by the Ministry of Technology and Research as a member of the national task force to develop a five-year national strategic S&T

plan for Sri Lanka 2011–2016. The same group leader was 2002–2006 Chairman of the UNESCO initiative Asian Physics Education Network (AsPEN), aiming, among other things, to develop university physics education in Asia.

Several group leaders from supported groups have had appointed positions at the National Science Foundation (NSF), organized under the Ministry of Technology & Research. NSF is assigned to strengthen and serve the Science and Technology sectors in Sri Lanka, and the appointments of ISP group leaders range from Chairman of the foundation, to Chairman of the NSF national committee of Basic sciences, to members of boards, committees and working groups within the foundation.

Several group leaders, mainly on the chemistry side, have also served as Council Members and one as Chairman of the National Research Council (NRC) in Sri Lanka. Researchers appointed as council members have, according to the council, top ratings regarding productivity of research publications in referred scientific journals (NRC, 2015).

There are also examples of appointments of graduates from supported research groups. One graduate from the Physics Department at University of Colombo was the previous Chairman of the Expert Study Group on Lightning Protection & Electromagnetic Compatibility Concerns, at the Ministry of Science and Technology, and also serves as an advisor to the Presidential Secretariat on Lightning Protection. One graduate is an Executive Committee Member of the Global Young Academy, aiming to mobilize and empower young scientist to enable them to address issues of importance to researchers in their early career. She is also one of the founders, and the current President, of the Sri Lankan Academy of Young Scientist, which serves as a national platform for interaction, collaboration and increased multidisciplinary research activities by leading young scientists in Sri Lanka.

Outreach to society and use of research and skills

There are several examples of ISP graduates reaching out to the Sri Lankan society with their knowledge, with information, and with research results. Some groups are more inclined to these types of activities than others.

Many graduates from the research groups in atmospheric physics and lightning at University of Colombo (IPPS SRI:01/1) have used their knowledge to educate others. Among other things, they are involved in consultancy services creating awareness and educating people working in the electricity area. As a consultancy mission, one ISP graduate has trained around 400 Sri Lankan technicians in lightning protection. Whenever there is a lightning problem in Sri Lanka, people can turn to the so-called data centers, where the trained technicians are available to answer questions. This graduate was also a member of the Sri Lanka Standard Institution working Group on developing guidelines for Lightning Protection Systems.[35]

In 2008, two ISP graduates and a team of professionals from relevant fields, were part of the Technical Advisory Committee appointed by the Telecommunications Regulatory Commission of Sri Lanka. The committee was assigned to develop a policy proposal to address issues related to structures and installation of antennas, such as impact on health, safety, economy, and the environment resulting from the recently rapid implementation of telecommunication networks (Sunday Observer, 2008).

Another graduate from the same group has been consulting as a "trainer of trainers", educator, and advisor on lightning and transient protection. He has conducted about 80 training programs in more than twelve countries. One example is an in-house two-day training program on Lightning Protection, Grounding and Bonding in Telecommunication Sector for engineers from the Sri Lanka Telecom, held in Colombo, Sri Lanka. A similar one-day course was conducted for engineering staff at the Ceylon Electricity Board in Sri Lanka. This graduate has moved to Malaysia and is currently the Head of the Center for Electromagnetic and Lightning Protection Research, at University Putra Malaysia. Even though he is not a Sri Lankan resident anymore, he is contributing in lightning protection in other parts of the world. In 2013 he, together with several leading scientists in the field, and an international organization (NAM S&T Centre, New Delhi), established the African Center for Lightning and Electromagnetics at Makerere University, Uganda. He is now acting as the Chief Advisor to the center. He has also been involved in the establishment of the Bangladesh Lightning Awareness Centre, and a Lightning Awareness Centre in Kerala, India, established under the Regional Energy Centre. Among other things, he was also a part of the initiation of a research group in lightning science at Jahangirnagar University, Bangladesh, where several PhD students currently are enrolled. Another graduate from the same research group was also involved in voluntary projects, which included lightning protection of the Sri Lankan National Railway Museum.

A graduate from the other physics group at University of Colombo (IPPS SRI:01/2) is trying to popularize physics in Sri Lanka by writing physics books for Sri Lankan students. At the moment he has written eight books, which are available at a reduced prize for students, in bookshops in Sri Lanka.

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35 SLSI is the national standards body of Sri Lanka, functioning under the Minister of Industry and Commerce. SLSI mission is to "*promote and facilitate standardization, measurement, quality Assurance and related activities in all sectors of the national economy*".

At University of Peradeniya members of the physics group (IPPS SRI:02) was involved in short-term training of high school physics teachers and university lecturers from other universities. The group members were also involved in training pre-university students and teachers through periodical seminars and science camps at schools in remote, less developed areas of Sri Lanka. Four such camps were organized and attended in 2009.

Two graduates from the research group in nutritional biochemistry (IPICS SRI:07) at University of Sri Jayewardenepura conducted a practical class for a certificate course titled “Development of functional foods” directed to industrialists working at the Institute of Chemistry Ceylon.

Regarding the use of research results, a database with glycemic indices (GI) values of local foods has been established by members of the research group in biochemistry at University of Sri Jayewardenepura (IPICS SRI:07). In 2009, it was made available to the doctors at the Family Practice Centre, University of Sri Jayewardenepura, to be used in the advising of patient diet plans.[36] A project aiming to determine the GI of a noodle-based product produced by an Ayurveda company led to the reformulation of the product to acquire the low glycemic response desired. The project has also led to the initiation of a “GI production label” on products from the company. Further, the group has contributed to the development of food based dietary guidelines by the Nutrition Division of the Sri Lankan Health Ministry.

A chemistry graduate (IPICS SRI:03/2) states having contributed to the tea industry of Sri Lanka, since they are now using the finding from his PhD thesis to improve the tea production.

At least four ISP graduates have filed for patents. A chemistry graduate has been a part of producing two US patents.[37] The patents include one antibiotic drug and an antioxidant drug, the latter being a joint patent between University of Peradeniya and University of Pakistan. One graduate from the lightning group at University of Colombo (SRI:01/1) has five patents, three on horizontal grounding system in Malaysia, Singapore and Indonesia, one on vertical grounding system, and one for a surge protective device for transient

36 The database is available through: www.nrc.gov.lk/SAG/index.html.

37 Patent numbers: www.google.com/patents/US20080318916; www.google.com/patents/US20090048332.

protection.[38] A physics student from the mass spectrometry group at University of Colombo (SRI:01/2) has one US patent, together with other researchers at, among other institutions, Uppsala University, for the invention of a tandem time of flight mass spectrometer. [39] A chemistry graduate at University of Colombo (SRI:02) have a US patent for cyclooxygenase variants and methods of use.[40]

Contributions of the ISP support

The group leaders were asked in the interviews what the ISP support has contributed with in material- and immaterial terms. The two main contributions pointed out were the development of the research infrastructure at the supported departments, and the provision of research training for students and staff. Other aspects, pointed out by two group leaders, were the building of their international reputation as researchers, and the importance of the provision of collaborative links. One group leader also emphasized that a research culture has been established at the department, as a result of the development of international research collaboration.

In material terms, most group leaders pointed to that ISP has contributed to the building of the laboratories with equipment, chemicals and consumables:

> *"They [ISP] helped us to develop the research in mass spectrometry. A lot of other developments came, like the mechanical workshop. We had to have the workshop to support our group. They supported it and gave several instruments, our generator as well. The standard of the workshop have gone up considerably". (Group leader, IPPS SRI:01/2)*

> *"The grant equipped the research laboratory at Department of Biochemistry. Many of the instruments are still being used for research, not only by the ISP group people but by both undergraduate and postgraduate students from the department as well as from other institutions at the university". (Group leader, IPICS SRI:07)*

38 Patents:
1) Horizontal Grounding System suited for rocky and arid areas: Malaysia-PI. 2010006071.
2) Vertical grounding system with improved backfill materials: Malaysia-PI. 20010003832.
3) Surge Protective Device for Transient Protection: Malaysia-PI 20083639.
4) Horizontal Grounding System: Singapore 201108989-3.
5) Horizontal Grounding System: Indonesia P-00 2011 00969.

39 Patent number: www.google.com.ar/patents/US6489610.

40 Patent number: www.google.com.na/patents/US7179627.

In immaterial terms the contribution mentioned most by group leaders was research training of staff and students. It is described as both providing opportunity for staff and students to be trained at Sri Lankan universities, through the development of local PhD programs, and in terms of providing foreign exposure for the students as well as means for them to continue their research:

> *"To do a PhD entirely in Sri Lanka it is hard, a sandwich program give access to equipment and literature we don't have here. Before the sandwich program people did master degree here, and one person did a PhD. Usually the chemicals or the compounds you get have to be sent abroad to be analyzed and then sent back. It was a long process. With the sandwich program the process was much shorter. The time to complete the degree was shorter". (Group leaders, IPICS SRI:03)*

> *"I like the sandwich model because when I came back from doing my PhD in UK I had nothing to do here, no research and no support. When the sandwich students come back from training they can continue their research work here, they can do that. That was not there earlier". (Group leader, IPPS SRI:01/2)*

Two other aspects mentioned by two group leaders, at two different universities, were the building of a scientific reputation, which has been a part of the career development of both staff and students, and the fact that ISP support helped the groups to get additional funding from other donors:

> *"From the ISP support we got reputation among the scientific community. That is the best thing we got. We published and interacted with foreign research and were introduced to foreign research and they knew us by name. So that reputation we could not have got without ISP. Even when we apply for local grants we have all the publications and we have the background so the chance to get the grant is very high. That I appreciate very much". (Group leader, IPPS SRI:01/1)*

> *"Through the ISP support we organized several International research conferences in Sri Lanka, we met people and experts in different field and made our image known internationally. (…) We attracted other research grants and other fellowships thanks to the research publication record of the researchers involved. We managed to get professorships and promotions thanks to this program. That is the personal benefits". (Group leader, IPPS SRI:02).*

> *"The support has contributed a lot because we built up the facilities then the students got the training. Through IPICS we were encouraged to make application to SAREC, and we got good and big funding for seven years. ISP could give occasionally small equipment but with the SAREC funding we could buy large equipment". (Group leader, IPICS SRI:03)*

Another aspect mentioned by a group leader in physics at University of Colombo was the introduction of research culture at Department of Physics:

> *"The most important thing is that they [ISP] have introduced the research culture to this department (…). Before Uppsala came we did not have any research. We had some project but not in this scale. People didn't know how to do basic research. When you send students to Uppsala they come to know how to do research and so other many other things. That culture wasn't here. We didn't have any facilities to get journal articles, a lot of people didn't know about journal articles so that exposure was great. They expose us to journals during that period. That culture is still there in a lot of groups. People talk about research". (Group leader, IPPS SRI:01/2)*

2.3.3 Funding overview

All research groups have to various extents had other sources of funding besides ISP. The focus of this section is on the funding that groups have been able to secure from other sources besides ISP, considering both the impact of ISP support and the group's capacity to obtain funding from external sources. Here will also be presented how ISP support differs from other funding agencies and research grants. Quantitative data have been obtained from internal ISP records on expenditures of groups, as well as from annual activity reporting, while the qualitative data is provided through interviews with group leaders. The funding sources of each group are specified in Appendix 6.

Funding from ISP and other sources

A maintained or increased level of external funding for research from other sources than ISP is a desirable outcome of the training and mentoring provided by ISP. The ultimate goal is that groups have reached a capacity where they are able to attract funding from other sources to such extent that ISP support is no longer needed. In all but one case, ISP was the single, main donor of the groups during the first six to fifteen years of collaboration. After that, all groups have managed to secure funding from national and/or international sources to various extents.

In total ISP has provided 43.5 MSEK to supported groups. Aggregated, this is the largest funding source for these groups over the years of ISP collaboration (Figure 2.26). Sida/SAREC has contributed with 37.7 MSEK (however only to chemistry groups), and other international funds providers, such as the ADB, EU, TWAS and foreign university scholarship, adding up to 1.1 MSEK. The national funding sources reported by groups are public and aggregate to 2.5 MSEK.

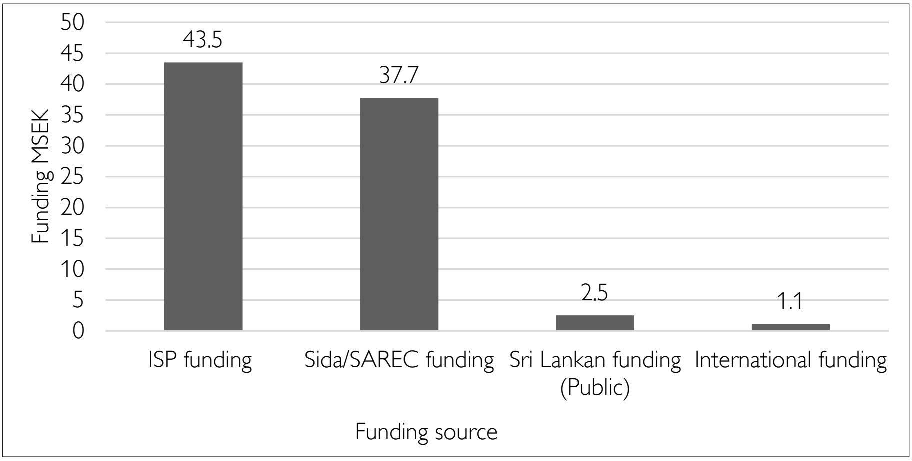


Figure 2.26 Sources of funding during the period of ISP collaboration, by type of funding source.

The physics groups

In general, the main source of funding, besides from ISP, of the four supported physics groups at University of Colombo (IPPS SRI:01/1, SRI:01/2, SRI:01/3) and University of Peradeniya (IPPS SRI:02) is from governmental sources, such as the own university or national granting agencies like NARESA its successor NSF, the NRC and the UGC.

There has been no increase in funding received from other sources over the years rather there has been a steady inflow. Generally, these grants were small in scale in comparison to the support received from ISP, and corresponded to approximately 3–12 % of the total amount of ISP funding. The one exception is a research group at University of Colombo (IPPS SRI:01/3), which is estimated to have matched the amount received by ISP with external funding sources.

Three out of four physics groups managed to secure international funding and fellowships from EU, TWAS, and ADB. Generally, grants from these sources were somewhat larger than the national grants received. Two group leaders of the supported physics group at University of Peradeniya (IPPS SRI:02) and University of Colombo (IPPS SRI:01/1), state that they believe that the publication record and number of PhD's trained under ISP support has been helpful to them in receiving other research grants and fellowships.

All physics groups, except IPPS SRI:01/3, which had other sources of funding at the start of ISP support, had a period in the beginning of the collaboration (six to eleven years) when ISP was the only funder. After that point, the groups secured funding from other sources, and continued to do so almost annually.

One physics group (IPPS SRI:01/2) did not receive any other funding than from ISP the seven final years of support. Furthermore, this research group did not receive sufficient funding from other sources to be able to continue its activities after the phase out of support. The group was involved in instrument development of mass spectrometry, a capital-intense field, which requires a steady inflow of funding and constant updates to keep up with the international research community. The two other research groups at University of Colombo (IPPS SRI:01/1 and SRI:01/3) have managed to secure sufficient funding to continue their activities. The continuation of activities will be considered in more detail in section 2.3.4 Sustainability.

The chemistry groups

The main difference between the supported groups in chemistry and physics is that three chemistry groups, at University of Colombo, University of Peradeniya and University of Jaffna (IPICS SRI:02, SRI:03 and SRI:04, respectively) received substantial Sida/SAREC support that extended beyond the phase out of ISP support. The support from ISP was very small in comparison to these grants. At University of Colombo, for instance, ISP contributed with 2.5 million SEK over the years of support while Sida/SAREC invested close to 26 million. However, in all cases ISP was the main supporter of the research group at the start of the collaboration, ranging between six to 15 years, before they received other funding. ISP also helped to facilitate the applications to Sida/SAREC and a majority of the funds were coordinated by ISP, assisting with contacts for training of students and purchasing of equipment and other items.

In addition, all groups receiving Sida/SAREC support also managed to secure other international funding, from TWAS, WHO, and the multinational pharmaceutical company Ciba Geigy Ltd (today Novartis). All groups also attracted funding from national sources. Many of the members of the supported groups on the chemistry side have also received individual, competitive grants from IFS.

It can be concluded that the chemistry groups receiving Sida/SAREC support secured sufficient funding to continue at the time of phase out of ISP support. The main reason for phasing out support to these groups was also due to the fact that they had received large grants from other sources. These large grants made it possible for the groups to establish well-equipped laboratories in Sri Lanka. For example, with Sida/SAREC funding and consultancy, and guidance from ISP, the chemistry group IPICS SRI:02 built and established the Institute of Biochemistry, Molecular Biology and Biotechnology (IBMBB) inaugurated at University of Colombo in 2004. IBMBB is a large, modern facility, built to serve as a resource center in Sri Lanka, which currently also is the case. The supported chemistry group at University of Peradeniya (IPICS SRI:03) had the opportunity to purchase large equipment with the help of the Sida/SAREC grant.

ISP compared to other donors

In perspective of the support from other donors, local or foreign, during the period of ISP collaboration, the question was asked to group leaders how they view ISP funding in comparison to these other donors.

Three group leaders brought up the long-term support and interest in building science in the country as distinguishing ISP from other donors. The described benefit of the ISP support was that the fellowship usually was followed by equipment related to the training of the student so the research could be continued upon return to the home institution. During the fellowship period this was called follow-up support, which was introduced by ISP in 1967. This procedure also continued when ISP started to support research groups as they could use the grant to purchase equipment needed for the research.

When it comes to the handling of funds, ISP is described as flexible compared to other donors, the procedures for purchasing equipment and chemicals were particularly emphasized. In comparison to other funders, ISP was described as having few regulations and restrictions. One group leader compared the ISP with grants received from an international donor organization:

> *"University grants are the best flexible grants we found after ISP. It is handled by the university staff so we can go to them and talk and modify it. We have to get the university to approve, but it goes smoothly. The grant we currently have from an international organization is terrible, it is extremely difficult. The whole university is fed up with them because of the way they handle regulations and so on. (…) The issue is that everything is handled by them. If I want to buy something I have to get their approval (…), and the call for quotations is extremely difficult. They send a thick pile of documents to the supplier even for small purchases. The supplier wonders why they should fill out all the papers and might throw it away. After maybe a month I get the quotations back and then I need to call a committee and discuss it with them". (Group leader, IPPS SRI:01/1)*

Group leaders also pointed to that using funds for short training periods abroad for staff and students, and for participation in conferences, is something that most (local) grant providers won't allow. Another group leader expressed his appreciation of the sandwich model:

> *"The sandwich model is what I liked the most. You don't find it in any other programs. When it is time for sabbatical, usually our academics go to Europe or US for a year and then come back. But in this program, while training the student also gives exposure to the local challenges and facilities of developed countries. They develop skills to work in both places. As a result there is a tendency to stay in the country with the local training and the roots here. (Group leader, IPPS SRI:02)*

This group leader describes that he promotes the sandwich model to national authorities whenever he gets the chance, through the various government committees he is in. He has succeeded in sending two students on sandwich based training to Chalmers University, Sweden, on a Sri Lankan grant combined with funding from Chalmers.

Another aspect brought up as separating ISP from other donors is the personal contact and human component that became established between the group and ISP, something that could fall under what ISP calls the mentoring aspect of its operational model. The groups had a person to turn to when they faced problems.

> *"Something that I learned was that the [ISP] funding was very supporting. There were people who you could turn to unlike other funding agencies where you only get the money. The human component was very important. The friendship and recognition was very important. And standing by us when we were down and raising our spirits. All of that was very important. Even after the retirement the people at IPICS stay in touch and are worried when they hear we have some problems and so on. The personal touch that we all have had has been very useful. We became very close, IPICS was like a family". (Group leader, IPICS SRI:07)*

One group leader wished that her students would also have gotten the chance to take part in the ISP training programs, which are no longer available:

> *"I wished that some of the younger people would have gotten the help we had in our career advancement. I don't think that equivalent programs are available now to young researchers". (Group leader, IPICS SRI:03)*

2.3.4 Sustainability

ISP has supported research groups in Sri Lanka for a long time. In this section the phase out of the supported groups will be considered: how group leaders experienced the phase out period, whether the activities of the research groups continued, and which the bottlenecks for further increasing research capacity are. Data have been obtained through interviews with current and former group leaders.

Phase out of support

The decision to phase out support to research groups in Sri Lanka was taken as a consequence of Sri Lanka transitioning from a low-income country to a lower/middle-income country in the mid-2000s, according to the World Bank rating. During this period, ISP directed support to low-income countries, and in particular least developed countries. The ISP board therefore decided that Sri Lanka should no longer be supported. However, because the economic transition in Sri Lanka was sudden, ISP decided to phase out the supported projects in Sri Lanka at a slower pace than usual. The final year of support was 2009 for chemistry and 2010 for physics. The physics support did to some extent stretched beyond these years, to allow for individual PhD students to complete their thesis work and graduate.

Three of the chemistry groups at University of Colombo, Peradeniya and Jaffna (IPICS SRI:02, SRI:03 and SRI:04) all received large Sida/SAREC funding from 1988, 1994 and 2000 respectively. Therefore, ISP support to these groups was no longer needed and phased out in the beginning/mid-2000s. The chemistry group at University of Sri Jayewardenepura (IPICS SRI:07) did, however, not receive any Sida/SAREC funding and ISP support therefore continued until 2009.

Experiences of the phase out

On the physics side, ISP was the main funder of almost all groups and they were thus more affected than the chemistry groups by the phase out of support.

The physics groups got two to three years of notice before the support was concluded. One physics group that was given notification about the phase out remained unaware that the support would come to a complete stop the final year. The group leaders believed that the support would continue in some way even after the final date. They did not perceive it as a real phase out period, argued that groups should be notified earlier, and pointed to that:

> *"It is important for ISP to realize that they have invested a lot of money in training and equipment so there is an indirect obligation to make sure that the group is continuing".*

Group leaders of the physics groups at University of Colombo accepted the phase out and found it to be done in a responsible manner. They were informed well in advanced and all students involved in the program received support until they had graduated, even after the official termination in 2010.

A possible improvement of the phase out of support, suggested by group leaders for ISP to consider, was to scale down the funds to the program and instead provide support for an additional number of years, to compensate for the fact that local funding agencies does not provide support for conferences, major equipment, and student exchange. Another possible improvement suggested was for ISP to allocate funds to support emergency needs of phased out groups, where group leaders can turn and ask for help when having urgent problems after the phase out. In relation to this, it was mentioned that ISP should better inform current and former groups about other possible external funding opportunities and programs of interest.

Continuation of activities

There are mixed results with regard to sustainability of research groups after the phase out of ISP support.

Some of the research group leaders have been in the same position from the start of the collaboration until the phase out of ISP support. Finding a reliable and inspiring person to build up a research group has been, and still is, stressed to be very important by both former and current ISP Directors.

There have been cases in the Sri Lankan collaboration where research group activities ceased with the retirement of the group leaders. This is to some extent the case for the research groups in physics (IPPS SRI:02) and in chemistry (IPICS SRI:03) at University of Peradeniya. The chemistry group did not continue after the retirement of the group leaders in 2007 and 2008, mainly due to the fact that there was no one to take over and keep the scientific work going. Three out of four subgroup leaders of the physics research group at the same university (IPPS SRI:02) retired at or shortly after the phase out of ISP support. The remaining group leader is currently supervising the only PhD student at the department.

At University of Sri Jayewardenepura (IPICS SRI:07) and University of Jaffna (IPICS SRI:04), however, retired group leaders have successfully been succeeded by others. In both cases, the successors are ISP graduates, one of whom currently is also the Vice Chancellor of University of Jaffna. Research activities at both departments are ongoing.

At the Physics Department at University of Colombo, there are mixed results with regard to the sustainability of the three previously supported research groups. The group in atmospheric physics and lightning (IPPS SRI:01/1) is continuing its operation after the phase out of support. In 2009, one year before the final year of support in 2010, the IPPS Director expressed a slight concern over the future of the supported physics groups in Sri Lanka, due to the limitation and small scale of local research grants, which could result in a quick degradation of what has been built up over the years (ISP, 2009). Regarding the research group in mass spectrometry (IPPS SRI:01/2), the concerns were verified because the group is no longer active. It started to face problems already early in the ISP collaboration because the building of instrumentation is very expensive and requires, besides substantial funding, technical staff trained on an advanced level to serve and maintain the instrumentation. After the end of ISP support a sufficient level of funding from University of Colombo could not be secured.

The second group in instrument building (IPPS SRI:01/3) is still active. Since the phase out of ISP support it has focused solely on solar energy, mainly because the government is supportive of projects in the field of energy, which is correlated to many of today's challenges facing Sri Lanka.

The research group at the Department of Biochemistry at University of Colombo (IPICS SRI:02), in 2004 evolved into the Institute of Biochemistry, Molecular Biology and Biotechnology. There, research is still active and expanding.

Bottlenecks for continued increase of research capacity

Both University of Peradeniya and University of Colombo have a large pool of four-year, special degree undergraduate science students, from where PhD candidates can be recruited. However, both the chemistry and physics departments at these universities are currently facing problems with attracting the best students to register for a local PhD and join the research groups. A great majority of the students from the special degree programs leave for postgraduate studies abroad, mainly to the USA, and very few return after completing their degrees. The attitude towards local degrees still is a challenge at Department of Physics at University of Colombo, both for group leaders and students. PhD degrees from universities abroad have a higher status and are viewed as better among the staff members than local degrees. Without ISP funding it will be harder to send students to conferences and exchange abroad, which means that one of the incentives for students to pursue local studies has disappeared.

At Department of Biochemistry at University of Sri Jayewardenepura and Department of Physics at University of Colombo, one bottleneck faced during the period of support, and still today, is the procurement of equipment and consumables. The university procedures with call for quotations to buy equipment or chemicals can take several months.

Another bottleneck is the lack of funds to maintain equipment. Normally research grants do not cover this and the contribution from the universities is therefore important for the continuation of the use of instrumentation. At some universities such as University of Sri Jayewardenepura this is not a problem, while the physics groups at University of Colombo struggle in this respect.

2.4 Conclusions Sri Lanka

ISP started to support many of the departments in Sri Lanka at a stage when they were seriously resource challenged, especially on the physics side. The two oldest and most established universities in Sri Lanka, University of Colombo and University of Peradeniya, were at the start of the ISP collaboration mainly focused on teaching. No PhD programs in physics existed anywhere in Sri Lanka, and the laboratories were in most cases lacking both basic equipment and consumables. In all but one case, ISP was the single, main donor of the groups during the first six to fifteen years of collaboration. At this stage of development, the ISP support can be said to have made a considerable difference in terms of building local research capacity, as well as for improving the conditions for research and postgraduate training at the supported departments.

Through the sandwich model, ISP support helped to establish PhD programs in both chemistry and physics at several departments at Universities in Sri Lanka. The first student to graduate with a PhD degree in physics from a Sri Lankan university was a sandwich student from an ISP supported research group at University of Peradeniya, in 1991. The sandwich model was highly valued by former students, group leaders and supervisors. Many of the expressed positive features of the model correspond well with the inherent objective of ISP, to build-up and strengthen research capacity at partner universities. The most explicit positive feature given, was the possibility to continue or start-up research back in Sri Lanka, something that otherwise was considered hard if returning home after completing a PhD fully abroad, having spent many years in advanced facilities. Through the sandwich model, students got the foreign exposure, access to advanced facilities, and the possibility to meet experts in the field without being isolated from Sri Lanka for several years. This continued connection with the home university, in combination with funds to develop the home laboratories, largely seems to have contributed to that a majority of the graduates (87 %) have stayed in Sri Lanka, and continued to do research, after graduation. These results confirms the positive retention effect of the sandwich model emphasized by ISP already in the late 1980s (Liminga, 1996), in a case study of ISP support to research groups in Bangladesh (Kuhn, 2012), and in the 2011 evaluation of ISP (GHD, 2011). The fact that the now highly educated ISP graduates still remain in the university sector in Sri Lanka indicates that the supporting of PhD and MPhil training through research groups has contributed to the building of institutional research capacity at supported universities, and at other universities in the country.

In relation to the relatively small amount of money invested by ISP and in relation to the low national output of PhD students, the support can be said to have contributed to the education of a significant number of PhD students. In terms of efficiency of PhD graduations, the Sri Lankan research groups have been as efficient, or more, as the average of all ISP supported research groups.

Further, the average number of years Sri Lankan PhD students took to complete degrees is similar to the completion time of Swedish graduates. This is a good result considering that a majority of the Sri Lankan respondents did a sandwich model PhD degree, which in general requires more time than a local degree. In addition, the civil war in Sri Lanka resulted in closure of universities for long periods of time, which has extended the completion time. Also, the high teaching and administrative burden at home universities, combined with less resources for research available, delayed graduations.

ISP graduates and ISP related researchers have been, and still are, actively contributing to the publication of scientific results at the formerly supported departments. A majority of the papers published over the years of support have been from ISP related authors. Publications by ISP supported groups have contributed substantially to the national publication output, comprising as much as 17 % of all WoS Sri Lankan publications in a given collaboration year. At all supported departments, ISP related researchers have also continued to author or co-author scientific articles after the phase out of ISP support. All supported departments have published papers in quality journals.

There are several examples of ISP graduates and group leaders using their knowledge to the benefit of the Sri Lankan society, through consultancy services, creating awareness and educating high school students, the public, and government employees. The research areas of some groups are more inclined for these types of activities than other. Some of the research activities have had influence on the development of national guidelines, for instance regarding lightning protection systems and food-based dietary recommendations.

In many groups the ISP funding has functioned as seed money, which enabled them to attract funding from other sources, including other international grant providers. All research groups have during the period of support received funding from other sources than ISP. The fact that groups were able to secure also national and international funding in competition, suggests that they have obtained a capacity to attract and manage research grants.

The leaders of supported research groups expressed that ISP distinguished itself from other donor agencies by the long-term aspect of support, which enabled the groups to build up capacity over time despite any intermittent failures and times of slow progress. Other distinguishing marks were the flexibility of the use of ISP funds, with few regulations and restrictions, allowing for staff exchange visits, and the possibility to attend and organize conferences, as well as the close personal contact with ISP staff. The sandwich model training was also brought up as a unique feature. An indirect effect of ISP support brought up by group leaders was the building of a scientific reputation, which has had impact on the career development of both staff and students at the supported departments. Several group leaders from supported groups have been appointed to committees and boards at government institutions relevant for the development of S&T in the country. In addition, one group leader also pointed to that ISP helped to establish a research culture at the department, which had been lacking before.

One challenge facing the groups with regard to sustainability has been the retirement of group leaders, which in two cases has led to ceased activities. Another difficulty has been retaining the best students to pursue PhD studies locally, because the majority of the top class students go for postgraduate studies abroad. The local PhD degree still has a relatively low status, and without the foreign training components obtained from ISP support, the incentive for students to stay to pursue a local degree has decreased.

The gender distribution of both staff and students correspond well with the general picture in ISP supported groups, with more females in the chemistry than in the physics program. The tracer study results show that the abroad training component in the sandwich program has worked differently for men and for women, with female respondents having spent much shorter time abroad than male respondents. However, the possibility for women to bring their families with them, made possible through the ISP family allowance and the modality of the sandwich model, with only a part of the training conducted abroad, is likely to have facilitated women going for research training abroad.

Part 3

ISP in Thailand

3. ISP in Thailand

By *Rebecca Andersson* & *Marta Zdravkovic*

This part consists of a tracer- and follow-up study of ISP's collaboration with research groups in Thailand, in the fields of physics and chemistry. The focus is on the ISP support between 1982 and 2007 to research groups at three universities in Thailand: Chiang Mai University, Chulalongkorn University, and Prince of Songkla University.

The tandem accelerator donated by Chalmers University of Technology, Sweden to the collaborating research group at the Fast Neutron Research Facility, Chiang Mai University. Photo courtesy: Rebecca Andersson.

3.1 Supported Thai research groups

This section contains a historical overview of the supported Thai research groups, including information about the start and development of the collaboration, the fields of research, challenges faced, outcomes, and the current situation and funding. It is based on interviews with group leaders in Thailand, and on data in IPICS and IPPS project catalogues.

3.1.1 Overview

ISP has collaborated with scientist and groups of scientist in Thailand between year 1970 and 2007. ISP has supported fellows and research groups in chemistry and physics at six different universities and one national authority in Thailand: Chiang Mai University, Chulalongkorn University, Khon Kaen University, Mahidol University, Prince of Songkla University, Srinakarinwirot University, and the Office of Atomic Energy for Peace (OAEP) (Table 3.1).

The support to these institutions has been of various characters. Mahidol University was part of ISP's regional cooperation, and mainly functioned as a host laboratory for students and scientists from the region. Mahidol did not receive any direct research group support from ISP other than small amounts needed to facilitate regional students. ISP received fellows from Khon Kaen University and OAEP, but no further collaboration developed. Fellows also came from Srinakarinwirot University, some of who was working together with the long-term supported physics group at Chiang Mai University (IPPS THA:03/1).

Long-term support has mainly been provided to two groups in chemistry and three groups in physics located at Chiang Mai University, Chulalongkorn University, and Prince of Songkla University. Groups at these universities are the main focus of this report (Table 3.2), with the exception of the supported chemistry group at Chiang Mai University (IPICS THA:02), where information is insufficient.[1]

The ISP support to these research groups has varied in nature, as different groups had different needs depending on their situation. Two of the physics research groups at Chulalongkorn and Chiang Mai University (IPPS THA:01 and THA:03/1) had significant amount of funding and equipment from other

[1] The group leader of IPICS THA:02 has passed away, and the contacted staff members associated with the formerly supported group were not able to provide any information about the support period. Because of the lack of information, it is not covered in this report.

sources than ISP. The groups were instead in need of scientific contacts, travel assistance, and postgraduate training. In contrast, the geophysics group (IPPS THA:04) and chemistry group (IPICS THA:03/1) at Prince of Songkla University were in need of support to build up both human capacity and facilities for research.

Table 3.1 All ISP supported Thai institutions 1961–2007, by type of support.

Institution	Fellowship program	Research group support
Chulalongkorn University	X	X*
Chiang Mai University	X	X*
Khon Kaen University	X	
Mahidol University	X**	
Prince of Songkla University	X	X*
Srinakarinwirot University	X	
Office of Atomic Energy for Peace	X	

* Institutions that are the focus of this report.
** Host institution for regional fellows and students.

Table 3.2 Overview of ISP supported research groups at Thai universities.

University	Period	Acronym	Name of research group
Chulalongkorn University			
Physics	1985–2003	THA:01	Semiconductor physics/Chalcopyrite semi-conductors and applications
Chiang Mai University			
Physics	1982–2005	THA:03/1	Plasma, neutron and ion beam technology, Formerly: Fast Neutron Research Facility (FNRF)
Prince of Songkla University			
Chemistry	1984–1995	THA:03/1	Trace metals and trace organics in the outer Songkla Lake and in natural water
Physics	1987–2007	THA:04	Geophysics

Chulalongkorn University

ISP has supported one research group in physics at Chulalongkorn University, between 1985 and 2003, in the field of Semiconductor physics/Chalcopyrite semi-conductors and applications (Table 3.2).

IPPS THA:01 Semiconductor physics/Chalcopyrite semi-conductors and applications, 1985–2003

The first contact between ISP and the Semiconductor Physics Research Laboratory at the Department of Physics at Chulalongkorn University was established in 1985 when the former Director of ISP's Physics Program, Professor Lennart

Hasselgren, came to visit. The ISP Chemistry Program had already established connections with Department of Chemistry at the university since the 1970s through a supported chemistry fellow working on X-ray crystallography.

Before the ISP collaboration started, the group had connections and collaboration with a university in Canada and received support for postgraduate training and equipment from the Canadian International Development Agency. A lot of equipment, consumables and materials also came from a General Electric laboratory in the US. The group used this equipment to build up the research laboratory from scratch. The first PhD student in experimental physics at the department started in the late 1980s.

Nature of the ISP support: Since the group had support from other sources, through which equipment were provided, ISP mainly contributed with contacts to laboratories in semiconductor physics in Sweden, as well as travel support for research visits. The group's main Swedish contacts were with Uppsala University, Linköping University, and Chalmers University of Technology, where they learned how to manage new techniques and systems relevant for their research. ISP also provided the group with some minor equipment, but mostly the support was used for connections and research visits, both from the Thai and Swedish research groups. Several PhD students have been involved and trained in the group during the period of the ISP collaboration, but these students were covered with Thai research funds. ISP mainly organized the contacts in Sweden, and coordinated the stays of the students while in Sweden.

Objectives: The research at the laboratory previously was divided into three main directions: 1) surface physics, 2) advanced semiconductor materials, and 3) polycrystalline thin film solar cells of copper indium gallium diselenide. The major objectives of the lab were to fabricate, characterize and develop semiconductor materials and alloys for solar energy conversion and other solid state devices, and to serve as a research base for the PhD program in solid state and semiconductor physics. Further, the lab aimed at developing expertise in semiconductor physics and technology. To train manpower in the field has always been viewed as the main priority of the group.

Challenges: The main challenge facing the research group has been the isolation from other scientists, internationally, in the same area of research. They were, and still are, the only research center in Thailand working with thin film solar cells, and therefore have no other collaborating partners in the country. Due to the isolation, the group is lagging behind internationally, and finds it hard to reach a sufficient level for publishing in experimental physics. The group also faces problems with attracting students, as many disappear abroad with Thai scholarships.

Outcomes: During the period of ISP collaboration, 1985–2003, 5 PhD students and 22 MSc students are listed to have graduated from the group, however not directly supported by ISP. The group has had 24 publications in international journals, nine in national and regional journal and has produced 48 conference contributions.

Funding: The research group had funding and equipment support from other sources before and during the ISP collaboration, and in general ISP has functioned as supplementary funding to the group, comprising 19 % of the group's total funding. The group has utilized approximately 1.3 million SEK of funding from ISP over the years of support, 1985–2003. All funding from other sources reported to ISP is from national governmental sources, such as Chulalongkorn University, MTEC and NRC. These sources of funding, as known to ISP, add up to 5.4 million SEK, but are likely to be much larger. An overview of the funding is available in Appendix 7.

Current situation: The group leaders during the time of ISP support are retired, but activities continue under the leadership of the son of one of the former leaders. The research group keeps its focus on thin film solar cells, and is one of the 24 research centers within the Thailand Center of Excellence in Physics (ThEP Center). The research laboratory is the leading center within the thin film focus area, and one of the former group leaders, Professor Kajornyod Yoodee, is now the ThEP Center Coordinator of that area. As a member of the center, the group receives funding and has established connection with other research laboratories in the country.

The group participates in the Thailand-Japan Technology Transfer project, and has established connection with several laboratories in Japan, providing the group with both research visits and instruments. The group currently receives grants from the Japanese Asahi Glass Foundation, and Chulalongkorn University. The group does not have any remaining collaboration with the former host collaborators in Sweden.

Retired group leaders, Professors Chatraphorn Somphong (left) and Kajornyod Yoodee (right), at the Research Center in Thin Film Physics at Chulalongkorn University in 2015. Photo courtesy: Rebecca Andersson.

The group has had six PhD graduations since the end of the ISP support in 2003, and there are currently three PhD students enrolled. PhD training can be conducted to a full extent locally, but if there are available research grants, the group prefers to send student for training abroad for shorter periods. Finding PhD student who wants to pursue PhD studies locally still remains a problem, as many students go abroad for studies, mainly with government scholarships. The main bottleneck for increased research capacity is still the isolation of the group, and the fact that the research community in this field in Thailand is too small.

The group plans to stay in, and improve, the field of thin film solar cells, and in the near future start to explore new materials. The main goal is to train students in the field and to build up expertise.

Chiang Mai University

ISP has supported one research group in physics at Chiang Mai University, between 1982 and 2005 (Table 3.2). The group is presently working in the field of Plasma, neutron and ion beam technology, but at the start of ISP support the group focused on fast neutron research under the designation Fast Neutron Research Facility.

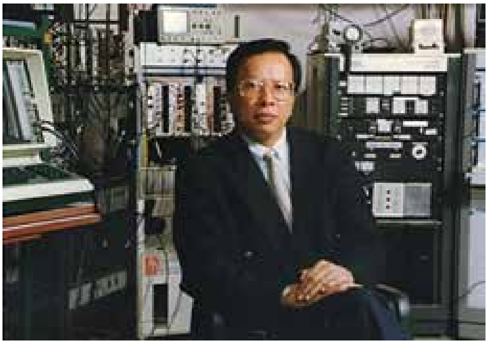
IPPS THA: 03/1 Plasma, neutron and ion beam technology, 1982–2005

The initial contact with the research group at the Department of Physics at Chiang Mai University was made in 1981 when the group leader, Professor Thiraphat Vilathong, received a fellowship from ISP's Physics Program to come to Chalmers University of Technology in Sweden for three months of research training.

In the mid-1980s, the main focus of the university was teaching, and no significant research in experimental physics was conducted. During this time, the group had two main goals: to build a research laboratory in neutron physics, and to start a physics PhD program at the university. The IAEA and the Thai government provided the main funding to equip the new laboratory. ISP provided additional support to buy instruments, and some were donated by Chalmers University of Technology. The lab was fully established in the 1990s and became one of the first experimental physics laboratories in the country. It was after the establishment of the laboratory that the research group could start up research in fast neutron physics and begin to publish papers based on experiments conducted in their own facilities.

During the same period, efforts to start a PhD program were made. To set the standard and to gain recognition of the PhD program it was considered important to include a foreign training component. Through ISP contacts, and in some cases with ISP funding, students were sent on sandwich based training for six months up to one year to Chalmers University of Technology, Lund University and Uppsala University, all in Sweden. The first PhD student started in 1985.

Objectives: In the beginning, the main focus of the group was fast neutron physics. However, it was realized that this research field lacked applications of apparent benefit to the Thai society, and attracting funding was difficult. Therefore, the group switched its focus to ion beam and plasma technology in the 1990s. The FNRF laboratory was assigned by the IAEA to establish a center of ion beam analysis in Thailand, which contributed to this change. During this time in Thailand, special efforts were needed in the field of surface modification and material synthesis utilizing ion beams and plasma pro-



IPPS THA:03/1 group leader, Professor Thiraphat Vilaithong, in front of the control system of the nsec pulsed neutron generator in the early 1990s. Photo curtesy: Professor Thiraphat Vilaithong.

cesses. With financial help from IAEA and from national funding agencies,[2] and with equipment donated from Swedish universities, the first facility for ion beam analysis in the country was established during the beginning of the 2000s. The tandem accelerator donated by Chalmers University of Technology is still in use today.

Challenges: At the beginning of the ISP collaboration the major challenge facing the group was how they could establish themselves and produce publications of international quality. During this time, physics in Thailand was less developed and there were no well-established experimental laboratories in in the country. The major challenge was to build up the laboratory, and to start the research work and PhD program.

Outcomes: In total, 13 PhD students and 47 MSc students have been trained in the group during the period of ISP collaboration, 1982–2005. The group has made 114 publications in international journals, 29 in national or regional journals and made 132 conference contributions, according to ISP records. The publication outcomes, as well as collaboration with foreign collaborators besides the ISP host institutions, rocketed in the 1990s, and have after that been extensive with several collaborators in Asia and Oceania, Europe, North America and Africa.[3]

2 The Science and Technology Development Board; th National Research Council; the National Metal and Materials Technology Center; and the Thailand Research Fund.

3 *Europe*: Austria, Belarus, England, Germany, Finland, France, the Netherlands, Poland, Romania, and Slovenia.
Asia and Oceania: Russia, China, India, Japan, South Korea, and Australia.
Africa: South Africa.
America: USA.

A self-built 2-nsec pulsed 14-MeV neutron generator installed at the Fast Neutron Research Facility in the early 1990s. Photo curtesy: Professor Thiraphat Vilaithong.

Funding: Over the years of support the research group has utilized approximately 3 million SEK provided by ISP. During the period of ISP collaboration, the group has received additionally around 15.5 million SEK from other funding sources. In all, the ISP funding has been of supplementary nature and comprised 17 % of the total (known) funding to the group. Since the group had other sources of funding to establish the laboratory, ISP mainly focused on the training component. Several staff members received fellowships and conducted research visits, and one PhD student received full support from the ISP grant. ISP helped to coordinate the stays in Sweden also of several other PhD students, who were supported on Thai funds. Besides ISP, the funding has mainly come from national government sources such as ISTRD, MTEC, NECTEC, NRC, NSTDA, the Royal Thai Army and TRF. Besides the national sources, the group has, as previously mentioned, also received substantial funding from the IAEA, used for establishing the laboratory, fellowships of students, expert visits and for technical assistance. An overview of the funding is available in Appendix 7.

Current situation: The group leader, Professor Vilathong, retired in 2006, shortly after the ISP support had ended. Together with a former retired graduate of the group, he administrated the ThEP Center, where he now is the Executive Director. The center is an organization located under the Ministry of Education in Thailand consisting of more than 15 collaborating Thai universities.

The Center is aiming to strengthen physics research and postgraduate training in the country and to show the willingness to provide local industries with innovative physics graduates. The organization provides fellowships, research grants and networking opportunities to its collaborating universities. The group is one of the research laboratories supported within the ThEP Center, and receives part of their current funding from there. A younger group member has succeeded the retired group leader, and the research activities, publication and research collaboration is still active and ongoing.

Currently, the research group has some problems finding funding for investments in equipment. The main problem facing the group is, however, manpower because they are having difficulties to attract postgraduate students and postdocs.

Prince of Songkla University

ISP has provided support to two research groups at Prince of Songkla University: one in chemistry and one in geophysics (Table 3.2).

IPICS THA:03/1 Trace metals and trace organics in the outer Songkla Lake and in natural water, 1984–1995

The initial contact with ISP was taken in 1983 when Professor Proespichaya Kanatharana, Head of Department of Chemistry, applied for ISP fellowships for her staff members. The research project in focus at the time was water quality analysis of the Outer Songkla Lake. A prerequisite for studying the environmental conditions of the lake was the access to a laboratory for environmental chemistry analysis, with the necessary analytical equipment, methodologies and competent staff. The work to develop such laboratory started in 1984 with training of staff and building up the laboratory facilities with the support from both ISP and Prince of Songkla University.

Nature of the ISP support: At the time, in the beginning of the 1980s, the group did not have any instrument for trace analysis at all. With the support from ISP, the group received some small instruments, which allowed them to start working in trace analysis. The results of this research work led to other research grants that could be used to buy larger equipment and to set up a cold room needed for the research. Another prerequisite to carry out trace analysis research was human capacity building in the field of heavy metal determination. Three staff members at the department were therefore sent to Chalmers University of Technology and Lund University, both in Sweden, for research training with ISP funds. Two of them later became PhD students on a sandwich basis. When the collaboration with ISP started, there was no

PhD program at the Chemistry Department. The big push for the start of the PhD program in chemistry at Prince of Songkla University came in the late 1980s, after the establishment of the Consortia of Postgraduate Education and Research Program in Chemistry, and the Royal Golden Jubilee PhD Program, which increased the funding and opportunities for PhD training at Thai universities.

Objectives and focus areas: During the time of the ISP collaboration, 1984–1995, the group mainly focused on tracing metals and organics as well the studies of biosensor technology and various applications. The group had since 1985 mostly studied physical and chemical environmental parameters of the Outer Songkla Lake, but the analysis of some important potential pollutants, such as trace metals and trace organics, had to be left out due to lack of the necessary equipment. Through the continued support by ISP and Prince of Songkla University, the project acquired the necessary equipment, methodology, and trained staff to include most of the required techniques of analyses in this field. In addition to the studies of the Outer Songkla Lake, the group also started environmental analyses of the natural water used locally. These studies were initiated by incidents in the area of Nakorn Sri Thammarat, where villagers developed arsenic poisoning symptoms. During the time of the ISP support, the group was also involved in a project to develop biosensors as an alternative technique for environmental analysis and monitoring.

In 2008, the group merged with the Biophysics Research Unit at the Prince of Songkla University, and together became the Trace Analysis and Biosensor Research Center. Today the center focuses on sample preparation and analysis techniques based on chromatography and biosensors that can be applied to industry, health care, food and environmental monitoring. The aim is to expand research and education in the fields of trace analysis and biosensors.

Challenges: During the time of the ISP collaboration, the group found it hard to acquire additional research funding and equipment. After the end of the ISP support, the group experienced a positive change in Thailand with more government research funding available for research groups to apply for. However, the group still struggles to acquire funding for equipment and is also experiencing that it has become harder to get research results published.

Outcomes: The group has over the period of ISP support, 1984–1995, graduated 2 PhD students and 5 students on the MSc level. They have had 10 publications in international journals, 5 in national journals and made 28 conference contributions.

Field arsenic monitoring by IPICS THA:03/1 group members, in the Ron Piboon district in Southern Thailand in the 1990s. Photo courtesy: Dr Roongronje Ratanaohpas.

Professor Panote Thavarungkul showing the process of tracing chemical residues in Coca Cola bottles at the Department of Chemistry, Prince of Songkla University, in 2015. Photo courtesy: Rebecca Andersson.

Funding: The group has utilized in total approximately 1.7 million SEK of ISP funding over the years of support. Other sources of funding have mainly come from national sources, namely Prince of Songkla University, the Consortia of Postgraduate Education and Research Program in Chemistry, NECTEC, and TRF. In addition, the group has received funding from the International Development Program, Australia and is collaborating with Thai industries. An overview of ISP's funding is available in Appendix 7, amounts and years of other funding are however not available.

Current situation: The research group is still very active through the established Trace Analysis and Biosensor Research Center. Currently more than 10 PhD students are actively involved. The research center has collaboration with Linköping University and Lund University in Sweden, University of California in USA, and University of Novi Sad in Serbia, where PhD students and researchers go for training and visits. The Thai government, through the Royal Golden Jubilee Program, and through national Science Talent Development Project Scholarships, is the main supporting body of today's students. Currently, the group has a Swedish Research Links-grant from the Swedish Research Council, which provides funds for travel exchange to and from Linköping University. In total, the center publishes approximately 8 papers per year in international journals.

IPPS THA:04 Geophysics, 1987–2007

ISP started to support geophysics at the Department of Physics at Prince of Songkla University in 1987. The initial contact between ISP and the Physics Department was established in the mid-1980s.

Nature of the ISP support: At the time of the start of the ISP's collaboration in the late 1980s, the department had a BSc program in physics, with suitable equipment for doing small undergraduate projects. The plan was to gradually build up a research group in geophysics at the department, starting by sending the intended group leader, Professor Warawutti Lohawijarn, for PhD training on a sandwich basis to Luleå University, Sweden in 1987. To further build up the group, PhD education of three other staff members followed, all on a sandwich basis, with Luleå and Uppsala University. In addition, ISP funds were used to buy research equipment, consumables and geophysical textbooks, and for travelling costs for Swedish supervisors. During the period of ISP support, an MSc program in geophysics was established at the department.

Undergraduate physics students from Prince of Songkla University carrying out electrical resistivity measurement during a geophysical excursion in Hat Yai. Photo curtesy: Department of Physics, Prince of Songkla University.

The former group leader, Professor Warawutti Lohawijarn, outside the Department of Physics, Prince of Songkla University in 2014. Photo courtesy: Rebecca Andersson.

Objectives: The initial and overall goal of the support was to build up good geophysics research and a laboratory with qualified staff, actively engaging in research work with MSc- and PhD students. The geophysics project included seismological research, archaeo-magnetism, palaeo-magnetism, and rock magnetism research applicable to environmental studies, as well as applied geophysics in ground water prospecting, to map regional geological structures, and related to engineering, archaeology, natural radioactivity, and environmental problems.

Challenges: The heavy teaching load following the start of the geophysics MSc program at the department is restricting time available for research. Besides the administration and managerial burden of the MSc program, another challenge for the group is finding qualified students to pursue the program. Another difficulty is to establish connections with foreign researchers something that is considered needed to be able to publish results internationally within the field. The high teaching load together with the lack of MSc students and international collaborating partners has resulted in a relatively low scientific productivity of the group.

Outcomes: Over the years of support, 1987–2007, the group has graduated 5 PhD students and 21 MSc students. The group has had 5 publications in international journals, 24 in national/regional journals and has produced 31 conference contributions.

Funding: The group has used approximately 6.2 million SEK of ISP funding over the years of support. Funding besides ISP has come from both private and governmental sources in Thailand; Prince of Songkla University, EGAT, TTSF, the Southern Culture Institute, the GFE Company, and the IRDC Exploration and Mining Co. Ltd. International funding has come from the Swedish Research Links. In total, the amount of other funding, known to ISP, adds up to approximately 3.3 million SEK. More than half of ISP's funds to Thailand have been allocated to this research group, because geophysics research and facilities was close to nonexistent by the start of the ISP collaboration. ISP funding has made out 65 % of the group's total funding during the period of collaboration. An overview of the funding is available in Appendix 7.

Current situation: The former group leader is retired, but activities are still ongoing. The human capacity for research has gradually increased, and, besides the retired group leader, all four PhD educated staff are still at the department, contributing to teaching and research. Staff members publish approximately one paper per year, which is the minimum requirement from the university. Currently two PhD students are enrolled in the group. In recent years, the group has also functioned as a host group for PhD and MSc students from the ISP supported geophysics research group in Laos.

3.2 Tracer Study Thailand

This tracer study specifically focuses on former PhD students from ISP supported research groups in Thailand, with the aim to collect and analyze quantitative and qualitative data on their mobility, career development, research outcomes and experiences.

In all, 33 PhD students were identified as having started training in supported research groups during the period 1982–2007. Out of these, 23 were traced with email addresses through help from group leaders of supported groups, the ISP internal records over visiting students and scientists, and through internet search. The traced former students were invited to fill an online questionnaire, sent out by email in April 2015, which received 17 responses (74 %).[4] Eleven respondents to the questionnaire were followed up by semi-structured in-depth interviews during two and a half weeks of field visit in Thailand in June 2015. A questionnaire was sent via email also to host supervisors in Sweden (five respondents) of Thai students. Furthermore, a bibliometric study was conducted in WoS to follow up on the publication data of former students.

The study is divided into four areas;

1. Characteristics of former students,
2. The period of research training,
3. Career development and mobility after graduation, and,
4. Research results and collaboration.

Characteristics of former students provides an overview of the former students in terms of gender, academic discipline and level of degree, age when starting training, and duration of training until graduation.

Period of research training covers both information about the organization of the research training, and former students training experiences. This area aims to answer the questions: How was the training organized? Where did the students go for research training and for how long? How did they experience the research training at home and abroad? What factors have contributed to good and bad experiences?

Career development and mobility after graduation focuses on the post training period, including current employment position and experienced working conditions, as well as patterns of mobility and career development since grad-

4 This can be considered an above normal response rate for emailed questionnaires, which according to Bernard (1994) typically is between 20–30 %.

uation. Questions to be answered here are: Where are the former students today and where have they been since graduation (geographically and employment wise)? What are the underlying factors for their decisions regarding mobility and career development? How do they experience their current employment position?

Research outcomes and collaboration focuses on the research activities since graduation and aims to answer: To what extent are former students still actively conducting research? How much have they published since graduation and where? Are they still publishing papers and collaborating nationally and internationally?

3.2.1 Characteristics of former students

In this section an overview of the identified, traced and responding former students is presented regarding gender, academic discipline and level of degree. How old respondents were when starting training and how many years it took to finalize degrees is also reported here. Data regarding the identified students are obtained from ISP records while information about the responding students comes from questionnaire answers.

Former student statistics

A large majority (94 %) of the 33 identified former students were part of the Physics Program, reflecting the fact that ISP was providing longer and more substantial support to physics than chemistry in Thailand (Table 3.3). A majority of the former students is male (82 %). In total, six female students were identified, one in the field of chemistry, and five in the field of physics.

Out of the 33 students identified in ISP records, 23 were traced with email addresses and invited to fill out an online questionnaire, to which 17 (74 %) responded. Similarly to the total sample of identified former students, the majority of the respondents is male (82 %) and from the Physics Program (88 %). All respondents pursued studies on the PhD level.

Table 3.3 Distribution of the identified and responding students, by field of science and gender.

	Identified students			Responding students		
Field	Women	Men	Total	Women	Men	Total
Chemistry	1 (50 %)	1 (50 %)	2 (100 %)	1 (50 %)	1 (50 %)	2 (100 %)
Physics	5 (16 %)	26 (84 %)	31 (100 %)	2 (13 %)	13 (87 %)	15 (100 %)
Total	**6 (18 %)**	**27 (82 %)**	**33 (100 %)**	**3 (18 %)**	**14 (82 %)**	**17 (100 %)**

Respondents come from four ISP supported research groups at three universities in Thailand (Table 3.4). At prince of Songkla University all of the identified former students in both chemistry and physics, responded to the questionnaire, while the response rate from other formerly supported research groups were lower. One explanation to this could be that all (seven) of the former students from the Prince of Songkla University research groups (IPPS THA:04 and IPICS THA:03/1) did their PhD on a sandwich basis with full support from ISP, through the research groups, while only one student from the research groups at the other two universities were fully supported by ISP funds. The remaining students were either local PhD students in Thailand benefiting indirectly from ISP support through provision of instruments, consumables and research contacts, or PhD students who did their training to a full extent or on a sandwich basis in Sweden with support from the Thai government, or other sources. In the latter case, ISP only coordinated the stay of these students in Sweden.

Table 3.4 Number of identified and responding students, by research group.

Research group	Identified students per group	Responding students per group
Chulalongkorn University		
IPPS THA:01	7	4
Chiang Mai University		
IPPS THA:03/1	19	6
Prince of Songkla University		
IPICS THA:03/1	2	2
IPPS THA:04	5	5
Total	**33**	**17**

Starting age and duration of training

Respondents to the questionnaire started their training at an average age of 32.4 years. The female respondents started their PhD training at a younger age (29.7) than their male counterparts (32.2). Figure 3.1 presents the age of the male and female students at the start of their training.

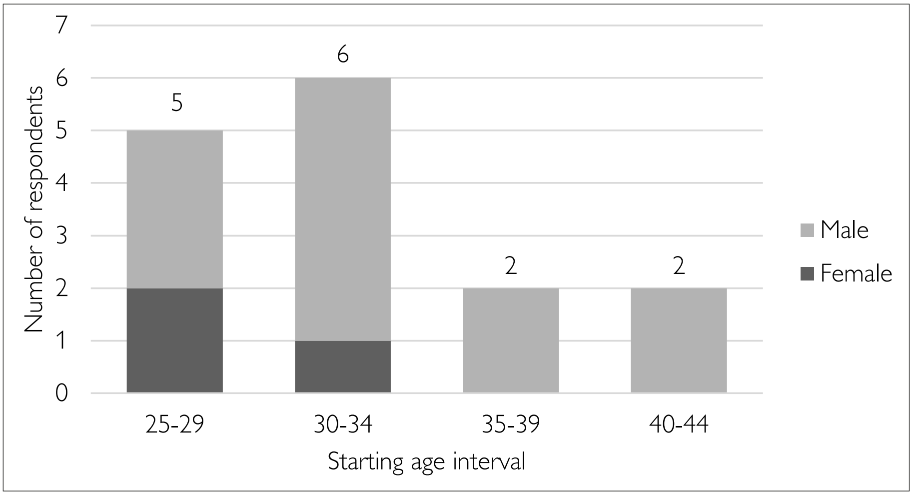


Figure 3.1 Age when starting training, by gender.[5]

Respondents began their training in the mid/late 1980s and onwards (Table 3.5). Three to four graduates starting training every five years between 1985 and 2004. Only one respondent started training in the period 2005 to 2009, when ISP support was phasing out.

A majority (77 %, 13 people) of the online questionnaire respondents held a position as staff member when starting their training. From interviews, it seems this was common at Thai universities during the period of collaboration. The requirements for obtaining a staff member position have however increased during the past decades in Thailand, along with the rapid increase in number of PhD graduates in the country, according to interviewees. Four respondents (24 %) were postgraduate students without a staff member position when starting training.

Table 3.5 Year when respondents started training.

Starting year	Number of respondents
1985–1989	3 (1 female; 2 male)
1990–1994	4 (0 female; 4 male)
1995–1999	3 (1 female; 2 male)
2000–2004	4 (1 female; 3 male)
2005–2009	1 (0 female; 1 male)
Total	**15 (3 female; 12 male)**

5 15 persons (three females and 12 males) responded to questions relevant for this figure, e.g. year of birth (q5), year of starting training (q10) and gender (q1). The full questionnaire can be found in Appendix 1.

On average, it took 7 years for the responding PhD students to finalize their studies. Eight PhD students graduated in 5.5 years or less, while six students took between 6.5–12.5 years to complete (Figure 3.2). All six students taking more than 5.5 years to graduate were sandwich students, but there are also four examples of sandwich students graduating in 5.5 years or less.

The main reason given by the students that took 6.5 years or more to graduate was the heavy teaching and administrative obligations at the home university, which delayed research activities. In all cases but one, these graduates were based at Prince of Songkla University. Some describe the sandwich model as doing the PhD halftime, with almost all research work carried out during the periods spent in Sweden. Beside the little time for research at the home university, another reason given by one respondent was the lack of online journal access at the home university, which added to the delay. Another respondent stated that the reason for taking many years to finish was the publication requirement in Sweden of five publications to complete a PhD degree:

> *"[It took] ten years, but if we count for number of months in Sweden it was five years. (…) It was the time it took to make the number of publication in international journals for a degree in Sweden. I had to continue until I had five publications". (Former PhD student, chemistry)*

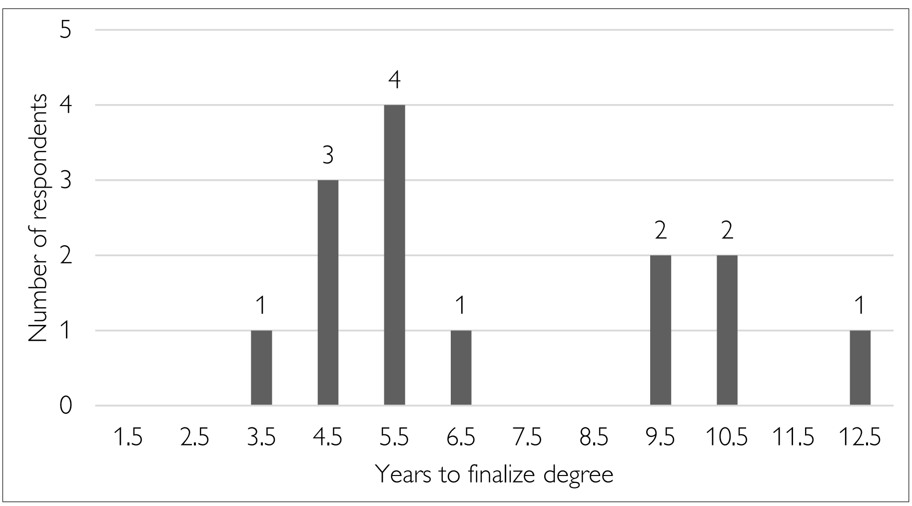


Figure 3.2 Number of years respondents took to finalize degree.[6]

6 Number of years to finalize degree is computed as year of graduation (q11) minus year of starting postgraduate training (q10), plus 0.5 years to compensate for not knowing when during the year the student started or graduated. Questions can be found in Appendix 1. 14 persons responded to these two questions.

3.2.2 The period of research training

In this section factors related to respondents research training in Thailand and abroad are presented. This includes an overview of where former students went for training and for how long, as well as positive and negative experiences of the research training. The section is based on a combination of qualitative and quantitative data obtained from the online questionnaire and from interviews with former students. In addition, the views and experiences of group leaders and Swedish host supervisors are presented here, collected through interviews with former group leaders, and an online questionnaire sent to the former host supervisors.

Organization of the training period

In ISP's collaboration with Thailand, postgraduate students on the PhD level have received training in one of three different ways: on a sandwich basis, to a full extent locally in Thailand or to a full extent in Sweden. The mode of training depended on the field of study, the capacity of the departments and universities in specific fields, as well as the year the training started. Students enrolled in a sandwich based program spend part of their research training at the home university and part at a host university abroad, while maintaining the connection to the home university and their respective research group.

A major part of the online questionnaire respondents (65 %, eleven respondents) underwent sandwich model training, and all sandwich students spent their time abroad at host universities in Sweden. The remaining respondents either did their PhD full time at a Swedish university (three respondents) supported with scholarships from the Thai government, or to a full extent locally in Thailand (three respondents).

There is no standardized sandwich program model, thus the length and number of stays abroad has varied according to the individual needs and preferences of the students. The total time that sandwich students spent in Sweden ranged between 5–60 months. The distribution of the abroad stay rates is shown in Figure 3.3. The number of visits to Sweden varied between 1–10. On average, respondents made four visits with an average stay of six months per visit. It is not possible to make any conclusion about the gender difference of the total stay rates abroad, because only one of the sandwich students was female. She visited Sweden eight times for a total of 60 months, over a ten-year period.

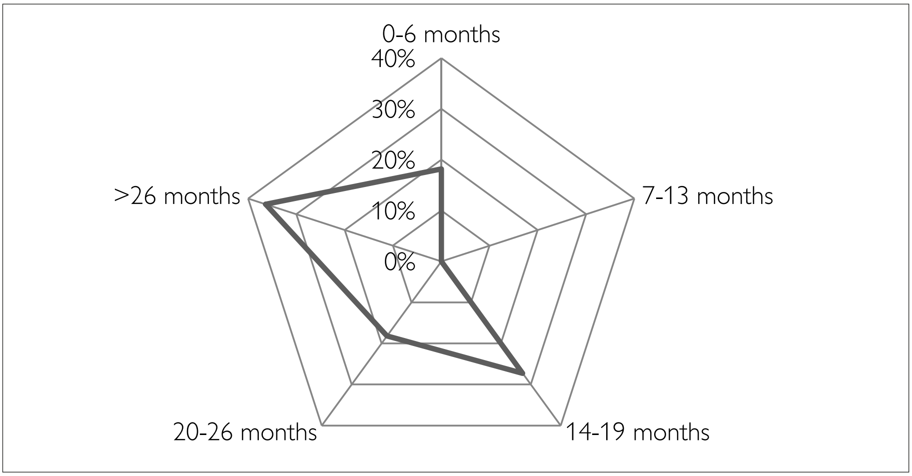


Figure 3.3 Total length of stay abroad of sandwich students.[7]

Regardless of being sandwich or local students, most respondents (eleven) received their degrees from their home university in Thailand. In countries where universities are certified to grant postgraduate degrees, students in ISP supported groups generally get their degrees from the home university.

Six respondents have degrees from universities in Sweden, namely Chalmers University of Technology, Linköping University, Luleå University, and Uppsala University. One of the reasons why students obtained degrees from Swedish universities was that Prince of Songkla University and Chiang Mai University did not have PhD programs in physics at the time. Two students were supported by the Thai government and a Thai university, respectively, and in both cases it was encouraged by the grant providers that staff members obtained their degrees from the foreign university. Some respondents expressed that it is the belief of the Thai society that a foreign degree is valued higher than a domestic one, both when applying for jobs and positions, and for the researcher personally. Three interviewees explain:

> *"The degree in itself is not different. But the feeling of the people is different, and you get more respect. (…) I feel more respected and confident. Also communication with foreigners is much easier". (Former PhD student, physics)*

7 All sandwich students (eleven people) responded to this question (q22, Appendix 1).

> *"To answer your question I think it is a lot better to get a PhD from abroad. Why? It is the belief from the Thai society. (…) Because I have a PhD degree from abroad, I can be the head of the group and the editor of the physics magazine, I can go to meetings in Bangkok and I can be a Chair Person and things like this. I can be the leader". (Former PhD student, physics)*

> *"In Thailand it is a very strong feeling that if you graduate from abroad you get a very good job after. Especially in the private sector they have a priority list, if someone comes from this university they come first and so on. It is more positive to have a degree from abroad, and to have that degree on the paper alone. If you have a Thai degree you have to prove something, that you are better". (Group leader, physics)*

Experiences of the sandwich model training

Most of the respondents were sandwich student who spent part of their research training at host universities located in Sweden. In addition to their valuable experiences of the sandwich model, the views and experiences of group leaders and host supervisors are also presented here.

Positive features

According to respondents, positive features of the sandwich model were 1) the chance to work in an advanced research environment with access to research facilities and new technology, 2) to meet experts in the field, and 3) to acquire new ways of thinking and learn new techniques. The opportunity to work with, address, and potentially solve problems related to Thailand was also mentioned. The visits to Sweden were very appreciated, not only for the scientific benefits, but also for the cultural experience. A majority of the respondents were positive to spend time abroad and learn about different research cultures and culture in general, as well as to improve their English language skills. A physics respondent stated:

> *"My [host] supervisor helped me to get to know Sweden, to get to know another country. He was more than a teacher for me".*

Importantly, many respondents emphasized the fact that after finalizing their PhD training they were able to continue the research work at the home department in Thailand, thanks to the continued contact with their research group during the whole period of training. Some also emphasized the importance of ISP providing follow-up support in terms of equipment and visits from experts, which helped in the starting up and continuation with the research upon return to Thailand.

Some former students and group leaders, who did their PhD training full time abroad, expressed the problems of starting up research when returning to Thailand, mainly related to the difference in available equipment in Thailand and abroad, and the field of specialization. A group leader in physics explains:

> *"When you do the whole program abroad like in Sweden or Canada the situation there is very much different than in Thailand. The graduates cannot do anything when they come back home. They have to build everything from scratch when they come back. This is unlike the sandwich program where they spend some time abroad to learn more and have connection with an advance lab and still have contact with the home university. When they come back they have the ability to work here in Thailand. Many people who graduated from abroad in experimental physics, they cannot do anything when they come back home".*

A PhD physics student who did the PhD to a full extent in Sweden serves as one example:

> *"My PhD was in seismology. In Uppsala they have a big equipment and system, here I had to change myself to work with another type of problem that was more suitable for the instruments we have here at Prince of Songkla University. So it was quite hard to start up".*
>
> *A current group leader holding a PhD from the US serves as another:*
>
> *"I cannot continue my research in the area I was trained for in the US. But I can change it to anything in the area in physics. I am trained in the general physics so it can be changed… ".*

The Swedish host supervisors were in general very positive to the hosting of PhD students from Thailand, and to the ISP program in general:

> *"The ISP program worked well. The interaction with the Thailand host department worked fine. The Thai students work hard, have a good theoretical background, but are in some cases less offensive, less willing to network and not taking initiatives to the same extent as other PhD students".*
>
> *"I am very happy to see that one of my previous PhD students now acts as a supervisor and that he, now with me as a co-supervisor, has presented the first PhD in geophysics ever to be examined in Thailand. ISP has played an important role in the transfer of research capacity to Thailand and hopefully ISP can continue doing so in the future".*

Three Swedish host supervisors stated that visiting students enriched their research groups and widen their scientific minds:

> *"It is beneficial for both sides: The students usually develop and learn new systems quickly, and contributing to our research projects. The students can bring back important experience and competence when they move back".*

> *"It is good to have students with different experiences and research topics that we don't have experiences of in Sweden, i.e. it broadened our scientific minds".*

Negative features

The lack of time for research in Thailand, due to teaching and administrative obligations, negatively affected the research productivity at the home university during the PhD training. According to respondents this made the sandwich program take considerable longer time than a full time PhD degree abroad. Both students and group leaders bring up the longer completion time:

> *"Bad things? It takes a bit longer than a normal PhD. I cannot say it is negative but it is a bit longer. In our case for the sandwich program it is quite difficult that the university require you to do the normal work as well. You can not only do research work. You do the study and the teaching at the same time. That is making it a bit long. That is the only problem that we can see". (Group leader, chemistry)*

> *"We cannot concentrate or continue with our research work when we are back in Thailand. Writing manuscripts in Thailand is impossible because of all the [teaching] work". (Former PhD student, physics)*

> *"In Sweden it is much easier to do research. You can get the results much faster, in a few months, while the same thing in Thailand takes two years. The key factor is the full time doing research. In Thailand the teaching work is very, very tough". (Former PhD student, chemistry)*

One Swedish host supervisor also pointed to the fact that the sandwich model takes longer time, but emphasized that the benefit the model gives to the home university makes it worth it:

> *"The study time is long, not only for the delay due to teaching etc. at the home universities, but also it takes extra time to get back into the research when the students come back to Sweden. However, this is something we may have to pay since the contact with and benefit for the home university is important to maintain".*

Two PhD respondents said that they would have preferred to do the degree to a full extent abroad in order to save time, to fully focus on research, to learn better English, and to be able to control the study plan to a larger extent. Some also emphasized that full time abroad is better when doing a PhD degree in science because the experiments requires continuation.

One respondent was offered to do a PhD on a sandwich basis through ISP, but rejected the offer to instead do a full time PhD in Sweden, supported by a Thai government scholarship. The respondent believed that it is difficult to conduct research when traveling back and forth, and similar to the other respondents pointed to the longer time, and many distractions in Thailand hindering students to fully focus on their research when doing a sandwich model PhD.

Another disadvantage of the sandwich program brought up by respondents is that the period spent in Sweden was too short to adapt to the research equipment and with colleagues. One respondent mentioned that during the time of training there were big cultural differences in how the research work was done in Sweden compared to Thailand, but stresses that it not an issue anymore.

Lastly, it was pointed to that the remuneration was significant less than the normal rate of Swedish PhD students. This resulted in that some students felt they had to live a more modest life compared to their Swedish PhD student colleagues, while in Sweden.

Difficulties in relation to the training at home and abroad

In the questionnaire, respondents were asked to rate their experiences of their training situation with regards to five aspects, at both the host- and home universities, on a scale comprising "mostly very good", "mostly good", "mostly difficult" and "mostly very difficult".

All respondent experienced the research training, the supervision, the resources for research, the access to information, and the collegial support at the host universities in Sweden as mostly very good, or mostly good. Even though a majority of respondents were satisfied with the conditions for research also at the home universities, some difficulties were expressed related to the situation in Thailand (Figure 3.4). Most dissatisfaction was shown regarding resources available for research in terms of both time and equipment (four respondents), followed by the period of research training, supervision and collegial support and research networks at respondents' home departments (three respondents, respectively).

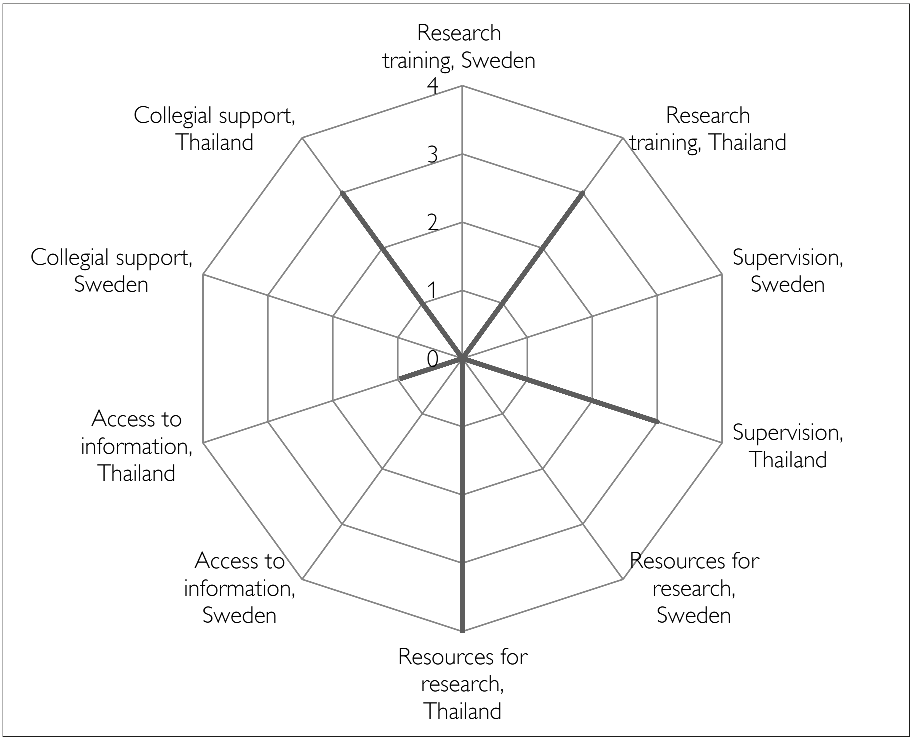


Figure 3.4 Number of respondents expressing difficulties with the training situation at home and host universities.[8]

Regarding the time for research at the home university, the difficulty according the interviewees was the obligations following their 100 % staff member position, involving teaching, and administrative tasks. In Sweden, they were free of these obligations and could focus fully on their research. Other difficulties brought up relating to research was the process of buying chemicals as well as the lack of, or the less functional, equipment and facilities available at the home universities.

> *"You have better equipment in Sweden. We have to devote our time to the machine in Thailand. Most our time we lose to prepare the machine. Sometimes we get donation of instruments that are very old, but then we have do very much reparation and maintenance". (Former PhD student, physics)*

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8 In the questionnaire respondents were asked to rate their experiences of their training situation in the five aspects shown in the figure, at both host and home universities, on a scale comprising "mostly very good", "mostly good", "mostly difficult" and "mostly very difficult" (Appendix 1, q23). Figure 3.4 show a summary of respondents' answers "mostly difficult" and "mostly very difficult". 12 people answered this question.

> *"In Thailand we had some equipment but we had some difficulties at home because we didn't have clean room to perform trace analysis. Some of the difficulties were to get financial support from the university on the Thai side. Now it is far better regarding the research support from the Thai government. During the last years the government has put a lot more support to the universities". (Former PhD student, chemistry)*

Regarding supervision in Thailand the difficulties were related to the fact that in some cases there was no supervision available. The local supervisor was in some cases only a supervisor "on paper", as the field of specialization differed between students and supervisors. The local supervisor and colleagues at the home department were used for discussions and support, but the main supervisor was the one in Sweden. In some cases the students expressed feeling isolated, because they were the only ones in that specific scientific field at the university. Communication with Sweden back in those days was also hard and expensive.

> *"There was no one in that area at the Thai university. I had contact with my supervisor in Sweden, but at that time it was not easy to communicate. It was very, very difficult to make communication to Sweden. First time I contacted Sweden I charged very much for each minute for calling to Sweden. Nowadays it is free". (Former PhD student, physics)*

Many of the host supervisors in Sweden stated that the communication with Thai supervisors was very good or good. One supervisor pointed to that he did not remember that there was any local supervision at all.

All respondents experienced all aspects at the Swedish host departments as mostly good or mostly very good, and in interviews expressed positive attitudes and gratitude towards their former host department and professors.

3.2.3 Career development and mobility

The previous section covered the period of training, whereas this section moves on to look at the post-training period, including current employment position and working conditions. Finally respondents' geographical and sectorial mobility is presented.

Current employment position and working conditions

A majority of the respondents are currently working in the university sector in Thailand (77 %, 13 respondents). Eight respondents are employed at their university of graduation, while five are working at another university in Thailand, than the one where they graduated (Figure 3.5). Two respondents recently retired from their university positions, and are currently working part time for a government organization and a private company, respectively. Two respondents are currently working and living outside Thailand, one at National University of Laos, where he is originally from, and one is working for a private company in China.

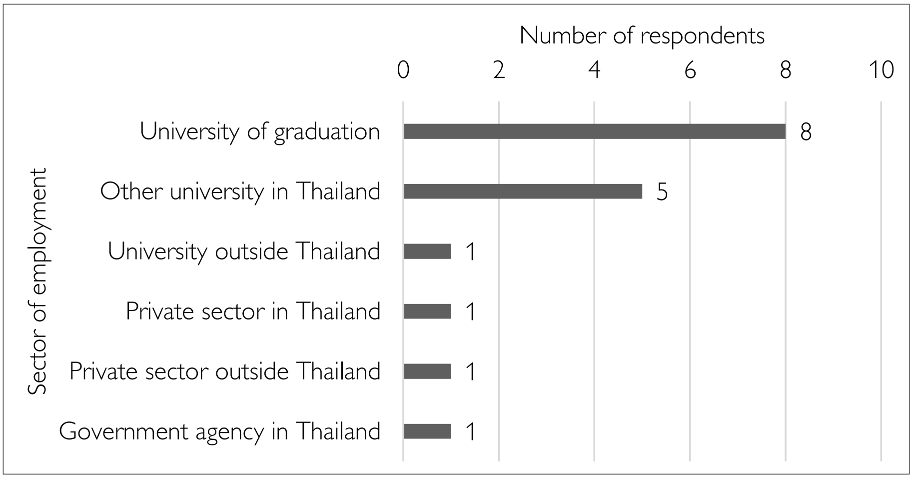

Figure 3.5 Current sector of employment of respondents.[9]

The most common position at universities among responding graduates is Lecturer or Senior Lecturer, held by nine respondents (Figure 3.6). Among the respondents are also three Deputy/Vice Deans, and two Deputy Heads of Department. Among respondents are one professor, three associate professors and four assistant professors.

9 17 respondents answered this question. All categories the respondents could choose from are available in Appendix 1, q32.

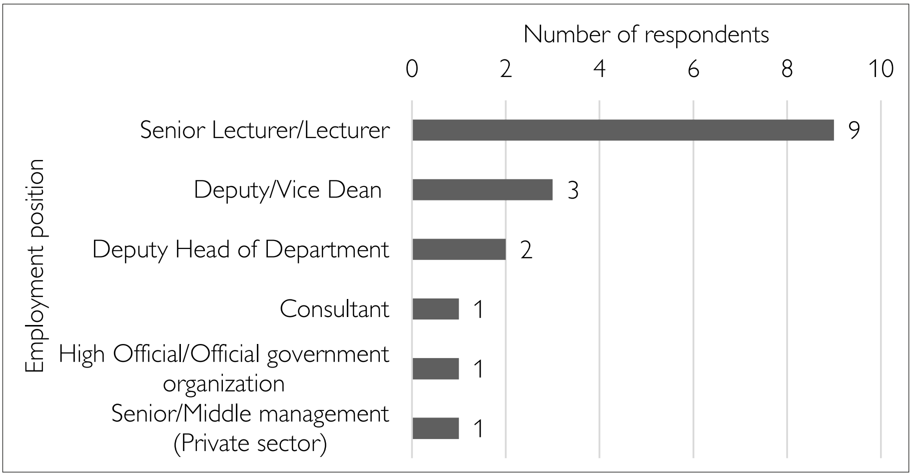

Figure 3.6 Current employment position of respondents.[10]

Satisfaction with current employment

All but one respondents believe that their current employment position correspond to a large or very large degree with their academic qualifications. In addition, all but two respondents express that their PhD degree has contributed "very much" to their current position.

In general, the respondents seem very pleased with the situation at their current workplace. When it comes to overall satisfaction 94 % stated that they are satisfied (ten respondents) or very satisfied (five respondents). This is also the case for specific areas related to their current work, with 88–94 % (14–15 respondents out of 16) stating they are satisfied or very satisfied with their working conditions, intellectual challenge, level of responsibility, degree of independence, contribution to society, as well as social status of their current position. Salary and job security stands out as the two area where respondents showed a bit more of dissatisfaction, with four respondents being dissatisfied with their salary at their current job, followed by three respondents being dissatisfied with the job security (Figure 3.7). In all, a large majority of the respondents reported that they are satisfied or very satisfied with all of the areas related to their current employment position.

10 17 respondents answered this question. All categories the respondents could choose from are available in Appendix 1, q33.

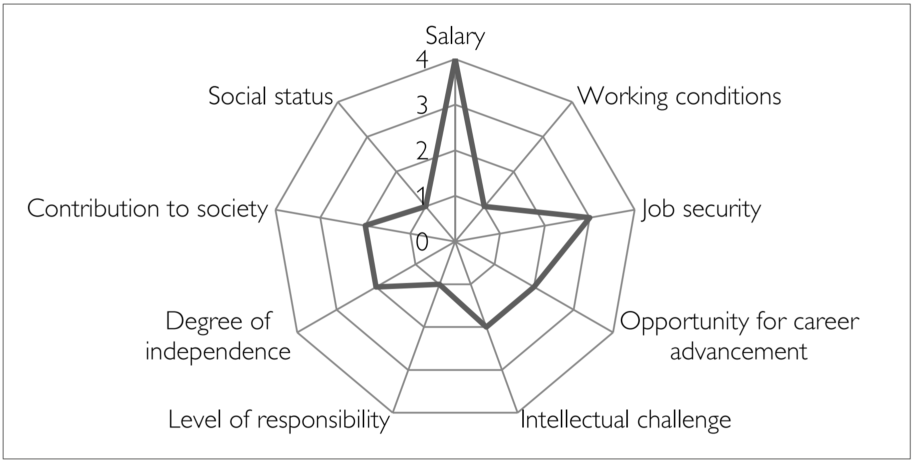

Figure 3.7 Number of respondents expressing dissatisfaction with aspects of current employment position.[11]

Only four out of the 17 respondents stated having an extra income generating employment, three of them as consultants for private companies and one holding an extra administrative position. Several research groups have developed collaboration with the industry in Thailand, where the groups normally stand for technology development and the industry for the raw material needed to carry out research. The respondents did not receive any extra income for these services, but functioned as a government consultancy to, or in collaboration with, private companies.

Geographical and sectoral mobility

Respondents' mobility between jobs has generally been low. All respondents of the questionnaire have held one to two positions since graduation. Many already had positions as staff members at the universities when they started their PhD, and most have stayed in those positions. Six respondents have had positions outside the university, mainly at private sector companies, organizations or actors in Thailand, but also single cases of private- and government sector actors outside Thailand. The security and honorability of a position at the university was mentioned as reasons for staying in the same position, despite the relatively low university salaries. One respondent describes the

11 In the questionnaire respondents were asked to rate their satisfaction with their current employment position ranging from "very satisfied", "satisfied", "dissatisfied" to "very dissatisfied" (Appendix 1, q38). Figure 3.7 presents number of respondents answering that they were "dissatisfied" with aspects related to their current position, no respondent answered that they were "very dissatisfied" with any aspects. 16 respondents answered this question.

lecturer work as a both prestigious and respectable job in Thailand. Another benefit mentioned was that some universities, Prince of Songkla being one example, also offers free housing for the employee and their families.

Through the Thai government "Talent Mobility Program" initiative, researchers can work for the private sector without giving up the security of their university position. One of the respondents, employed at the university for many years, is currently working once a week for a digital company to improve the technology of their hard drives, with a top up of the salary from the company. This government initiative was launched to address the problem of R&D personnel shortage in the industrial sector. Through this program, staff from academic and research institutions, which host nearly three-fourths of the Thai R&D personnel, can work full- or part time at private companies to help out in the development of the industries and their technologies.

Six of the respondents have worked abroad since graduation, both at private companies in the US and China and at academic institutions in Germany, Japan and Sweden. Positions held were Researcher, Postdoc, Principal Engineer, and Chief Technology Officer. One example is a respondent working as a researcher for 1.5 year at a hard drive company in US, with the aim to transfer new technology to the sister company in Thailand. The company and the Thai government jointly paid the researcher's salary. Two thirds of the respondents have not worked abroad since graduation.

Some of the respondents were not fully supported by ISP, but instead received scholarships for studies abroad from the Thai government. In the scholarship contract signed by the recipients it was stated that they have an obligation to come back and work for the Thai government after graduating, for the same time period or twice the period of their stay abroad. Otherwise they would have been obligated to pay back two- or three times the amount of the scholarship cost.[12] This rule has restricted their geographical mobility after finalizing their PhD training. One graduate who received a Thai government scholarship explains:

> *"When I graduated I had a chance to go work in the US but I couldn't because of the binding contract. The price of the contract is very, very high. If I didn't come back to Thailand I needed to pay back twice the amount. (…) I think the policy is fair enough. I think it is a good thing that people need to sit down and think a little bit about the future". (Former PhD student, physics)*

[12] Several types of scholarships are provided and the terms and conditions differ. Some also allow graduates to work within the private sector in Thailand.

One respondent who were supported by ISP on a sandwich basis describes a similar restriction for university employees:

> *"If you are a government official and take leave to work abroad, you have to work the double amount of time in Thailand. That is the rule if you take leave while working at the university. This was the case even for me even though I did not get a scholarship from the Thai government. At some universities it is even three times longer. The university is keeping track. Since I did the sandwich model I went for six months abroad and then six months here, at the end of my program I was not under any obligations to stay in Thailand". (Former PhD student, chemistry)*

It should however be stated that many respondent also wanted to return to Thailand, for family reasons, for starting up a specific field of research, or to study problems of relevance to Thailand. As a result of the will of the respondents or because of the government policies, all but two of the respondents are currently living and working in Thailand.

3.2.4 Research results and collaboration

In the previous section we learned that a majority of responding graduates are working at universities and research institutes in Thailand. This section focuses on the research activities and collaboration: are respondents still actively conducting research? How much have they published since graduation and where? Which are the opportunities for research funding? Are respondents collaborating with other scientists, nationally and internationally?

In order to understand research activities in the supported groups and the possible impact of ISP's former support, three data gathering methods were used: online questionnaires, in-depth interviews and data from the WoS database.

Research activity

The primary responsibility of a university academic in Thailand is teaching, and the volume of research depends largely on the load of teaching and the time remaining for research. Data from the questionnaires show that a majority of the respondents (71 %, 12 respondents) spend 50 % or more of their time on research; nine respondents conduct research on a half-time basis, two spend 75 % of their time on research. One respondent, working for a private company, is a full time researcher. The remaining five respondents spend 25 % of their time on research (Figure 3.8).

In practice, research activities involved MSc- and PhD supervision, collaborative research with other colleagues, performing testing and measurements in the lab, writing funding proposals, and in case of approved funding, conducting the proposed research.

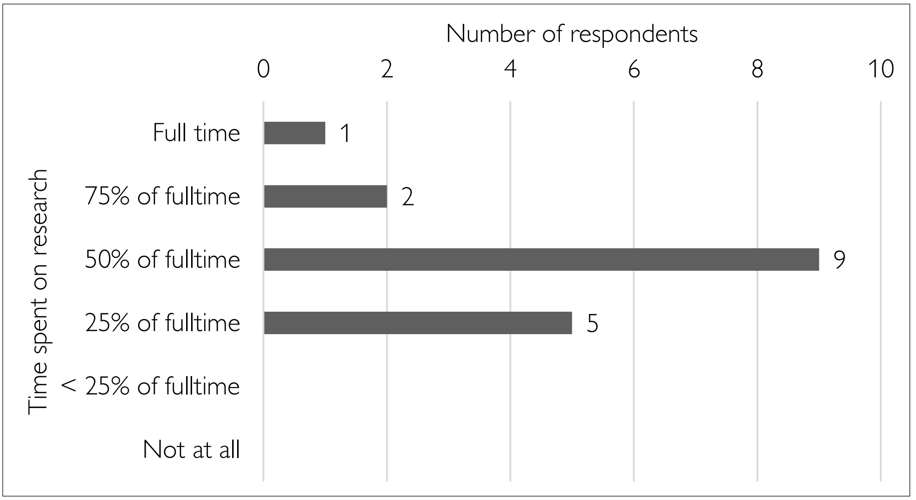

Figure 3.8 Number of respondents currently actively conducting research, to different degrees of full time.[13]

During the interviews, respondents explained that university lecturers have teaching as their first responsibility, and depending on the teaching load, one can do more or less research. There are incentives encouraging research, such as academic promotion at the universities. The criteria for the promotion differs between supported universities, but generally involve publications outcomes, and the extent of collaboration and international recognition (which is measured through number and importance of invitations to give lectures or presentations). However, the majority of the respondents stated that they are not able to do as much research as they would have liked to, due to teaching and other administrative responsibilities at the universities.

The inability to practice research at the home department was most clearly noted among sandwich graduates, spending part of their studies in Sweden, and part at the home university in Thailand. All of the respondents stated that their research stopped or largely slowed down when in Thailand due to other responsibilities.

13 17 respondents answered this question, available in Appendix 1, q40.

> *"The bad thing is that when you come back you have to take part in all the teaching at the department and we are not as free as when we are in Sweden, with no responsibility. In Sweden we had 24 hours for research and free time. It is more difficult in Thailand. To arrange the time for the research work it is hard because you had the course work and so on. We use weekends or holidays to go for data collection (...). (Former PhD student, physics)*

Research funding

The data from the online questionnaires show that most of the respondents (13) have, during some point in their research careers, received funding for research from the Thai government (Figure 3.9). The private sector had contributed to eight out of 16 respondents' work, while international research funding had contributed to the work of six respondents. Half of the respondents have received funding from more than one source, while two of the respondents have received funding from all three sources.

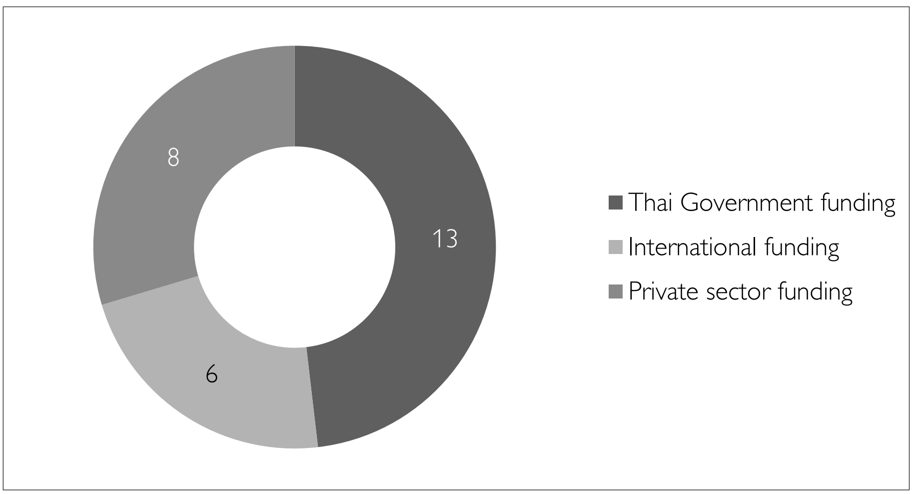

Figure 3.9 Number of respondents receiving funding for current research activities, by source of funding (respondents could choose multiple options).[14]

Regarding the research funding in Thailand, there are several sources available. Respondents have a general impression that there is much more opportunities for a researcher to apply for now than it was before. However, the competition for funding has also increased according to PhD graduates:

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14 16 respondents answered this question, available in Appendix 1, q42. Respondents could choose multiple options.

> *"It is not easy. We apply every year, but we get every second or third year. But since we are a big research group usually someone gets the funding, so we share".*

Funding from the private sector is becoming more common, partly because of governmental efforts to encourage and promote this kind of collaboration and partly because of the general need for innovations in the Thai industry.

Research productivity

A large majority of the respondents (14) stated that their major motivation for publishing is of professional nature (Figure 3.10), as providing scientific results is part of their job description and career development. Scientific publication is a requirement for academic promotion. Two respondents stated that publishing is also required by their funding agency. In one case a respondent did not publish his scientific results because his private sector employer had a nondisclosure agreement with him. Two respondents stated that their motivation for publishing scientific research results was personal satisfaction. For one other respondent, publishing was a way to attract attention from the private sector.

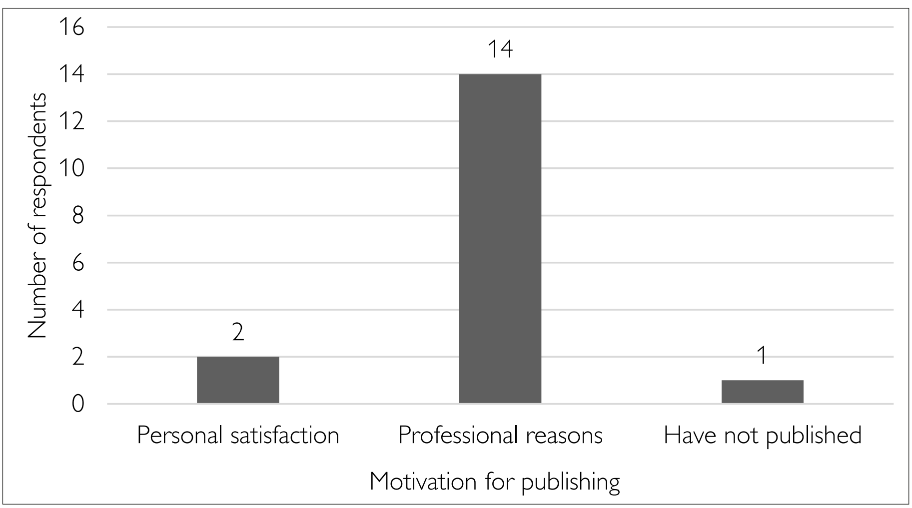


Figure 3.10 Respondents motivation for publishing.[15]

15 17 respondents answered this question, available in Appendix 1, q52.

In order to examine the scientific productivity of the respondents, a WoS database search was carried out. According to the search, the 17 respondents have in total published 207 papers during the period 1981–2014, with an average citation rate of 8.3, in journals with an average impact factor of 1.8 (Table 3.6).

Table 3.6 Publication data of respondents, by research group.

University *(Field of research)*	Number of respondents	Total number of publications 1981–2014*	Average number of publications/ person**	Average number of citations	Average IF of journals
Chulalongkorn University					
IPPS THA:01 *(Semiconductor physics)*	4	43	11.2	7.9	2.1
Chiang Mai University					
IPPS THA:03/1 *(Plasma, neutron and ion beam technology)*	6	142	23.7	7.7	1.9
Prince of Songkla University					
IPICS THA:03/1 *(Trace metals and organics)*	2	11	5.5	20.5	3.1
IPPS THA:04 *(Geophysics)*	5	11	2.2	5.5	1.8
Total	**17**	**207**	**12.2**	**8.3**	**1.8**

* In the case that two or more scientists from the same department co-published a paper, it could appear multiple times. In this column such duplicate papers are removed, and the actual number of papers per group is presented.
** Duplicate papers are included here as a measure of productivity per person.

Physics respondents from the research group at Chiang Mai University (IPPS THA:03/1) have the highest publication productivity, with an average of 23.7 papers per person. Respondents graduated from the Chulalongkorn physics group (IPPS THA:01) follows with in an average 11.2 papers per person, while respondents from both the chemistry group (IPICS THA:03/1) and physics group (IPPS THA:04) at Prince of Songkla University have a lower productivity average (5.5 and 2.2 respectively). The development of the scientific productivity of the supported individuals depends on many factors, such as the state of the group they belong to: when the group was formed, number of members of the group, number of PhD- and MSc students, sources of financial support, and extent of external collaboration. Also external factors, such as more available funding sources for research, are of importance for the scientific productivity. Additionally, the scientific productivity of a group depends on the productivity of individual scientists, because one person with a large number of publications has an impact on the group as a whole.

However, the highest productivity does not imply the highest impact, which may be better represented by number of citations. The number of citations is highest for respondents from the chemistry group (IPICS THA:03/1) at Prince of Songkla University (20.5), followed by 7.9 for respondents from the physics groups at Chulalongkorn University (IPPS THA:01), 7.7 for Chiang Mai respondents (IPPS THA:03/1), and 5.5 for physics respondents from Prince of Songkla University (IPPS THA:04). When the impact factors of journals of publications are considered, a similar order is repeated with the Prince of Songkla chemistry group publishing papers in journals with on average the highest impact factor (3.1), followed by the physics groups at Chulalongkorn (2.1), Chiang Mai (1.9), and Prince of Songkla University (1.8).

Publications before thesis defense

The WoS search also revealed that 71 % (12 persons) of the respondents to the tracer study have published papers before graduating; on average three papers each. This is not unexpected given that a majority (77 %) did their dissertation by articles, in which case the publication of a certain number of articles is a requirement for graduation.

Research collaboration

The nature and scope of scientific collaboration differs between respondents from the three supported universities. Looking at the number of co-authored papers with authors outside the respondents own university, both in Thailand and abroad, respondents from the physics group at Chiang Mai University (IPPS THA:03/1) have the highest number of such papers (110), while respondents from Chulalongkorn University (IPPS THA:01), and Prince of Songkla University, including both physics (IPPS THA:04) and chemistry (IPICS THA:03/1) respondents, have less (27, 10 and 8 respectively).

However, looking at the percentage of co-authored papers (Table 3.7) the highest share of internationally co-authored papers is among respondents from Prince of Songkla physics (83 %) and chemistry groups (73 %), followed by physics respondents from Chiang Mai University (77 %), and respondents from Chulalongkorn University (63 %). A much smaller share of papers is co-authored with other Asian scientists, outside Thailand.

Table 3.7 Respondents share of internationally co-authored papers, and percentage of co-authored papers with Asian scientists, by group belonging.

Share of internationally co-authored papers	% International co-authors	% Asian co-authors*
Chulalongkorn University (IPPS THA:01)	63 %	11 %
Chiang Mai University (IPPS THA:03/1)	77 %	20 %
Prince of Songkla University (IPPS THA:04)	83 %	11 %
Prince of Songkla University (IPICS THA:03/1)	73 %	0 %
Total	**74 %**	**11 %**

* Excluding papers co-authored only with scientists from Thailand.

On average, respondents have co-authored at least seven times as many papers with non-Asian scientists as with scientists coming from within Asia. The number one country of collaboration is Sweden (Table 3.8). Respondents have co-authored around twice as many papers with scientists from Sweden as with scientists from other institutions than their own within Thailand. The largest number of collaborators, apart from Sweden and Thailand, come from Japan, USA, France, Germany, Netherlands, Russia, Finland, and Australia.

Table 3.8 Top ten collaborating countries and number of papers co-authored with scientists from these countries.

Country	Total	Chulalongkorn IPPS THA:01	Chiang Mai IPPS THA:03/1	Songkla IPICS THA:03/1	Songkla IPPS THA:04
Sweden	**103**	22	64	8	9
Thailand	**57**	8	48	0	1
Japan	**28**	4	24	0	0
USA	**25**	0	25	0	0
France	**22**	0	22	0	0
Germany	**17**	5	12	0	0
The Netherlands	**13**	0	13	0	0
Russia	**10**	0	9	0	1
Finland	**6**	0	6	0	0
Australia	**5**	1	0	4	0

The high number of Swedish co-authors is not surprising considering the fact that all of the respondents (except three local PhD students) spent a portion of, or all of, their PhD education in Sweden, being part of Swedish research groups. Most questionnaire respondents (65 %) also stated that they still are in contact with their former supervisors in Sweden. Four respondents still conduct research, co-publish, and jointly write research proposals together with their former host institutions; two respondents are co-supervising students;

while the rest remain in contact for nonscientific, personal reasons. Hence, the contacts acquired during the PhD studies, have significantly contributed to a high level of Thai-Swedish collaboration. Further, ISP's role in providing the contacts and supporting students by organizing and funding the student stays in Sweden could be considered significant for the Thai-Swedish research collaboration and co-authorships accounted for here.

Through the online questionnaire, respondents' attitudes towards working with Thai collaborators in relation to working with international collaborators were collected. Many thought that it was easier to communicate and get in contact with Thai scientists (five respondents) even though it was hard to arrange meetings due to the heavy workload (three respondents). Collaborating with Thai scientist was also considered more useful for the Thai society (six respondents), which is positive when applying for Thai government funding (one respondent), even though the funding was not seen as systematic (one respondent).

Thai scientists were also seen as having lower commitment towards collaborative research (one respondent) due to the mentioned high workload, and as having limited knowledge (one respondent) and less functional and advanced equipment (one respondent) compared to international scientists, who were seen as more responsible (two respondents), knowledgeable and established (three respondents), and more prone to consider new knowledge and cutting edge technology (seven respondents). Publishing in international journals was therefore seen as easier when collaborating with international scientist (one respondent). However, communication with international collaborators was stated as an issue (five respondents) due to language, and cultural problems, as well as high costs of travel (two respondents). One respondent had experienced unfair management of the funds when working on a common project with international collaborators.

From the interviews, more insights of respondents' attitudes towards collaboration in general were gained, showing that attitudes differed between the three universities in question, and among scientists. Respondents from the physics group at Prince of Songkla University (IPPS THA:04) generally considered establishing contacts as hard:

> *"We go to the conferences but it is hard to establish that kind of contact that you can do research together. I went to every conference and tried to make ourselves known and tried to convince other Thai scientists to collaborate. It didn't work out with the collaborative research, but we managed to start a geophysics conference that is organized annually by different universities in Thailand."*

> *"I don't like to collaborate. I feel uncomfortable collaborating with foreign people because I am worried about what do they think of us."*

> *"I don't have collaborations abroad. That is my weakness. I am still in contact with my supervisor from Sweden, but we have not co-published. Maybe in the future."*

> *"It is not easy to collaborate with neither Thai nor foreign."*

The leader of the supported chemistry group at the same university expressed similar collaborating issues:

> *"It is not common to collaborate among Thai universities, but it will be. Government sat up a Chemistry Consortia in order to support collaboration".*

The respondents from the Chiang Mai University physics group (IPPS THA:03/1) were more recognized (higher scientific productivity and larger collaboration network), and it seems that collaboration has been easier for them. Respondents from this group stand for a vast majority of the co-publications made with countries besides Sweden and Thailand (Table 3.8). However, the opinions among respondents were mixed. Some respondents found it hard to collaborate mostly with foreign scientists:

> *"It is difficult to collaborate with foreign scientists because our level is lower and they are too busy to look down. We have to go through private connections first."*

> *"I would prefer to work with foreign researchers, but it is hard because it is hard to communicate as my English is not good."*

While other respondents from the group had extensive international collaboration:

> *"Our group has collaboration with Japan, Korea, Germany in field of plasma development. We have collaboration with China and Russia in field of material physics."*

> *"For me it should be equally easy to collaborate with Thai or not Thai scientists. In Thailand we are kind of forced to collaborate across universities because equipment is decentralized."*

> *"It is easy to collaborate. It is a network. I have connections in Sweden, Japan, France."*

Respondents from the physics group at Chulalongkorn University (IPPS THA:01) did not seem to have any problems establishing networks and new contact according to the group leader:

> *"It is not hard to collaborate, we meet on meetings, conferences, every year we have congress, and we get visits".*

However they faced the problem of isolation since they were the only group in Thailand working in the field. Their closest collaborating partner is in Japan, which is a five-hour flight away.

The most common way to network expressed by the respondents was through conferences and workshops (Figure 3.11). The second most important way to start collaboration was through PhD supervision, followed by work with the colleagues at the own universities, and through existing scientific networks. The respondents also mentioned the internet, sabbatical visits and Thai governmental involvement as a way to get in contact with new potential collaborators.

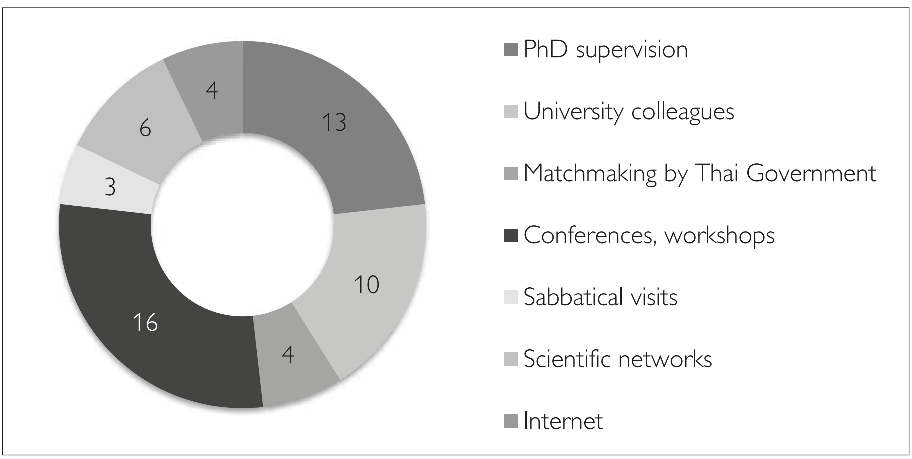


Figure 3.11 Number of respondents expanding their networks, by different networking means (respondents could choose multiple options).[16]

Government-related involvement includes working through different consortia that encourage private sector and universities to collaborate. These consortia work as matchmakers between the private sector, which provides research problems, and academic institutions, which are able to provide solutions to

[16] 17 respondents answered this question, available in Appendix 1, q59.

these problems. Three formerly supported groups (IPICS THA:03/1, IPPS THA:01 and IPPS THA:03/1) are a part of two such consortia; the Center of Excellence for Innovation in Chemistry and the Thailand Center of Excellence in Physics (ThEP Center). A former group leader and graduate from the supported physics group at Chiang Mai University (IPPS THA:03/1) is currently the Executive and Deputy Director of the ThEP Center.

Future plans

Respondents to the questionnaire were on average 50 years old. As senior academics, most had no plans to change their current positions. The results from the online questionnaire show that the majority of the respondents think that it is most likely that they will continue work at their current university as lecturers and researchers.

3.3 Follow-up study Thailand

While the tracer study focused on former students part of ISP supported groups, this part focuses on the supported research groups as a whole. The purpose of the follow-up is to analyze and assess ISP's collaboration with Thai research groups in chemistry and physics in relation to ISP's most recent goals, and the objectives stated in the ISP Strategic Plan 2013–2017 (ISP, 2013b).

This part covers areas of effectiveness, efficiency, impact, and sustainability. To the extent applicable, the Results Based Management Logical Framework established by ISP in 2013 (ISP, 2013b) serves as a base for assessment.[17] The focus is on research groups located at three universities in Thailand; Chiang Mai University, Chulalongkorn University, and Prince of Songkla University, during the period 1982–2007.

The quantitative data is provided from ISP's internal records (IPICS- and IPPS Project Catalogues and ISP Annual Reports), and the online questionnaire sent out to former students from ISP supported research groups. In addition, publication data has been obtained from the WoS database. The qualitative data comes from interviews with group leaders and graduates from supported research groups.

3.3.1 Training and publication outcomes

The goal of ISP's operations has always been to contribute to the strengthening of scientific research and postgraduate education within the basic sciences in low-income countries. The most basic and measurable outcome of the provision of research training has been postgraduate degrees and publications. Therefore, this section will focus on research and capacity building of the supported groups in terms of training outcomes and publication activity, including quality of publications and journals. Other related issues like scientific collaboration and the efficiency of the support in terms of training and publication outcomes is also presented here.

Data comes from the research groups' annual reporting gathered from the late 1970s and onwards. The online database WoS has been used to provide

17 When ISP was evaluated in 2011 (GHD, 2011), the evaluators observed the lack of a program logic and clear linkages between different levels of result. Based on their recommendations, and as required by Sida, ISP developed a Results Based Management Logical Framework, which to the extent possible will serve as reference to this evaluation report. Despite of the fact that the collaboration reaches over 30 years back in time the Logical Framework is relevant because the main objectives of ISP have been based on essentially the same core values since the beginning of the 1970s.

additional information and to look further into the effects of ISP supported groups at this fundamental level of capacity building.

Training outcomes

ISP has since the start been providing fellowships to individual staff members at institutions in low-income countries, which after an increased demand in 1983/84 also included postgraduate students. During this time, the sandwich model was implemented, implying that postgraduate students were carrying out part of their degree work abroad, and part at their home institution in Thailand. Postgraduate students in the ISP collaboration with Thai universities have received training on the PhD level, sandwich based or to a full extent in Thailand or in Sweden, depending on the field of study and the capacity of the department. The number of stays abroad of the sandwich students, just like the amount of time spent, has varied, because the programs have been adapted to individual needs and available resources.

Aggregated, the ISP supported groups have over the collaboration period graduated in total 25 PhD students and 95 students on the MSc level, altogether using 12.4 million SEK of ISP funds. All graduated students were not directly supported by ISP in terms of fellowships and other benefits, but graduated with indirect contributions by ISP through the research groups with which they were associated. The 12.4 million SEK are the total expenditures of the groups, including objectives such as instrumentation, consumables and research visits.

The number of graduates varies considerably between the research groups (Table 3.9), due to reasons such as their capacity for postgraduate training when starting support, the number of supervisors available in the group, the number of years of support, the amount of funding from ISP and other sources, and the supply of PhD students.

Table 3.9 Number of graduations, expenditures and number of years of support, by research group.

Research group/ university	Graduations		Expenditures	Years of support	
	PhD	MSc			
Chulalongkorn University					
IPPS THA:01	5	22	1.3 MSEK	1985–2003	19 years
Chiang Mai University					
IPPS THA:03/1	13	47	3.2 MSEK	1982–2005	24 years
Prince of Songkla University					
IPICS THA:03/1	2	5	1.7 MSEK	1984–1995	12 years
IPPS THA:04	5	21	6.2 MSEK	1987–2007	20 years
Total	**25**	**95**	**12.4 MSEK**	**1982–2007**	**26 years**

The geophysics group at Prince of Songkla University (IPPS THA:04) have received the largest amount of funding (6.2 million SEK) of all ISP supported groups in Thailand, and has graduated five PhD's over the 20 years of support. However, it should be noted that the geophysics group, including the research, the laboratory, and the human capital, had to be built up from scratch. The facilities available at the start of the collaboration were only suitable for BSc projects. The first collaborative action taken was to gradually build up the human capital through PhD education of staff members at the department, one at a time, through sandwich training with Swedish host institutions. Some of the group members took around ten years to complete their degrees and, consequently, the capacity building process took time. In parallel, the group established an MSc program, resulting in 21 MSc graduates during the period of support. In recent years, a geophysics PhD program was set up and the group has graduated the first PhD in geophysics in Thailand.

The chemistry group at Prince of Songkla university (IPICS THA:03/1) has graduated two PhD students and five MSc's over the period of support. The support to this group started out with fellowships awarded to staff members at the department, which later transformed into PhD training on a sandwich basis. Support ended when these two graduates had completed their degrees.

The physics group at Chulalongkorn University (IPPS THA:01) was at the start of ISP support already on a developed level, in terms of both staff and equipment, through previously established contacts with aid organizations in Canada and laboratories in the US. Five PhD students graduated during the 19 years of ISP support. They were, however, mostly funded by Thai agencies, while ISP provided the organization and administration of the period abroad for these students. ISP funds mainly covered travel expenses to and from Sweden for group members and visitors, and ISP provided scientific collaborators in Sweden. The ISP support to the group was complementary in nature and amounted to 1.3 million SEK. The group had both the capacity and funding for PhD student training, but faced problems with attracting students to pursue doctoral studies locally with the group.

The physics group at Chiang Mai University (IPPS THA:03/1) stands out by having graduated 13 PhD's and 47 MSc/Licentiate students over a period of 24 years of support. This group started a PhD program at the department in the mid-1980s, a few years after the start of the ISP collaboration. ISP assisted with the foreign training component of the PhD program, through provision of contacts with research groups at Swedish universities. The group was during the same period establishing a research laboratory, and it therefore took a while before the research and training of students could take off. The capacity has grown over time, with a rapid increase in both number of graduates and publications. The sources of other funding of the group, besides ISP, have been substantial, and ISP's support has mainly been complementary in nature. Only one of the 13 graduated students were covered directly with ISP support through the group, while the rest were indirectly supported or had their time abroad only organized and administrated by ISP.

The longitude data of graduations in the group indicate an increased capacity of PhD graduations over time, with a majority of the PhD graduations taking place during the latter years of support, in the later part of the first decade of the 2000s. Also in the other physics groups (IPPS THA:01 and THA:04) there are signs of PhD graduations at a more regular basis, even though numbers are quite low.

Completion time of degrees

Recent data on completion time of PhD graduates from ISP supported groups and networks between 2008 and 2013 show an average of 4.9 years (Andersson & Sundin, 2016). The 17 responding Thai graduates to the online tracer questionnaire took on average 7 years to finalize PhD degrees. The average number of years for respondents to complete their PhD degree is above both the average completion time for ISP graduates as well as the average Swedish completion time of a PhD degree in the natural sciences, which has been reduced from 6.5 years in the beginning of the 1990s to 5.5 years in 2013 (SCB, 2002; SCB, 2014). A slightly higher completion time than Swedish graduates can still be seen as a good result considering that the majority of the respondents PhD training were organized on a sandwich basis, which is usually more time consuming than local training, or full time training abroad.

National impact

In general, the number of individuals trained to PhD degrees through ISP supported research groups has made little impact on the national outcome of PhD graduates in Thailand, which has risen considerably during the first decade of the 2000s. At the most, graduates from ISP supported groups have made out 0.5 % of the annual outcomes of all PhD graduates in the country during the 1999–2007 (Table 3.10).

Table 3.10 Number of PhD graduations in Thailand, number of PhD graduations in ISP supported groups, and share of graduations from ISP supported groups in relation to the national graduation output, by year.

Year	Number of PhD graduations in Thailand*	Number of PhD graduations in ISP groups	% PhD graduations in ISP groups of total number of PhD graduations in Thailand
1999	179	0	0 %
2000	568	3	0.5 %
2001	401	1	0.3 %
2002	735	1	0.1 %
2003	N/A	0	0 %
2004	N/A	2	0 %
2005	3,128	0	0 %
2006	N/A	5	0 %
2007	1,644	2	0.1 %

* Source: NSO, 2010.

Publication activity

Extensive longitudinal data of the publication of articles and conference contributions are available in ISP's records because it has since long been part of the annual activity reporting. Besides the number of graduated students, this has been the most important indicator recorded by ISP.

Aggregated, the formerly supported Thai research groups have published 149 articles in international journals, 66 in national or regional journals and made 258 contributions to conferences (Table 3.11). The supported group at Department of Physics (IPPS THA:03/1) published 114 papers in international journals over the 24 years of support, the physics group at Chulalongkorn University (IPPS THA:01) published 24 papers during ISP's 19-year support, and the supported physics (IPPS THA:04) and chemistry group (IPICS THA:03/1) at Prince of Songkla University had 5 and 6 recorded publications in international journals over 20 and 12 years of support, respectively.

Table 3.11 Number of publications, expenditures and number of years of support, by research group.

Research group/ university	Publications: Intl. Journals	Publications: Nat./Reg. Journals	Publications: Conf. Contrib.*	Exp. SEK	Years of support	
Chulalongkorn University						
IPPS THA:01	24	9	48	1.3 M	1985–2003	19 years
Chiang Mai University						
IPPS THA:03/1	114	29	132	3.2 M	1982–2005	24 years
Prince of Songkla University						
IPICS THA:03/1	6	4	47	1.7 M	1984–1995	12 years
IPPS THA:04	5	24	31	6.2 M	1987–2007	20 years
Total	**149**	**66**	**258**	**12.4 M**		**26 years**

* ISP defines conference contributions as papers published in conferences proceeding, not merely presentation abstracts.

The development of the scientific productivity of the research groups has been followed by noting the number of papers reported to ISP during the period of support, as well as the number of published papers in the following years (Figure 3.12). The figures show that the Chiang Mai physics research group (IPPS THA:03/1) has had a continued flow of publications in international journals almost annually since the beginning of the ISP collaboration in 1982, and with an increase of publications during the first decade of the 2000s. The physics research group at Chulalongkorn University (IPPS THA:01) shows a similar pattern with publications from early on, and an increase during the first decade of the 2000s. At Prince of Songkla University the physics research group (IPPS THA:04), supported since 1987, started to produce publications in international journals in 2005. The chemistry group at the same university (IPICS THA:03/1), started to publish a few years after the ISP collaboration started in 1984.

The variations in publication activity between the groups depend on the different circumstances they have been facing. The lower publication activity of the geophysics research group at Prince of Songkla University (IPPS THA:04) is not unexpected given that the group has built up research laboratories and manpower from scratch. The most productive research group at Chiang Mai University (IPPS THA:03/1) faced a similar starting situation, but the difference in the amount of external funding sources of the two groups, the extent of international collaboration, and the increased number of PhD graduates, are three factors behind the higher and increasing publication outcome at Chiang Mai, compared to the Prince of Songkla based research group. The research group at Chulalongkorn University (IPPS THA:01) already had an established laboratory by the start of the ISP collaboration, and hence had better preconditions for publishing. Instead the group faced other challenges like isolation from other research groups in the same scientific field, which delayed, and sometimes hindered, the research process.

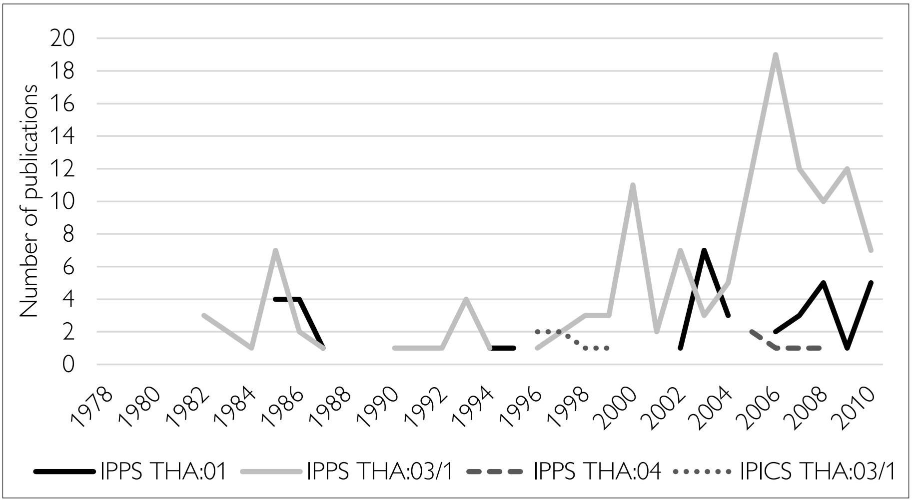


Figure 3.12 Number of publications reported by research groups over the period of ISP support and onwards.[18]

National impact

Even though the number of publications from supported groups has increased over time, the groups have made little impact on the total national publication output of Thailand. The number of publications in WoS journals by Thai authors has increased considerably from the 1980s until 2009 (Table 3.12). In total, scientist from Thailand have published 37,278 articles in WoS journals during this period, out of which articles from ISP supported groups have accounted for approximately 0.4 % (148 articles). The number is an estimate because the publications with ISP support is only recorded and divided in international and national journals and not number of publications in WoS or peer-reviewed journals. Only publications in international journals are accounted for. ISP publications make out a very small part of the annual national publication output over the years.

18 Data is based on the annual number of international publications reported by each group annually during the period of support and a few years after. After the end of ISP support, publication data from the WoS database has been used to mark the continued activity also after phase out up to year 2010. Years with no publications have been removed to increase the readability of the figure.

The highest contribution was in the mid-1980s where ISP supported publications accounted for 3 % of the national output. The other years it has varied between 0–2 % of the annual publication output in WoS journals.

Table 3.12 Number of publications in WoS journals by Thai authors, number of publications by ISP supported groups, and share of publications from ISP supported groups in relation to the national publication output, by year.

Publication year	Number of publications by Thai authors in WoS	Number of publications by ISP supported Thai research groups	Share of publications by ISP supported Thai research groups of total number published by Thai authors in WoS
1980	317	0	0 %
1981	325	0	0 %
1982	341	3	1 %
1983	403	2	0 %
1984	417	1	0 %
1985	387	11	3 %
1986	384	6	2 %
1987	340	2	1 %
1988	396	0	0 %
1989	374	1	0 %
1990	438	1	0 %
1991	343	5	1 %
1992	466	2	0 %
1993	498	4	1 %
1994	563	2	0 %
1995	586	1	0 %
1996	734	1	0 %
1997	807	2	0 %
1998	998	4	0 %
1999	1,081	3	0 %
2000	1,249	11	1 %
2001	1,417	2	0 %
2002	1,709	9	1 %
2003	2,016	10	0 %
2004	2,211	8	0 %
2005	2,542	14	1 %
2006	3,103	20	1 %
2007	3,689	13	0 %
2008	4,348	10	0 %
2009	4,796	0	0 %
Total	**37,278**	**148**	**0.4 %**

Publication activity at supported universities and departments

To get additional information about the publication activity by ISP supported departments a WoS database search was carried out. From the WoS database search it is not fully possible to tell if the articles were published with ISP support or not.[19] Instead, the number of articles published by ISP related authors over the years has been counted in the search, which gives an indication of the effect the support have had on the supported departments and universities. ISP related authors are defined as persons listed in ISP records as having taken part of ISP support or ISP related activities in various ways and to various extents, i.e. fellows, students, graduates, staff members or group leaders.

The Thai publication activity has experienced a steady rising upward trend with 438 index publications in 1990 compared to 6,661 annual indexed papers in 2014. A similar increasing trend is found for the three universities where ISP supported activities, all contributing to the overall Thai publication output (Figure 3.13). ISP supported departments at these universities have accounted for between 2–24 % of the total university output found in WoS at the respective universities.

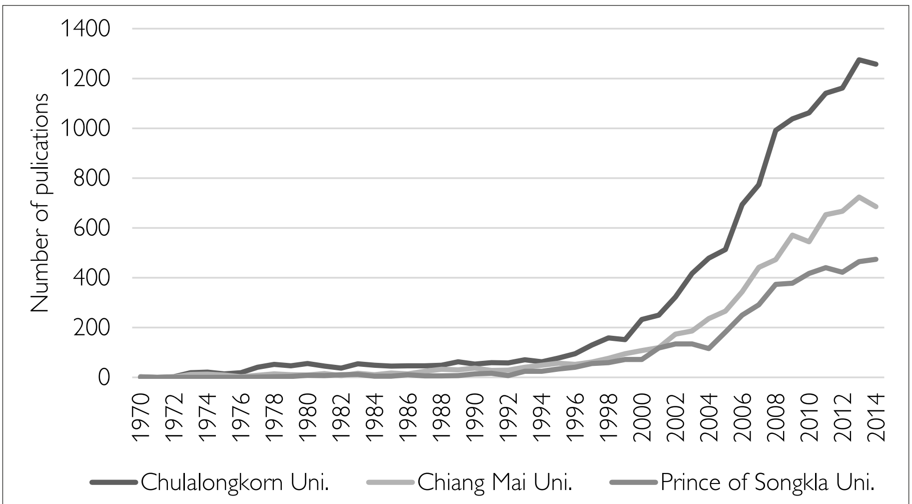


Figure 3.13 Publication activity at supported universities, 1970–2014.

19 Authors can acknowledge funding agencies in articles but far from all do so, making it a poor data material for analysis. Four of the publications have emphasized ISP, IPICS, IPPS or Uppsala University as a donor, which is not likely to reflect the real number of articles produced with direct, or indirect support from ISP.

Chulalongkorn University

Chulalongkorn University has had a rapid upswing in number of publications in the past two decades (Figure 3.13), and the same goes for the Department of Physics (Figure 3.14) where ISP has supported one research group between 1985 and 2003 (IPPS THA:01). When looking at the total publication activity from the Physics Department it comprises 2 % of the total publication activity of the university. Approximately one third (29 %) of the publications coming from Department of Physics have at least one author associated with ISP. The department has published papers and has been active before the start of the ISP collaboration. Publications coming from ISP related authors have also continued after the phase out in 2003.

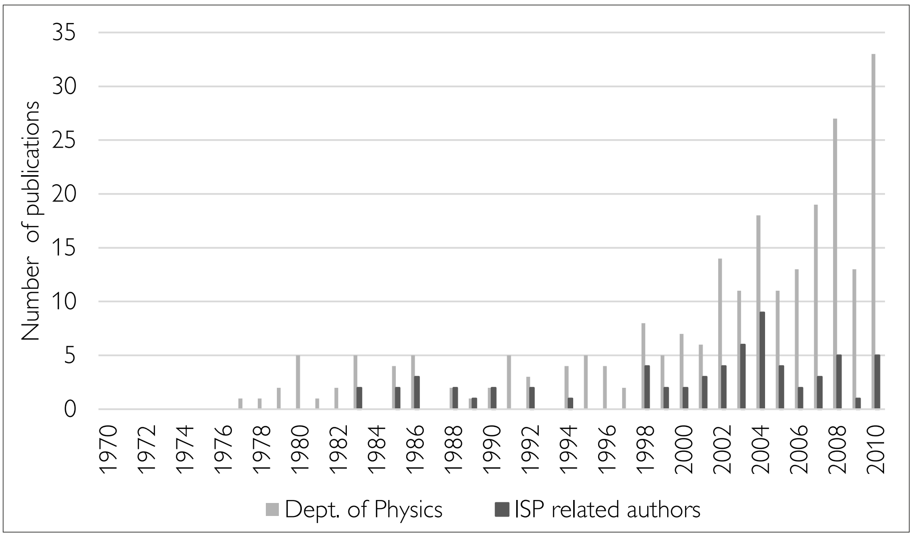


Figure 3.14 Publication activity (number) at Department of Physics, of Chulalongkorn University, and by ISP related authors, over time.

Chiang Mai University

Chiang Mai University has experienced a rapid publication growth during the past two decades (Figure 3.13). ISP has supported one group at Department of Chemistry between 1983 and 1994 (IPICS THA:02) and one group at Department of Physics between 1982 and 2005 (IPPS THA:03/1). The chemistry group is, however, not considered here.

The Physics Department has, like Chiang Mai University, increased the number of publications over time (Figure 3.15), and in total contributed to 24 % of the university publication activity. Out of the publications coming from the Physics Department, 17 % had at least one author related to ISP.

Some scarce publication activity was going on before the start of the ISP collaboration in the beginning of the 1980s. Publications from ISP related authors have continued also after phase out, to a larger extent than during the period of collaboration.

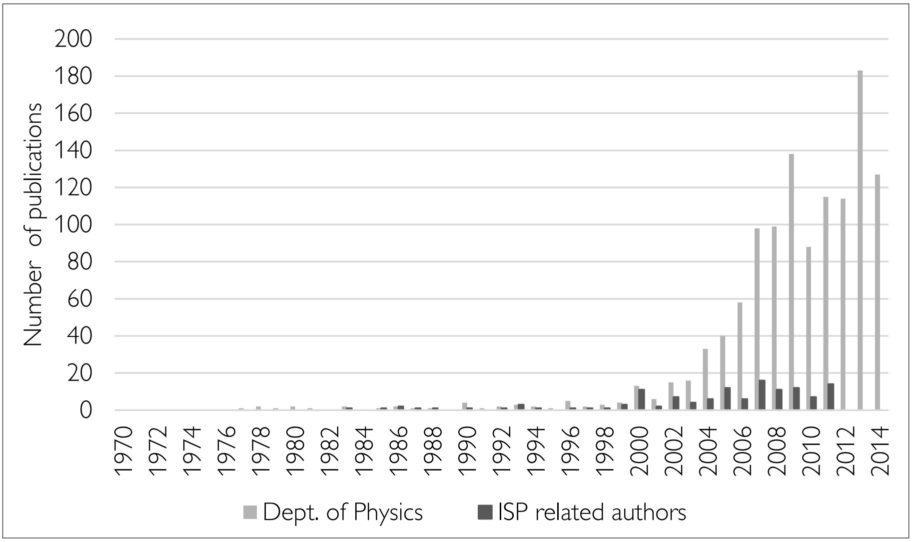


Figure 3.15 Publication activity (number) of Department of Physics, University of Chiang Mai, and by ISP related authors, over time.

Prince of Songkla University

As with the other universities, Prince of Songkla has experienced a rapid increase in number of publications during the last two decades (Figure 3.13). ISP has supported one group at Department of Chemistry between 1984 and 1995 (IPICS THA:03/1), and one group at Department of Physics between 1987 and 2007 (IPPS THA:04) (Figure 3.16 and Figure 3.17).

The supported group at the Department of Chemistry accounts for 24 % of the university publication activity between 1970 and 2002. The Department of Chemistry actively published papers before the ISP collaboration started and contributed during the 1970s, 1980s and the beginning of the 1990s to a large part of the university publication output. 10 % of the publications coming from the department during this period have been from ISP related authors.

Department of Physics accounted for 4 % of the university publication outcome. Of the publications from Department of Physics 7 % had at least one author related to ISP. The Physics Department had no WoS-listed publications before the start of the ISP collaboration.

At both departments, ISP related authors have, to some extent, continued to contribute to the publication activity of departments after the end of support in the years 1995 and 2007, respectively.

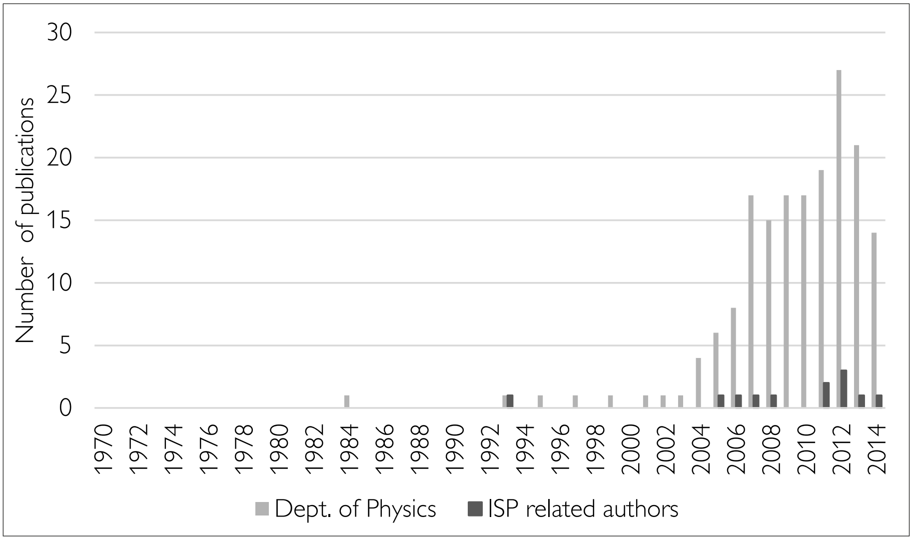


Figure 3.16 Publication activity (number) of Department of Physics, Prince of Songkla University, and by ISP related authors, over time.

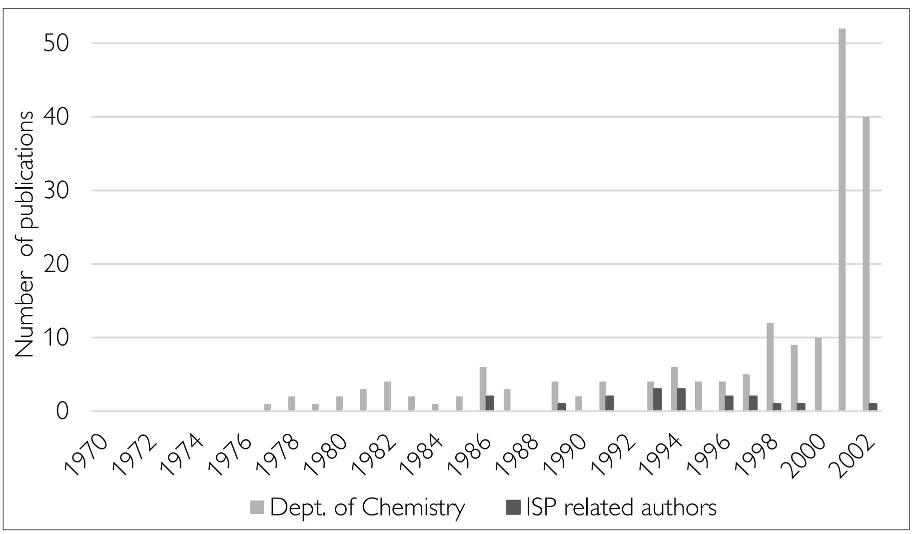


Figure 3.17 Publication activity (number) of Department of Chemistry, Prince of Songkla University, and by ISP related authors, over time.

Quality of publications – citation and journals

Citations

A citation count in WoS was carried out for each supported department at Chiang Mai-, Chulalongkorn- and Prince of Songkla University, and compared to yearly citation averages provided by the Thomson Reuters (TR) Essential Science Indicators (Table 3.13). The top three articles published by ISP related authors are all above the citation average for each respective field and year, with the exception of one article from Department of Physics at Prince of Songkla University. The top cited articles are specified in the footnotes, with ISP related authors underlined. Averages were only accessible for 2000–2010, the few articles published before that are therefore compared to the citation average for the 2000s.

Quality of journals

The WoS database search also targeted the top three most common journals of publication of each supported department (Table 3.14 and Table 3.15). Applying the Norwegian NSD rank, a majority (90 %) of the publications are published in journals ranked and classified as scientific publication venues (level 1), and the remaining 10 % in *Physical Review B. Condensed Matter and Materials Physics* classified as an outstanding publication venue (level 2).

None of the top three journals of publications of each department was found on the so called "blacklist" of journals, listing "potential, possible, or probable predatory scholarly open-access journals". Overall there is a good quality of the journals of publications of ISP related authors at the supported departments, according to NSD rankings.

Table 3.13 Top three most cited articles published by ISP related authors, by departmental affiliation and average citation data (rounded to integer) from the Thomson Reuters (TR) Essential Science Indicators database.

Ranking	1	2	3
Chulalongkorn University, Department of Physics			
Number of cites	47[1)]	46	22
Year of publication	2003	2001	1998
TR Citation average Physics, given years	12	14	16[2)]
TR Citation average Material science, given years	11	12	12[3)]
Chiang Mai University, Department of Physics			
Number of cites	46[4)]	41	40
Year of publication	2005	2000	2009
TR Citation average Physics, given years	16	10	2
TR Citation average Material science, given years	12	8	2
Prince of Songkla University, Department of Chemistry			
Number of cites	35[5)]	24	14
Year of publication	1993	1997	1994
TR Citation average Chemistry, 2000s	12	12	12
Prince of Songkla University, Department of Physics			
Number of cites	31[6)]	5	4
Year of publication	2005	2006	2008
TR Citation average Material science, given years	10	8	4

1) 47 cites: Kessler, J., Chityuttakan, C., Lu, J., Scholdstrom, J. & Stolt, L. (2003). Cu(In,Ga)Se-2 thin films grown with a Cu-poor/rich/poor sequence: Growth model and structural considerations. Progress in Photovoltaics, 11(5), pp. 319–331.

2) 1998 not available. 16 is the citation average for year 2000.

3) 1998 not available. 12 is the citation average for year 2000.

4) 46 cites: Chaivan, P., Pasaja, N., Boonyawan, D., Suanpoot, P. & Vilaithong, T. (2005). Low-temperature plasma treatment for hydrophobicity improvement of silk. Surface & Coatings Technology, 193(1–3), pp. 356–360.

5) 35 cites: Jagner, D., Sahlin, E., Axelsson, B. & Ratanaophas, R. (1993). Rapid Method for the Determination of Copper (II) and Lead (II) in Tap Water Using a Portable Potentiometric Stripping Analyzer. Analytica Chimica Acta, 278(2), pp. 237–242. DOI: 10.1016/0003-2670(93)85105-S.

6) 31 citations: Nuannin, P., Kulhanek, O. & Persson, L. (2005). Spatial and temporal b value anomalies preceding the devastating off coast of NW Sumatra earthquake of December 26, 2004. Geophysical Research Letters, 32(11).

Table 3.14 Ranking of the top three most common journals of publication of ISP supported departments, aggregated.

NSD rank*	Number of publications	% of publications
Level 2	9	10 %
Level 1	83	90 %
Total	92	

* The Norwegian NSD list stretches from 0–2, where 2 is the highest rank.

Table 3.15 Top publication venues of ISP related authors at supported departments.

University/Department	No. of publications	NSD rank
Chulalongkorn University, Department of Physics		
Physical Review B. Condensed Matter and Materials Physics	9	2
International Journal of Modern Physics B	9	1
Physics Letters A	5	1
Chiang Mai University, Department of Physics		
Surface & Coatings Technology	25	1
Nuclear Instruments and Methods in Physics Research Section B: Beam and Interactions with Materials and Atoms	16	1
Nuclear Instruments and Methods in Physics Research Section A: Accelerators Spectrometers Detectors and Associated Equipment	11	1
Prince of Songkla University, Department of Chemistry		
Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering	5	1
Environmental Monitoring and Assessment	3	1
Analytica Chimica Acta	3	1
Prince of Songkla University, Department of Physics		
Journal of Applied Geophysics	3	1
Journal of Asian Earth Science	2	1
Geophysical Research Letters	1	1

Cost and efficiency of training and publication outcomes

The four research groups have over the years 1982–2007, together used 12.4 million SEK, which has resulted in 25 PhD degrees, 95 MSc degrees, 215 journal articles and 258 conference contributions.

It is not possible, however, to say to what extent the publications have been produced with ISP support or with contributions from elsewhere, and if the authors have been directly or indirectly supported by ISP. The latter is referring to graduates who have not received training funded directly through ISP, but have benefitted through using ISP funded equipment and consumables. ISP relies on the group leaders and network nodes to report on the number of graduates and publications that has resulted from the ISP support.

After interviews with graduates and group leaders in Thailand, it has become clear that some groups have used more of the funding for postgraduate training, while other groups have used it in other ways needed. In the physics and chemistry groups at Prince of Songkla University (IPPS THA:04 and IPICS THA:03/1) all reported PhD students were supported fully by ISP. While in the physics group at Chiang Mai University (IPPS THA:03/1) only one of the 13 reported graduated PhD students was supported to a full extent by ISP funds. The remaining PhD graduates either were local students pursuing a PhD at Chiang Mai University, or had scholarship support from the Thai government to study abroad. ISP provided contacts and coordinated stays in Sweden. At Chulalongkorn University (IPPS THA:01), all postgraduate students had support from other sources, and ISP also here had a more coordinating function.

Besides postgraduate training, the 12.4 million SEK has also been used for institutional resource development in terms of for example equipment, instruments and consumables, as well as collaborating links, staff training and exchange visits, and conference attendance. The collaborating links and staff research visits have for instance been a vital part of the support to IPPS THA:01.

To measure the efficiency of the ISP support to the Thai research groups in terms of quantitative measures, such as the number of graduates and publications, is not straightforward considering the above. However, it may serve as a way to compare the outcomes of the Thai research groups with the outcome of other ISP supported research groups, because all groups report their data in a similar manner. In addition, it could also serve as a way to look at the increase in capacity of the groups over the years.

Considering the outcomes per million SEK spent, the Thailand collaboration has been as efficient or more efficient when comparing with the average outcome of ISP supported research groups 2003–2010 (Figure 3.18). Only during the 1980s, the efficiency was lower than the efficiency of all ISP supported groups, on average. There has also been a positive increase in efficiency over the decades of support. Number of PhD's per million SEK has, for instance, increased from 0.2 in the 1980s to one per million in the 1990s, and to six PhD's per million in the first decade of the 2000s. This could be seen as an indication of increased capacity as well as increased preconditions for PhD training in the groups, gained over the years. But not solely as an effect of ISP support, because ISP only provided complementary funding to two out of three physics groups.

Also regarding publications, both international, national, and conference contributions, the Thai research groups have been as or more efficient than the average of ISP's overall support. Just like the number of PhD graduates per million, and likely correlated to it, the number of publications and conference contributions per million SEK has increased over the decades of support.

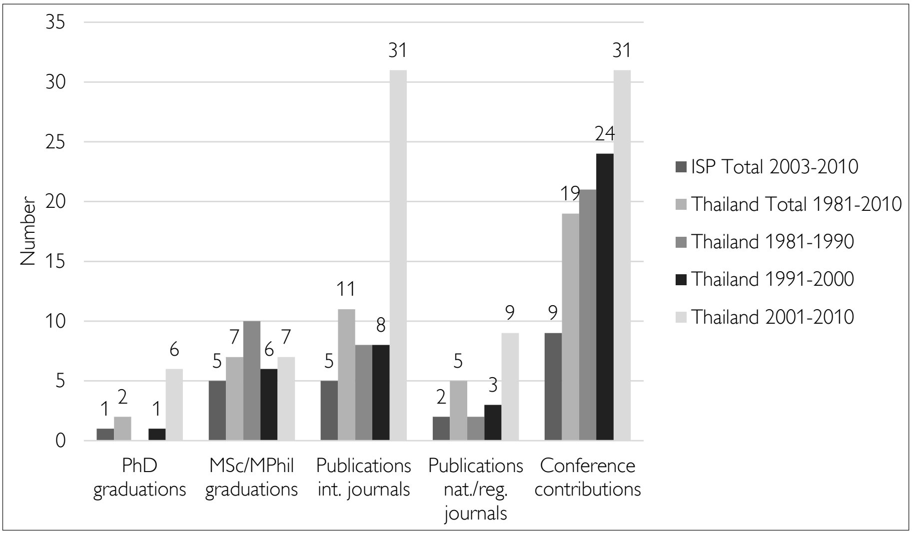


Figure 3.18 Outcomes per each million SEK spent by Thai research groups and the total average of all ISP groups and networks, by type of outcome and time period.

3.3.2 Societal impact

The number of graduated students, the number of attended conferences and published papers have been reported to ISP and recorded since the start of the collaboration. What has been lacking is the follow-up. Have graduates reached any relevant positions? And are the research results and skills coming from groups being used by the society in any way? This section addresses these questions. The information is provided through questionnaire answers and interviews with respondents of the tracer study, and interviews with group leaders.

Appointments and honors

Around half of the interviewed former students and group leaders stated that they have been, or currently are, appointed members of government committees, boards or working groups. The appointments are of various characters. Some are strictly on the university level, whereas some are of importance to the development of both education and research in physics and chemistry in Thailand, also considering national policy- and strategy development.

One former physics graduate is selected as an expert of the Thai Nuclear Policy Committee Board, consisting of 20 people with the task to draft and comment on the future Thai Nuclear Policy. Another physics graduate has been on the committee for strategy development at the National Metal and Material Technology Center (MTEC), a government organization under the National Science and Technology Development Agency (NSTDA).

A member of the formerly supported chemistry group at Prince of Songkla University (IPICS THA:03/1) is on the technical committee of the NSTDA. The group leader of the same group is currently on the technical committee of the National Nanotechnology Center which functions as the national R&D center and as a funding agency supporting activities in public- and university institutions. The group leader is also on the technical committee of the Center for Genetic Engineering and Biotechnology. She is also involved in the Thailand Research Fund (TRF) reviewing committee of grant proposals.

The group leader of the physics group at Chiang Mai University (IPPS THA:03/1) is the Executive Director of the ThEP Center. The ThEP Center is located under the Ministry of Education in Thailand and consists of more than 20 collaborating Thai universities. In addition, a graduate from the same group is the current Deputy Director of the organization. The ThEP Center aims to strengthen physics research and postgraduate training in the country and to show the willingness to provide local industries with innovative physics graduates. The organization provides fellowships, research grants and networking opportunities to its collaborating universities. The ThEP Center operates on five selected focus areas of physics. One of these focus areas is thin film physics, where the former ISP supported group at Chulalongkorn University (IPPS THA:01) functions as the leading laboratory. The now retired group leader of the group is also the coordinator of the Research Center in Thin Film Physics within the ThEP Center.

Outreach to society and use of research results and skills

Roughly, two thirds of the respondents to the online questionnaire thought that they had contributed to policy development in Thailand through their research and 77 % believed that their work contributed to the poverty reduction in Thailand to different extents. Regarding their academic contribution, 67 % thought that they contributed to the international research frontline, and all but one respondent, believed they contributed to the advancement of the research frontline in Thailand.

The cause and effect of the above is, however, indirect and often very difficult to trace. What can be confirmed is that the research conducted in the supported groups to different extent has been useful to the Thai society, and that some areas of research have been more purposeful for this than others.

The research of the geophysics research group at Prince of Songkla University (IPPS THA:04) has, for instance, been applied to many different areas relevant for the Thai community and the government, such as mineral resource exploration, groundwater search, archeology, sustainable management of natural resources, and the reduction of effects of natural disasters such as earthquakes. The group has been involved in drafting a sustainable management plan for a touristic area with hot springs, part of a larger project called "The Sustainable Tourism Development of the Klongtom Saline Hot Spring, Krabi". Group members studied the geology of this area, the water quality, and the impact of the tourists. As an MSc project, the group also investigated promising areas for locating groundwater wells for a village in the Songkla region where ground water resources are scarce. In related studies, students also mapped out potential areas for tin mining in the region. Data from a PhD study have been used to analyze the sediment areas for presence of oil, considering the possible mineral resource exploration.

The group has also done a study on active fault zones, which is useful for risk management of geological hazards and earthquake preparedness within Thailand. Another seismological study provided the Electricity Generating Authority of Thailand with information on the best suitable location, from an earthquake hazard perspective, for building a future nuclear power plant. In addition, the group has been involved in archeological research, which aimed at identifying an ancient road in the northern part of Thailand.

Former students and members of the supported chemistry research group at Prince of Songkla University (IPICS THA:03/1) studied the presence of arsenic in tap- and well water in the Ron Piboon district in Southern Thailand. The results showed arsenic presence in the groundwater wells in the area, which had been caused by pollution from tin mining in the past. The local government was provided with these research results, and efforts were made to eliminate the arsenic by removing contaminated layers of soil. The group has also done several studies of the Songkla Lake, where they looked at the impact of heavy metals on fish, plants and planktons.

Research at the former supported physics group at Chiang Mai University (IPPS THA:03/1), now focusing on plasma, ion beam and electron beam technology, can be applied in many useful ways for the Thai society. Together with scientists and medical doctors from Mahidol University, Bangkok, researchers from the group have developed a plasma technology that can be used for medical purposes such as disinfection and treatment of infections in wounds, and for esthetical purposes like "skin whitening and purification". The equipment built by the group is currently being tested on hospital patients. The group members have also used ion beam technology to induce mutations in plant cells. Rice seeds have been modified in such a way so that the plant grows shorter, which hinders them to fall over. The PhD who graduated from this project received a large grant from the Thai government with the aim to improve the rice growing for Thai farmers. In addition, group members have used ion beam technology to improve the quality of the gemstones, one of Thailand's most important export goods. Unlike the former way of the stone modifications, which destroyed large part of the material, the ion beam technology uses the appropriate amount of energy for best preserving the commodity. This technique adds value to low-quality natural gemstones in Thailand. One graduate from the group has obtained a patent for the improvement of ruby quality using ion beam technique, and another graduate has a patent pending for gem stones modification.

A former member of the Chulalongkorn physics group (IPPS THA:01) turned towards the pedagogical side of physics, and has been assigned by the Ministry of Education to work on improving the teaching of physics in high schools. Together with others, a series of online media used for basic physics teaching have been produced for high school students and teachers.[20] The leader of the groups is also one of the co-founders of a vocational engineering school, where he teaches and is involved in the development of the curriculum.

As an academic service, a former member of the same group at Chulalongkorn University volunteers to promote science in high schools in the Bangkok area. Another graduate from the group has been part of producing a patent at the hard drive company he works for once a week through the Thailand Mobility Program.

University – private sector collaboration

Historically, university-private sector collaboration in Thailand has not been common. Currently, this type of collaboration is growing in scale and is increasingly encouraged by the Thai government. Through different initiatives, the government is working to increase the use of R&D resources and the knowledge present at the universities within the country to develop private sector companies and their technologies.

According to the Executive Director of Chemistry Center of Excellence of Thailand,[21] the private and the public sector have overcome some of the major collaborating hurdles, but there is still some way to go:

> *"Collaborating with the private sector is not easy. It took long time for us [academics] before we could speak the same language as the industry". (...)* Our academy *and faculty members must have the right set of mind. If they convince the industry that there is something that they should spend the money on, they will do that. The industry is in a stage when they need new technology. They cannot buy the new*

[20] Available (in Thai) at: https://www.youtube.com/user/CoursewareMaster.

[21] The Executive Director is also a former collaborating partner to ISP, head of a host laboratory at Mahidol University, Thailand, receiving regional ISP students.

technology from abroad because if foreign companies sell the technology, the Thai producers will become competition for them. The only way to stay competitive is to develop our own technology".

Currently, the Thai government is working to become a knowledge-based economy, by boosting its own technology development through, for example, encouraging university-private sector collaboration. Through interviews with graduates and group leaders, four ways of this type of collaboration have been identified in formerly supported research groups. Namely: 1) government co-sponsored technology transfers, 2) government funded research projects where research results contribute to the Thai industry, 3) the establishment of field specific consortia functioning as match-makers for researchers and the private sector, and 4) the government funded "Talent Mobility Program" aiming to address the problem of R&D personnel shortage in industries.

The first type of collaboration is government co-sponsored technology transfer from Western to Thai companies. It involves Thai companies sending researchers on internships abroad so that they can learn and then transfer different technologies back to Thailand. One physics graduate explains:

"I had the technology type exchange. Together with my colleague we went to US for a 1.5-year internship. We got high technology for hard disc drives. Now we can train the students to work in this industry. Our stay was sponsored by a Thai computer company, and the Thai government". (Former PhD student, physics)

The second type collaboration includes the Thai government sponsoring research projects where research results contribute to the Thai industry. At Chiang Mai University, the physics group (IPPS THA:03/1) has, among other things, been working with improving the quality of gemstones for private sector use, through ion beam technology. The group is paid in kind, through provision of raw material or small equipment needed. When applying for research funding to the Thai government, respondents express that it is an advantage to be able to state how the project will benefit the private sector.

Formation of consortia is another way in which university-private sector collaboration is expressed. The chemistry research group at Prince of Songkla University (IPICS THA:03/1) and the physics research group at Chiang Mai University (IPPS THA:03/1) are both part of national consortia in their respective area. The chemistry group at Prince of Songkla is part of the Chemistry Center of Excellence of Thailand functioning as a matchmaker for researchers at universities and the private sector:

> *"Our center works as consortia. We match the needs of industry with universities that can help them. We go to the industry and listen to their problems and then we match it with the members of the consortia". (Executive Director of the Center of Excellence)*

The chemistry group (IPICS THA:03/1) has been matched several times with industry companies in need of technology development and improvement. For instance, they helped the Coca Cola Company to improve the technology of tracing chemical residues in their plastic bottles, reducing the time needed from 24 hours to only one hour. They have also developed a new, more efficient technique for glue production for a local company. This technology is currently being used, and the glue is sold on the Thai market.

The ThEP Center gathers scientists in the field of physics. The center has a goal to strengthen physics education and research in Thailand. Their ideology is to make the physics research useful to the Thai society, and they direct applicants in that direction. The ThEP Center is headed by the group leader and graduate of the supported physics research group at Chiang Mai University (IPPS THA:03/1). The laboratory at Chiang Mai University and the laboratory of the physics group IPPS THA:01 at Chulalongkorn University, both functioning as research centers under the ThEP Center.

The TRF also has a similar program where they assist the industry in finding researchers that can help them solve their problems. One such example is a graduate from the Chulalongkorn physics group (IPPS THA:01) who received a grant from the Thailand Research Fund and developed a new coating for knifes in the pineapple industry:

> *"I improved the life length for knives that are used for cutting pineapples from two days to two weeks. The funding for this research came half from the industry and half from the Thailand Research Fund". (Former PhD Student, physics)*

Finally, in 2011 the government has launched the Talent Mobility Program aiming to address the problem of R&D personnel shortage in industries, through mobilizing personnel from the public sector such as government-, academic- and research organizations to work either full- or part time at private companies. One graduate from the physics group at Chulalongkorn University (THA:01) currently works one day a week at a private company to develop the technology of hard drives while spending the other four at the university.

While some of the responding groups took part in governmental actions to collaborate with the industry (IPPS THA:03/1 and IPICS THA:03/1), some of the supported groups did not. The supported geophysics group at Prince of Songkla University (THA:04) is one the research group with little interactions with the Thai industry. However, the group has been helpful both to the government and the local community, through, among other things, locating the best possible areas for drilling for groundwater and for mineral resource extraction. Similarly, the physics research group (IPPS THA:01) at Chulalongkorn University has also had little direct contact with the industry. The stated reason is that Thailand does not have any solar energy panel production, and that there is few opportunities for collaboration. One former graduate and member of the group has been actively involved with the industry through the above-mentioned government initiatives, but in a different area than solar panels.

3.3.3 Funding overview

All research groups have to various extents had other sources of funding besides ISP. The focus of this section is on the funding that groups have been able to secure from other funding sources, considering both the impact of ISP support and the groups' capacity to obtain funding from external sources. Here will also be presented how ISP support differs from other funding agencies and research grants. Quantitative data have been obtained from internal ISP records on expenditures of groups, as well as from annual reports, while the qualitative data is provided through interviews with group leaders. The funding sources of each group are specified in Appendix 7.

Funding from other sources

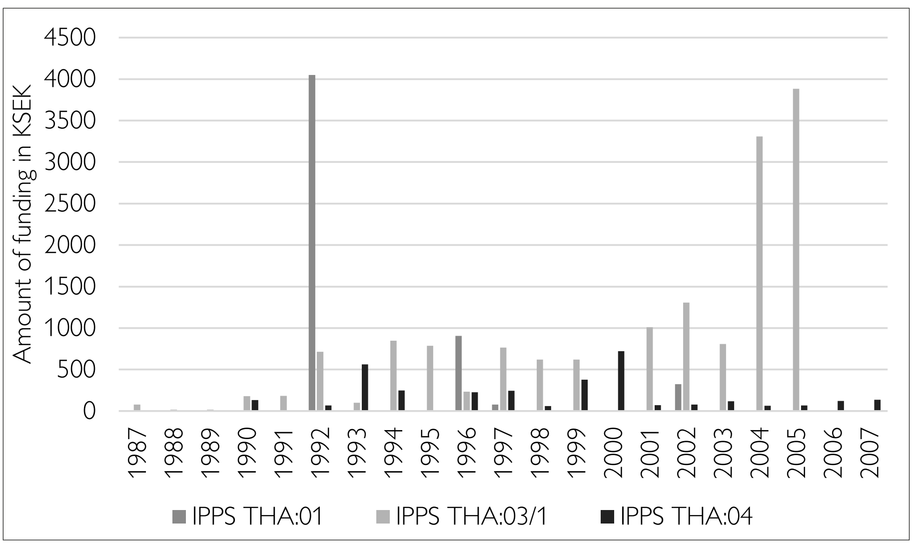
One of ISP's goals is that supported research groups eventually can sustain on their own. Groups' ability to acquire funding from other sources is an indication of that capacity. Private and public national research funding sources available in Thailand have increased during the period of the ISP collaboration. Regarding PhD scholarships, the Thai government has made enormous efforts to create a sustainable base to support their national technological development. In 1996, the Thailand Research Fund in cooperation with the Ministry of University Affairs, and the National Science and Technology Development Agency, agreed to support a 25-year project aiming to produce 5,000 PhD graduates in the first 15 years (RGJ, 2015). These scholarships remain to be an important part of building research capacity at Thai universities. The increase in domestic availability of funding and scholarships opportunities was a main reason for ISP to end the support in Thailand.

The amount of funding obtained from other sources than ISP over the years of support varies between research groups (Figure 3.19). The physics groups at Chulalongkorn University (IPPS THA:01) and at Chiang Mai University (IPPS THA:03/1) have received substantial grants from other sources besides ISP.

In total, IPPS THA:01 received 1.3 MSEK from ISP and 5.4 MSEK from other sources, and IPPS THA:03/1 received 3.2 MSEK from ISP and as much as 15.5 MSEK from other sources during the period of collaboration. This means that the funds from ISP amounted for 19 % and 17 %, respectively, of the total (known) funding to the research groups over the years. Both groups have also early on received large grants from other sources than ISP.

ISP support to the physics group IPPS THA:04 at Prince of Songkla University did however play a larger role, because ISP support was used to initiate geophysics research from scratch at the university in 1987, and ISP has remained the major donor to the group over the years of support. ISP funds has accounted for 65 % of the group's total funding. IPPS THA:04 has received 6.2 MSEK, which is the largest amount of ISP funds of all supported groups in Thailand, while 3.3 MSEK have come from other sources.

Figure 3.19 Overview of the research groups funding from other sources, by research group



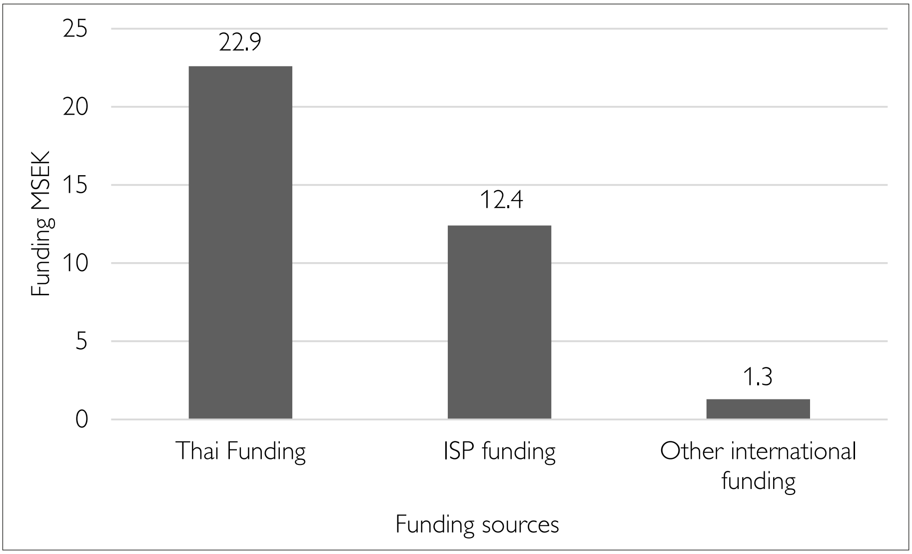
and year.[22]

When summing up the amount of support received by all of the groups during the period of collaboration, it is clear that national sources funding has been the most prominent (Figure 3.20), mostly comprising government funding. The major contributors to the groups come from EGAT, MTEC, NECTEC, NRC, NSTDA, TRF and university funding. On the private side, funding has

[22] Information is only available for the physics groups. Information regarding other funding sources is lacking for the chemistry research group at Prince of Songkla University (IPICS THA:03/1).

come from IRDC Exploration and Mining Co. Ltd., the GFE Company and the Chaiyong Limthongkul Foundation. Interviews show that the sources of funding have become more diversified over time. The funding from the private sector is increasingly common, and collaboration between universities and the industry is strongly supported by the government. Besides from ISP, the group has also managed to secure some international funding, from the IAEA, and from the Swedish Research Links of the Swedish Research Council.

Figure 3.20 Sources of funding during the period of ISP collaboration, by type of funding source.[23]



The fact that ISP groups were able to secure funding in competition suggests that the groups have the capacity to acquire and manage research funds. It is especially true for the physics groups IPPS THA:03/1 and IPPS THA:01 that have been able to secure large research grants in competition.

ISP compared to other donors

All of the supported groups had to some extent secured funding from other donors during the period of ISP collaboration. In interviews, the supported students and group leaders were asked to compare ISP support to the other types of support they received.

The ISP support to the Thai research groups were of different character and has therefore contributed in different ways. At Department of Physics

23 Information is only available for the physics groups. Information regarding other funding sources is lacking for the chemistry research group at Prince of Songkla University (IPICS THA:03/1).

at Prince of Songkla University (IPPS THA:04), there was almost no activity in geophysics at the time of start of the ISP collaboration. ISP started with financing the PhD education of the future group leader and some necessary equipment, and continued to fund the education of other staff members. The group leader pointed to that the long-term character and the patience of the ISP support was of great value. It took between 8–10 years for some of the staff members to graduate, which gradually developed the group. According to the group leader, ISP funding helped to consolidate the foundation for research in geophysics at the university. Other benefits of the support were that ISP helped the research group to negotiate with the Vice Chancellor of Prince of Songkla University to secure supplementary local funding needed for the project.

The supported group at Department of Chemistry at Prince of Songkla University (IPICS THA:03/1) in particular brought up the long-term support from ISP as a great advantage. The group used ISP funding for small equipment and consumables, and for the training of two PhD students on sandwich basis.

> *"We have talked about this and IPICS is different from the others in a sense that is focus on human resource development that can generate strength in each area and support is quite long-term. Especially for PhD training. The Sandwich program is good because you can continue the research when you come back. And then you have the equipment and things like that. The small equipment can function as seed money for people to start-off research". (Group leader, chemistry)*

At the Department of Physics at Chulalongkorn University (IPPS THA:01), the ISP support was more complementary in nature, because the group had funding from other sources. ISP funding provided for some minor equipment, but most importantly, according to the group leader, for the connections and short visits to and from Swedish laboratories working within the same field as the group. The ISP funding was not used for postgraduate training abroad, but ISP coordinated the stay of students from the group who came to Sweden on Thai government scholarships. The difference from other sources of funding was the provision of travel grants. As the main problem of the group was the isolation from other groups in the same field, they felt that the connections provided by ISP, and that the funding could be used for travels, were of great value.

The support to, and the situation at, the research group at Department of Physics at Chiang Mai University (IPPS THA:03/1) was quite similar to that at Chulalongkorn University. The research group had received funding from other sources to establish a laboratory, and ISP funding was complementary and used for equipment. Besides establishing the laboratory, the other goal of the group was to start up a PhD program at the department. Here, ISP was instrumental in providing contacts with universities in Sweden. ISP's provision of places to send staff and students was seen as an important component in the capacity building efforts. In addition, one of their main international funders was the IAEA, and the difference from ISP was that IAEA was working on the government level while ISP was working at lower, more accessible level. One experienced benefit of the ISP support was that proposals and contracts could be discussed with ISP directly, while with IAEA it had to go through the government, which was a more complicated and time consuming process.

3.3.4 Sustainability

ISP has supported research groups in Thailand for a long time. In this section the phase out of the supported groups will be considered, including the experiences of the group leaders, the continuation of activities of the research groups, and bottlenecks for increased research capacity. Data have been obtained through interviews with current and former group leaders of supported groups.

Phase out of support

The support to the physics groups was phased out in 2001 (IPPS THA:01), 2005 (IPPS THA:03/1) and 2007 (IPPS THA:04), respectively, while support to the chemistry group (IPICS THA:03/1) ended already in the late 1990s. The main reason for phase out was that physics and chemistry in Thailand had become rather strong, and national research grants and scholarships had been made available to a sufficient extent to allow for continued development of the groups.

In two out of the three physics research groups (IPPS THA:01 and IPPS THA:03/1) ISP support was predominantly complementary in nature. Both of these groups had sufficient continued funding from other sources to be able to sustain on their own. One of the groups (IPPS THA:01) simply stopped applying for funding from ISP. The group leader had retired and the group had funding from other sources that could replace ISP grants, comprising travel grants and funding for consumables.

At Chiang Mai University (IPPS THA:03/1) the group leader was of the opinion that the reasons given for phasing out the support were fair and that research groups in other countries were more in need of the type of support that ISP provides. The group leader emphasized that once a group has been established they should be able to find other sources of funding. The ISP support ended with the retirement of the group leader.

At Prince of Songkla University, ISP was part of supporting the build-up of the geophysics group from scratch in 1987 and has remained the major donor to the group over the years of support. ISP funds accounted for a majority of the group's total funding and the group has received the largest amount of ISP funds of all supported groups in Thailand. Still, the group leader pointed to that the phase out was fair as they by this point had built up the qualified staff and equipment needed to run on their own. The support was supposed to have ended before 2007, but continued to allow for one ongoing PhD student to graduate.

The group leader of the Prince of Songkla chemistry research group (THA:03/1) experienced to have been given a fair notice, and support continued until two ongoing PhD students graduated. At this time, the chemistry consortia in Thailand had been established and the group could apply for funding from there. The group also had other sources of funding to be able to sustain research activities.

Continuation of activities

All supported research group has continued research and training PhD graduates, to various extent. In all physics groups (IPPS THA:01, THA:03/1, and THA:04), the "original" group leaders have retired and have been replaced by others who have continued the activities of the groups. The chemistry research group at Prince of Songkla University (IPICS THA:03/1) is still headed by the original leader, and a future replacement has been appointed.

The group leaders of the physics group IPPS THA:01 at Chulalongkorn University are both retired, but have been succeeded by the son of one of them. The research group is still active and the focus of the lab is still thin film solar cells. The research group is one of the laboratories under the ThEP Center. The research group constitutes the leading laboratory within the thin film focus area, and one of the former group leaders is now the ThEP Center coordinator of the thin film area in the country. As a member of the center, the group receives funding for five-year periods and has established connections with other research laboratories in the country. Through the Thailand Japan Technology Transfer project the group has established connection also with several laboratories in Japan, which provides the group with both instruments and opportunities for research visits. The group currently receives grants from the Japanese Asahi Glass Foundation, and Chulalongkorn University. The group does not have any active collaboration with the former partners in Sweden, because the persons responsible for the connections, on both sides, have retired. The group has had six PhD graduations since the end of ISP support in 2003, and there are currently three PhD students enrolled. PhD training can be conducted to a full extent locally but if there are available research grants, the group prefers to send student for training abroad for shorter periods. Members of the group have actively published papers from the phase out until today.

The research group at Chiang Mai University (IPPS THA:03/1) is currently active and is also a part of the ThEP Center, which serves as the main source of funding of the group. The former group leader became the Executive Director of the center after retiring from the university, and a retired graduate from the group is acting as Deputy Director. A colleague has succeeded the retired group leader. Two PhD students are currently enrolled, and members of the group have been active in publishing papers in international journals since the end of support until today.

At Prince of Songkla University, the chemistry research group (IPICS THA:03/1) is still active and has become a Trace Analysis and Biosensor Research Center. Currently, more than ten PhD students are enrolled. The research center still has collaboration with the former host institutions at Linköping University and Lund University, Sweden, as well as University of California, USA, where PhD students and researchers go for research training and visits. The students are mainly supported by the government, through the Royal Golden Jubilee PhD Program, and through the Thai Science Talent Development Project Scholarships. In addition, a Swedish Research Links grant provides funds for staff exchange with Linköping University. In total, the center publishes approximately eight papers per year in international journals. Members of the group are also recognized within the chemistry community in the country through participation in various committees.

At the Physics Department at Prince of Songkla University (IPPS THA:04), the former group leader is retired but replaced by a colleague. The group is still active and staff members publish approximately one paper per year, which is the minimum requirement from the university. Currently two students are enrolled in the PhD program in geophysics that started six years ago. In addition, over the recent years the group has functioned as a host group for PhD and MSc students from an ISP supported geophysics research group in Laos. Since the end of ISP support, the group has developed collaboration also with Serbia and Russia, through MoU's at the university level. The group is still in contact with the collaborating host departments in Sweden in terms of research projects and supervision of PhD candidates. Current funding of the group comes from TRF, from private companies, and annual funding for small equipment from the university and the faculty.

Bottlenecks for increased research capacity

Despite the fact that all of the research groups are active, they are still facing bottlenecks and challenges in their continued endeavor to further increase their research capacity. The main bottlenecks stated are isolation or inability to collaborate, problems with attracting postgraduate students, lack of equipment and instrumentation, and a heavy teaching load.

Something that is standing in the way for the physics research group (IPPS THA:01) at Chulalongkorn University is the fact that the research community in their field in Thailand is comparatively small. Despite having sufficient funding for research and scholarships for students, they feel isolated from other research groups in the same research field, something that is affecting their research progress. They were, and still are, the only research center working with thin film solar cells in Thailand and therefore has no close collaborating partner in the country. They also face challenges to reach a sufficient level of qualification to publish in experimental physics. The research group at Prince of Songkla University (IPPS THA:04) has similar difficulties with establishing connections with foreign researchers, something that is considered necessary to be able to publish their results.

Difficulties to attract postgraduate students were mentioned as a problem in all supported physics groups, at all three universities. At Chulalongkorn University (IPPS THA:01) many of the potential PhD students in physics disappear abroad if they get the chance, or choose engineering or computer science. Similarly, the research group at Prince of Songkla University (IPPS THA:04) has had a hard time finding qualified students to their MSc program. There is a requirement from the university to admit at least five students per year, and sometimes the group finds it hard to fill the quota with good, qualified students. The group is also facing problems with attracting PhD students. Since 2007, when the ISP support ended, one student from Laos graduated with a PhD in geophysics under ISP support, and there are currently two PhD students in the group. The low number of students is seen as one of the major bottlenecks for the further research growth in this group, and the volume of the active research at the departments is largely dependent on the number of master and doctoral students enrolled. The physics research group leader at Chiang Mai University (IPPS THA:03/1) also stated that their main problem is an insufficient number of MSc- and PhD students coming to the department.

Lack of funding for equipment and instrumentation was stated as another bottleneck for the research capacity building at some universities. Group leaders at both Prince of Songkla University and Chiang Mai University (IPICS THA:03/1 and IPPS THA:03/1) stated that they are facing problems to acquire funding for buying equipment because the university is currently cutting down investment as a result of less money provided by the government. The geophysics research groups at Prince of Songkla University (IPPS THA:04) and Chiang Mai University (IPPS THA:03/1) also brought up as a hinder the heavy teaching load, which is restricting the time available for research.

3.4 Conclusions Thailand

ISP support to Thailand started in the 1980s and has been of various character and significance, depending on the different needs of the groups. For some groups, ISP support has been important for the establishment of research laboratories and starting research in general, while for others the contacts with Swedish universities has been essential for starting up and maintaining PhD programs and research collaboration.

At the Department of Physics at Prince of Songkla University, ISP played a large role in supporting the start of the geophysics research at the university, both in terms of building up facilities and supporting PhD training of staff members. Here, ISP also remained the major donor to the group over the years of support. Similarly, the support to the research group at the Department of Chemistry at the same university provided the group with the equipment needed to start up research. The results of this research work led to other research grants, which could be used to buy larger equipment and to set up the lab. Human capacity in the area was also built through research training and PhD education of staff members, supported by ISP funds.

ISP support to the physics laboratories at Chulalongkorn University and Chiang Mai University was, however, modest compared to other donors. The groups received substantial grants from other sources, besides ISP, which helped them to build up laboratories. For these groups, ISP support provided for activities that were not funded by other donors, such as connections with other institutions in the same research areas abroad, which helped to break the isolation and to start up PhD programs.

Through supported groups a total of 25 PhD students and 95 MSc students in physics and chemistry have graduated over the years of support. There are indications that the capacity of the groups to graduate PhDs has increased over the years, with more graduations taking part in the later years of support. There are also signs of increased efficiency, when looking at number of graduations per million SEK spent over the decades of support. However, graduates from ISP supported groups have been few compared to the total annual number of PhD graduates in the country, comprising at the most 0.5 % of the annual national number during the first decade of the 2000s. The Thai government has been making considerable efforts for the transitioning of the country into a knowledge-based economy through focusing on, among other things, increasing the number of PhD graduates. The number of PhD graduates from Thai research institutions therefore boomed during the first decade of the 2000s, making the contribution of graduates from ISP supported groups modest. On the other hand, ISP helped in the establishment of PhD programs, which have impacted on the capacity for research and postgraduate education at the targeted departments through PhD training of staff members. Also in terms of retaining research capacity at universities, the ISP collaboration with Thailand can be considered successful. A majority of the respondents to the tracer study are currently working in Thailand (88 %). A majority has stayed in the university sector, either at the university of graduation or at other universities in the country.

Many of the graduates were sandwich students, a modality appreciated by both the graduates and the group leaders. The positive sides of the sandwich model mentioned were that the students were able to continue their research work when returning home from abroad, because of the maintained connection to the home institution as well as the follow-up support in terms of instruments. A full PhD program abroad could result in problems to continue research after returning to Thailand. Other positive features of the sandwich model mentioned were the chance to work in an improved research environment with access to research facilities and new, advanced technology, and the opportunity to meet experts in the field and to improve the English language skills. Respondents also mentioned the possibility to work with, address, and potentially solve, research questions relevant to Thailand.

The main negative feature of the sandwich model brought up was the long time it took to complete degrees. Several respondents point out that there was little time to spend on research back in Thailand due to obligations at the home university, because the primary responsibility of university academics in Thailand is teaching. Some would even have preferred to do a full time PhD in Sweden to shorten the completion time, to fully focus on their research, to more intensely improve their English, and to be in better control of their study plan. Sandwich graduates took considerably longer periods of time to complete their degrees, some taking 9–12 years, than graduates who did their training to a full extent locally or abroad. On average, Thai sandwich PhD students took 7 years to graduate which is above the average Swedish completion time of a PhD degree in the natural science (6.5 years in 1999 and 5.5 years in 2013) and the average of ISP sandwich graduates (4.9 years). Besides long completion time of degrees, some respondents experienced that the local degrees awarded via the sandwich model were valued less than degrees from universities abroad.

Together, the supported groups have published 149 scientific articles in international journals and 66 articles in national or regional journals over the years of collaboration. Publication wise, ISP supported groups has had little impact on both the respective university publication number, as well as the number of national publications in general. However, taking into account the low total amount of money the groups have received from ISP over the years of support, the publication efficiency (publications per million SEK spent) are as efficient or more than the average efficiency of all ISP supported research groups. All supported departments have also published papers in quality journals. At almost all supported departments, one or more of the top articles from ISP related authors are cited above world benchmarks.

A majority of the responding graduates believe that their research have contributed to policy development, poverty reduction, and advancement of the national and international research frontlines. The pathway of this impact is often indirect and generally difficult to trace. However, it can be confirmed that the research conducted in the supported groups, and the skill that graduates have obtained, have been useful to the Thai society and to the local and national government. Supported groups have also been involved in the increasingly common university-private sector collaboration in Thailand. The physics research group at Chiang Mai University and the trace analysis chemistry group at Prince of Songkla University stand out among supported groups in this sense, by improving industry technologies in various ways. In addition, half of the interviewed former students and group leaders have been, or currently are, appointed members of governmental committees, boards or working groups, some of them of importance for the development of physics and chemistry education and research in Thailand.

The support to the physics groups was phased out during the 2000s and support to the chemistry group ended in the late 1990s. The main reason for phase out was that physics in Thailand had become rather strong, and national research grants and scholarships had been made available to a larger extent. Hence, ISP funding was no longer needed. All research groups have continued their research activities after ISP has phased out its support. All former physics group leaders have retired but have successfully been replaced by colleagues. The support to the two most developed physics groups ended at the time of the retirement of the group leaders. The groups had funding from other sources, and since the primary contact with ISP had come through the group leaders the collaboration simply stopped.

Despite of the fact that all of the research groups are active, the groups are still facing bottlenecks and problems to further develop and increase their research capacity. The main bottlenecks stated are isolation or inability to collaborate, problems with attracting postgraduate students, problems with equipment and instrumentation, and a heavy teaching load for staff members. Nevertheless, since the end of ISP support all groups have been publishing quality papers in international journals and been continued to graduate PhD students.

Part 4

The way forward

4. The way forward

ISP's support to Sri Lanka and Thailand ended during the first decade of the 2000s, and it is not likely that support to groups in these countries will be resumed. The specific Sri Lankan and Thai contexts make it difficult to draw general conclusions, or to make general recommendations, relevant to all countries where ISP provides support. However, some lessons learned could be generally relevant also for present and future ISP support. Based on the findings and experiences from respondents and interviewees in the Sri Lanka and Thailand collaborations, a number of possible improvements of the ISP support model are presented below.

Promote Licentiate degrees from Swedish universities

ISP could consider promoting, to a larger extent, the possibility that Swedish host institutions register sandwich students for Licentiate degrees, in cases where this is relevant. It is standard in the ISP sandwich model that, when possible, degrees are awarded locally from the home university. However, questionnaire results indicate a relatively low status of PhD degrees awarded through the sandwich program from Sri Lankan- and Thai universities, compared to degrees awarded from universities abroad. Therefore, awarding Licentiate degrees from Swedish universities could function as an incentive for students to pursue a PhD on a sandwich basis, instead of leaving for a full time PhD abroad. It would also generate a financial reward for the Swedish host institution. The lack of compensation to the host institution for sandwich students registered at their home universities was something brought up by some of the host supervisors in Sweden as a negative feature of the sandwich model.[1] The awarding of a Licentiate degree from a Swedish university is commonly practiced in the ISP mathematical program, and could be more regularly promoted in the chemistry- and physics programs.

1 Today there are examples of this type of compensation. In 2001, the Faculty of Science and Technology at Uppsala University decided to financially compensate departments training ISP sandwich students at half the rate of registered faculty students.

Guide in potential buy-outs from teaching at the home university

The main drawback of the sandwich model, and the reason for delayed completion time of PhD degrees, was the teaching and administrative obligations at the home university, limiting the time available for research, if any at all. To reduce the completion time of degrees, to increase the amount of research carried out, and to promote a research culture at the home department, teaching buy-outs could be suggested as an option for PhD students while at the home university, if possible.

Look into the level of student allowance

Some of the Thai and Sri Lankan respondents experienced that the student allowances paid by ISP while in Sweden were low compared to the salary of PhD students at the host institutions. Besides feelings of inequality, low student allowances decreases the incentives for choosing a sandwich based PhD over a full time PhD scholarship abroad. Many of the Sri Lankan and Thai respondents graduated a long time ago, and remuneration rates have been revised several times since then. Nevertheless, it is recommended that ISP keeps track of the opinions of students currently receiving allowances, to know if the issue still remains today and consider how it can be dealt with.

Clarify the processes and justification of new support

ISP applies an "application by invitation" process where research groups and networks are invited to apply for funding. Based on the experiences from the Sri Lanka and Thailand collaboration, the selection process of new research groups and networks should be made in a more objective, and more competitive manner, with proper documentation and justifications of why specific academic institutions, groups and/or networks have been selected for support. ISP has in recent years, updated its selection process, and the issue is considered in ISP's strategic plan 2013–2017 (ISP, 2013b). Furthermore, ISP should consider future sustainability when starting support to new projects. Experiences from the Sri Lanka collaboration show that highly capital- or instrument intense projects should only be considered if they can secure funding from other sources, to ensure that they can sustain on their own in the long run and that decades of investments do not go to waste.

Take actions to improve gender equality in supported groups

The gender distribution of students in the Sri Lanka and Thailand collaborations is quite similar to the general picture in ISP supported research groups and networks, with a higher proportion of female students in the chemistry- than in the physics groups. The questionnaire results from the Sri Lanka study also show that the abroad training component in the sandwich model has worked differently for men and for women, with female students having spent significantly shorter time abroad than male students. Sri Lankan female respondents also expressed feeling discriminated to a larger extent than male respondents, both at the home and host university. More concrete efforts are needed from ISP on how groups and networks can be assisted in gender equality related issues, in particular in the field of physics.

Stress the importance of successors

ISP generally strives to find a trustworthy, dependable, responsible and accountable group leader, who can take on the task of research leadership at a longer term. Based on experiences from the Thailand and Sri Lanka collaboration it is clear that the retirement of group leaders poses a threat to the continuation of the activities of research groups. Therefore, ISP needs to stress the importance of a successor or deputy group leader at an early stage. In recent years, ISP has introduced a requirement that groups assign deputy leaders. It is important that this is followed up from ISP's side, especially in cases where the group leaders are close to retirement age.

Improve communication and mentoring in the phase out of groups

Currently no clear criteria or procedures for phasing out support to research groups and networks exist. Today, the responsible Program Director usually notifies the group leaders and coordinators that support might be ending with a final three-year period of support. The decision is based on an overview assessment of the development level of the activities, and the potential to continue development on other funding. The matter also has to be brought up with the Executive Committee before the Board makes a final decision on the phase out. ISP could take on a clearer mentoring role in the phase out of groups and networks, improve the communication about the phase out of activities, and help to develop individual adapted exit plans. It was suggested by group leaders that ISP set aside a specific fund, to be used for emergency needs of phased out groups and networks. Further, they requested ISP to continuously inform current and former groups about possible external funding opportunities and programs.

Make better use of the competence in phased out groups

Most of the Thai group leaders expressed a wish to continue the collaboration with ISP through regional collaboration with other Southeast Asian countries supported by ISP. Significant capacity has been built up in supported research groups and their willingness to serve as host institutions should be utilized, not only in Thailand and Sri Lanka but also in other phased out groups where capacity is considered high. ISP could gain from creating a more structured form or forum for this, where interested group leaders and alumni could interact or seek information about collaborations where they can contribute and potentially also collaborate with each other.

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Appendix

Appendix 1. Questionnaires former students

The quantitative data of the tracer study is extracted from an online questionnaire sent out to former PhD- and MPhil students part of the Sri Lanka and Thailand collaboration at two separate occasions. Both questionnaires are presented below. Some questions have been removed and others have been added in the Thailand questionnaire, based on lessons learned from the Sri Lankan tracer study conducted a year before. Both questionnaires are based on a tracer study carried out by researchers at the Nordic Africa Institute, on mobility and career development of PhD graduates in the Swedish research cooperation with Tanzania and Mozambique (Fellesson & Mählck, 2013).

Uppsala University's internal system for web questionnaires "KURT"[1] was used to produce and carry out both questionnaires.

Sri Lanka

This questionnaire is part of an evaluation of the International Science Programme, Uppsala University, considering the collaboration with scientists in Sri Lanka between 1978 and 2010. In this questionnaire we will ask you questions about your participation in and experiences of research training and education in ISP funded research groups, your mobility and career development since graduation, as well as your future plans.

Your response to all questions is voluntary. We will keep your answers strictly confidential, and you will not in any way be personally identified in the report of the study, in statistical summaries or in any other information resulting from the study. It will take on average 10–20 minutes to complete the questionnaire.

Your participation is very important to us! The results will be used to identify trends and experiences of ISP supported MPhil and PhD students, as well as to improve the quality and operation of ISP's work. This questionnaire is based on one made by the Nordic Africa Institute, on mobility and career development of PhD graduates in the Swedish research cooperation with Tanzania and Mozambique.

Thank you for your time and participation! If you have any questions please don't hesitate to contact Rebecca Andersson:
Rebecca.andersson@isp.uu.se

[1] KURT can be reached (in Swedish) through: https://doit.medfarm.uu.se/kurt/.

Part 1: Socio-demographics

1. Gender
   ☐ Female
   ☐ Male

2. First and last name

3. Email address

4. Address where USB should be sent

5. Year of birth

6. Country of birth

7. Country of residence

8. Marital status
   ☐ Married
   ☐ Single
   ☐ Divorced
   ☐ Widowed
   ☐ Partner
   ☐ Other

9. Do you have children?
   ☐ Yes
   ☐ No

10. If yes, how many?
    ☐ 1
    ☐ 2
    ☐ 3
    ☐ 4
    ☐ 5 or more

Part 2: Educational attainment

11. Highest obtained degree
    ☐MPhil or equivalent
    ☐PhD

12. Year of starting MPhil/PhD training (enter starting year of your highest obtained degree only)

13. Year of graduation MPhil/PhD degree (enter graduation year of highest obtained degree only)

14. Did you exit your MPhil/PhD training before graduating?
    ☐ Yes
    ☐ No

15. If yes, what was the reason(s) for exiting?

16. Discipline of science of MPhil/PhD training

    ☐ Chemistry
    ☐ Physics

17. Title of thesis (highest obtained degree)

18. Name and affiliation of supervisor and co-supervisor(s)

19. Country of graduation MPhil/PhD degree (highest obtained degree)
    ☐ Sweden
    ☐ Sri Lanka
    ☐ Other, please specify

20. University of graduation MPhil /PhD degree (Highest obtained degree)
    ☐ University of Colombo
    ☐ University of Jaffna
    ☐ University of Kelaniya
    ☐ University of Peradeniya
    ☐ University of Ruhuna
    ☐ University of Sri Jayewardenepura
    ☐ Other university, please specify

21. Which university did you belong to when starting your MPhil/PhD training?
   ☐ University of Colombo
   ☐ University of Jaffna
   ☐ University of Kelaniya
   ☐ University of Peradeniya
   ☐ University of Ruhuna
   ☐ University of Sri Jayewardenepura
   ☐ Other university, please specify

22. What type of dissertation did you write?
   ☐ Dissertation by monograph
   ☐ Dissertation by articles

23. What was your position at the time of starting the MPhil/PhD training (at the start of your highest obtained degree)
   ☐ Postgraduate student
   ☐ Staff member
   ☐ Other. Please specify

24. Was your MPhil/PhD training organized in accordance with the sandwich model?
   ☐ Yes
   ☐ No, please specify how it was organized

25. If you were a sandwich student, where were you trained?
   ☐ Sweden
   ☐ Other country/countries

26. How many months in total did you spend in Sweden (or any other country) during your period of MPhil/PhD training?
   ☐ 0 – 6 months
   ☐ 7 – 13 months
   ☐ 14 – 19 months
   ☐ 20 – 26 months
   ☐ More than 26 months

27. What was the average number of months each stay?
☐ 2 – 3 months
☐ 4 – 5 months
☐ 6 – 7 months
☐ 8 – 9 months
☐ 10 – 11 months
☐ 12 –

28. How did you experience the period of training in relation to the following aspects?

	Mostly very good	Mostly good	Mostly difficult	Mostly very difficult
Period of research training while at the host university in Sweden (or other country)	☐	☐	☐	☐
Period of research training while at the home university in Sri Lanka	☐	☐	☐	☐
Supervision in Sweden (or other country)	☐	☐	☐	☐
Co-supervision in Sri Lanka	☐	☐	☐	☐
Resources (equipment and time) for research at the host university in Sweden (or other country)	☐	☐	☐	☐
Resources (equipment and time) for research at the home university in Sri Lanka	☐	☐	☐	☐
Access to information on administrative rules and regulations of the department at the home university in Sri Lanka	☐	☐	☐	☐

	Mostly very good	Mostly good	Mostly difficult	Mostly very difficult
Access to information on administrative rules and regulations of the department at the university in Sweden (or other country)	☐	☐	☐	☐
Collegial support and research networks at your department of training in Sri Lanka	☐	☐	☐	☐
Collegial support and research networks at your department of training in Sweden (or other country)	☐	☐	☐	☐

29. Did you experience any problems entering the EU/Sweden/other country during training?
    ☐ Yes, many times
    ☐ Yes, a few times
    ☐ No

30. To what extent have you during the time of MPhil/PhD training while in Sweden/other country experienced discrimination ranging from unwanted attention to direct harassment on the basis of the following?

	To a very large extent	To a large extent	To a small extent	Not at all
Gender	☐	☐	☐	☐
Age	☐	☐	☐	☐
Ethnic background	☐	☐	☐	☐
Socio-economic background (class)	☐	☐	☐	☐
Color of skin	☐	☐	☐	☐
Sexual orientation	☐	☐	☐	☐
Disability	☐	☐	☐	☐
Position at the Workplace	☐	☐	☐	☐
Family situation (caring responsibility children, parents, etc)	☐	☐	☐	☐

31. If you have experienced discrimination in Sweden/other country, was this expressed in any of the following ways?

	Yes	No
Physical harassment	☐	☐
Sexual harassment	☐	☐
Verbal harassment	☐	☐
Being ignored	☐	☐
Other, please specify		

32. To what extent have you during the time of your MPhil/PhD training while at your home university in Sri Lanka experienced discrimination ranging from unwanted attention to direct harassment on the basis of the following?

	To a very large extent	To a large extent	To a small extent	Not at all
Gender	☐	☐	☐	☐
Age	☐	☐	☐	☐
Ethnic background	☐	☐	☐	☐
Socio-economic background (class)	☐	☐	☐	☐
Color of skin	☐	☐	☐	☐
Sexual orientation	☐	☐	☐	☐
Disability	☐	☐	☐	☐
Position at the Workplace	☐	☐	☐	☐
Family situation (caring responsibility children, parents, etc)	☐	☐	☐	☐

33. If you have experienced discrimination in the Sri Lankan academia, was this expressed in any of the following ways?

	Yes	No
Physical harassment	☐	☐
Sexual harassment	☐	☐
Verbal harassment	☐	☐
Being ignored	☐	☐
Other, please specify	☐	☐

34. If applicable, describe in short, what did you experience as being the most positive features with of the sandwich model?

35. If applicable, describe in short what did you experience as being the most negative features of the sandwich model?

36. At the present, do you have any contact with the collaborating department in Sweden, or elsewhere?
   ☐Yes
   ☐No

37. If yes, what type of contact?
   ☐ Research cooperation, joint research project, co-publishing
   ☐ Lecturing
   ☐ Supervision of PhD candidate(s)
   ☐ Administrative collaboration
   ☐ Other, specify

Part 3: Employments/positions since graduation - sectorial mobility

38. Where is your current principal employment/position?
    ☐ Same as Sri Lankan university of studies at highest level attained. Please specify below which university
    ☐ Other university in Sri Lanka. Please specify below which university
    ☐ University outside Sri Lanka. Please specify below which country and university
    ☐ Government/public agency/organization/actor in Sri Lanka. Please specify below which agency/organization/actor
    ☐ Private sector company/organization/actor in Sri Lanka. Please specify below which agency/organization/actor
    ☐ International donor/aid organizations/ NGOs in Sri Lanka. Please specify below which organization/NGO
    ☐ Other government/public agency/organization/actor outside Sri Lanka. Please specify below which country and agency/organization/actor
    ☐ Private sector company/organization/actor outside Sri Lanka. Please specify below which country and agency/organization/actor
    ☐ International donor organizations/ NGOs outside Sri Lanka. Please specify which country and organization/NGO
    ☐ Self-employed. Own business/consultant
    ☐ Unemployed
    ☐ Other. Please specify

39. What is your current position? The selection of multiple options is possible.
    ☐ Executive (minister, director general, etc)
    ☐ Professor
    ☐ Associate professor
    ☐ Head of department
    ☐ Lecturer
    ☐ Professional staff (medical doctor, agronomist, forester, etc)
    ☐ High official/official government organization, international organization, NGO
    ☐ Senior management, middle management (private sector)
    ☐ Consultant
    ☐ Student
    ☐ Other, please specify

40. Do you currently have more than one income generating employment/job/activity?
    ☐ Yes
    ☐ No

41. Are you working on research with researchers in a country other than the one you are living in any of the following ways?

	Yes	No
Working on a joint publication with people in another country	☐	☐
Collaborating at a distance on a joint research project with researchers in another country	☐	☐
Fund raising collaboration, joint applications	☐	☐

42. If you have collaboration with researchers in other countries, which region(s) does it mainly concern?
   ☐ Africa
   ☐ Europe
   ☐ North America
   ☐ Latin America
   ☐ Asia

Part 4: Working conditions

43. To what extent do you think that your MPhil/PhD degree has contributed to your current position?

Very much	Much	Little	Very little
☐	☐	☐	☐

44. To what extent do you think your current work tasks correspond to your academic qualifications?

To a very large extent	To a large extent	To a small extent	Not at all
☐	☐	☐	☐

45. Please rate your satisfaction with your current position

	Very satisfied	Satisfied	Dissatisfied	Very dissatisfied
Salary	☐	☐	☐	☐
Working conditions	☐	☐	☐	☐
Job security	☐	☐	☐	☐
Opportunity for career advancement	☐	☐	☐	☐
Intellectual challenge	☐	☐	☐	☐
Level of responsibility	☐	☐	☐	☐
Degree of independence	☐	☐	☐	☐
Contribution to society	☐	☐	☐	☐
Social status	☐	☐	☐	☐
Overall level of satisfaction	☐	☐	☐	☐

46. To what extent have you from time of graduation up to your current position experienced discrimination ranging from unwanted attention to direct harassment on the basis of the following?

	To a very large extent	To a large extent	To a small extent	To a very small extent	Not at all
Gender	☐	☐	☐	☐	☐
Age	☐	☐	☐	☐	☐
Ethnic background	☐	☐	☐	☐	☐
Socio-economic background (class)	☐	☐	☐	☐	☐
Color of skin	☐	☐	☐	☐	☐
Sexual orientation	☐	☐	☐	☐	☐
Disability	☐	☐	☐	☐	☐

	To a very large extent	To a large extent	To a small extent	To a very small extent	Not at all
Position at the Workplace	☐	☐	☐	☐	☐
Family situation (caring responsibility children, parents, etc)	☐	☐	☐	☐	☐

47. Besides your current position, how many employment/positions have you held since graduation?
☐ 1 – 2 positions
☐ 3 – 4 positions
☐ 5 – 6 positions
☐ 7 – 8 positions
☐ 9 – 10 positions
☐ More than 10 positions

48. How many employments/positions have you had at an university as researcher/teacher/administrator?
☐ 1 – 2 positions
☐ 3 – 4 positions
☐ 5 – 6 positions
☐ 7 – 8 positions
☐ 9 –10 positions
☐ More than 10 positions

49. If you have had employments/positions outside the university, what type? The selection of multiple options is possible
☐ Other government/public agency/organization/actor in Sri Lanka. Please specify below which agency/organization/actor
☐ Private sector company/organization/actor in Sri Lanka. Please specify below which agency/organization/actor
☐ International donor/aid organizations/ NGOs in Sri Lanka Please specify below which organization/NGO
☐ Other government/public agency/organization/actor outside Sri Lanka. Please specify below which country and agency/organization/actor
☐ Private sector company/organization/actor outside Sri Lanka. Please specify below which country and agency/organization/actor
☐ International donor organizations/ NGOs outside Sri Lanka Please specify which country and organization/NGO
☐ Self-employed. Own business/consultant
☐ Other. Please specify
Specify:

Part 5: Employments/positions since graduation - geographic mobility

50. Have you ever worked abroad since graduation?
    ☐ Yes
    ☐ No

51. If yes, please provide the name(s) of the country (countries) and duration of stay for each country

52. What kind of work/positions did you have during your stay(s) abroad? Several options are possible
    ☐ Researcher
    ☐ Lecturer
    ☐ Official (government, international organization, NGO)
    ☐ Employee in the private sector
    ☐ Consultant
    ☐ Other, please specify

53. How important have the following aspects been for your decisions to work abroad?

	Very important	Important	Minor importance	Not important at all
Working conditions/facilities for research	☐	☐	☐	☐
Salary	☐	☐	☐	☐
Career development	☐	☐	☐	☐
Language/culture	☐	☐	☐	☐
Recognition of educational degrees	☐	☐	☐	☐
The existence of leading experts in your field	☐	☐	☐	☐
Existence of alternative employments	☐	☐	☐	☐
Development opportunities for your family members (schools, employment etc.)	☐	☐	☐	☐

Other important aspects:

54. If you have a position at an university, to what extent do you conduct research?

Full time	75 % of full time	50 % of full time	25 % of full time	Less than 25 % of full time	No at all
☐	☐	☐	☐	☐	☐

55. If you conduct research, how is it financed?
    - ☐ The government
    - ☐ International donor
    - ☐ International research funding (foundations)
    - ☐ Private funding (business, industry)
    - ☐ Other, please specify

56. If you conduct research, how many publications of the following types have you had since graduation?

	No publications	1–3	4–6	7–9	10–12	13 or more
Peer-reviewed International journals	☐	☐	☐	☐	☐	☐
Peer-reviewed national journals	☐	☐	☐	☐	☐	☐
University reports (non-peer-reviewed)	☐	☐	☐	☐	☐	☐
Other reports (government/international organizations, NGOs, private sector)	☐	☐	☐	☐	☐	☐
Books	☐	☐	☐	☐	☐	☐
Teaching material	☐	☐	☐	☐	☐	☐
Papers for seminars/conferences/ workshops	☐	☐	☐	☐	☐	☐

57. To what extent are you involved in following types of research network?

	To a large extent	To some extent	To a small extent	Not at all
International (global) research networks involving researchers from many countries	☐	☐	☐	☐
Pan-Asian or regional research networks involving researchers from Asian countries	☐	☐	☐	☐
National research networks involving researchers from Sri Lankan research institutions	☐	☐	☐	☐

58. If you have a position at an university, to what extent are you involved in coursework lecturing?

Full time	75 % of full time	50 % of full time	25 % of full time	Less than 25 % of full time	No at all
☐	☐	☐	☐	☐	☐

59. To what extent do think your research results have contributed to the following?

	To a large extent	To some extent	To a small extent	Not at all
Policy development (government)	☐	☐	☐	☐
Poverty reduction in Sri Lanka	☐	☐	☐	☐
Advancement of the international research frontline	☐	☐	☐	☐
Advancement of the national research frontline	☐	☐	☐	☐

Part 6: Future plans

60. If picture yourself three years from now, to what extent do thing you are doing the following?

	Most likely	Possibly	Not likely	Don't know
Work at your home university as a researcher	☐	☐	☐	☐
Work at your home university as a lecturer	☐	☐	☐	☐
Work at another university/university college in Sri Lanka	☐	☐	☐	☐
Work at an university/ research institution in another country in the region	☐	☐	☐	☐
Work at an university/ research institution in another country outside Asia	☐	☐	☐	☐
Work for a government agency in Sri Lanka	☐	☐	☐	☐
Work for an international organization/NGO in Sri Lanka	☐	☐	☐	☐
Work for an international organization/NGO abroad	☐	☐	☐	☐
Work for a private business company in Sri Lanka	☐	☐	☐	☐
Work for a private business company abroad	☐	☐	☐	☐
Having my own business (consultant)	☐	☐	☐	☐

61. Would you be interested in positions at universities or other employments abroad?
☐ Yes
☐ No

62. If yes, how do you rate the importance of the following potential obstacles for mobility?

	Very important factor	Important factor	Not so important factor	Not important at all
Lack of employment opportunities/funding	☐	☐	☐	☐
Language limitations	☐	☐	☐	☐
Family situation	☐	☐	☐	☐
Risk of discrimination (gender, age, ethnic and social background, skin color, disability, sexual orientation)	☐	☐	☐	☐

Thank you for your participation!

As a token of our appreciation for your effort you will receive as a gift an **Uppsala University USB flash drive** will be sent to you, given you have provided your name, email and home/work address. Thank you again.

Thailand

This questionnaire is part of an evaluation of the International Science Programme, Uppsala University, formerly known as “International Programme in the Physical Sciences” (IPPS) and the “International Programme in the Chemical Sciences” (IPICS). The questionnaire concerns you who have received MPhil, Licentiate or PhD training in ISP funded IPICS and IPPS research groups in Thailand.

In this questionnaire we will ask you questions about your participation in and experiences of research training and education in IPPS or IPICS research groups, your research and collaborations, your mobility and career development since graduation, as well as your future plans. Your response to all questions is voluntary. We will keep your answers strictly confidential, and you will not in any way be personally identified in the report of the study, in statistical summaries or in any other information resulting from the study.

It will take on average 15–20 minutes to complete the questionnaire. As a token of your participation you will receive an Uppsala University USB flash drive, given you have provided your work or home address. Your participation is very important to us and the results will be used to identify trends and experiences of ISP supported MPhil, Licentiate and PhD students, as well as to improve the quality and operation of ISP’s work.

Thank you for your time and participation! If you have any questions please don’t hesitate to contact Rebecca Andersson - Rebecca.andersson@isp.uu.se

Part 1: Socio-demographics

1. Gender
   ☐ Female
   ☐ Male

2. Given name and family name

3. Email address

4. Home/work address where the USB flash drive will be sent

5. Year of birth

6. Country of birth

7. Country of residence

Part 2: Educational attainment

8. Degree obtained with ISP support
   ☐ PhD
   ☐ Licentiate degree
   ☐ MPhil or equivalent
   ☐ MSc

9. Highest degree obtained
   ☐ PhD
   ☐ Licentiate degree
   ☐ MPhil or equivalent
   ☐ MSc

10. Year of starting ISP supported MPhil/PhD training

11. Year of graduation of ISP supported MPhil/PhD degree

12. Did you exit your MPhil/PhD training before graduating?
    ☐ Yes, please specify the reasons for exiting
    ☐ No
    Specify

13. Discipline of science of MPhil/PhD training
    ☐ Chemistry
    ☐ Physics

14. Name and affiliation of supervisor and co-supervisor(s)

15. Country of graduation of ISP supported MPhil/PhD degree
    ☐ Sweden
    ☐ Thailand
    ☐ Other, please specify

16. University of graduation of ISP supported MPhil/PhD degree
    ☐ Chiang Mai University
    ☐ Chulalongkorn University
    ☐ Mahidol University
    ☐ Prince of Songkla University
    ☐ Srinakarinwirot University
    ☐ Swedish university, please specify
    ☐ Other university, please specify

17. What type of dissertation did you write?
    ☐ Dissertation by monograph
    ☐ Dissertation by articles

18. What was your position at the time of starting the MPhil/PhD training, obtained with ISP support
☐ Student
☐ Staff member
☐ Other, please specify

19. Was your MPhil/PhD training organized in accordance with the sandwich model? **If no, jump to question 32**
☐ Yes
☐ No, please specify how it was organized

20. If you were a sandwich student, where were you trained?
☐ Sweden
☐ Other country/countries

21. How many times did you go for sandwich stays in Sweden or other host country during your period of MPhil/PhD training?
☐ 1 time
☐ 2 times
☐ 3 times
☐ 4 times
☐ 5 times
☐ 6 times
☐ 7 times
☐ 8 times
☐ 9 times
☐ 10 times

22. How many months in total did you spend in Sweden and/or other host country, during your period of MPhil/PhD training?

23. How did you experience the period of training in relation to the following aspects?

	Mostly very good	Mostly good	Mostly difficult	Mostly very difficult
Period of research training while at the host university in Sweden (or other country)	☐	☐	☐	☐
Period of research training while at the home university in Thailand	☐	☐	☐	☐
Supervision in Sweden (or other country)	☐	☐	☐	☐
Co-supervision in Thailand	☐	☐	☐	☐
Resources (equipment and time) for research at the host university in Sweden (or other country)	☐	☐	☐	☐
Resources (equipment and time) for research at the home university in Thailand	☐	☐	☐	☐
Access to information on administrative rules and regulations of the department at the host university in Sweden (or other country)	☐	☐	☐	☐

	Mostly very good	Mostly good	Mostly difficult	Mostly very difficult
Access to information on administrative rules and regulations of the department at the home university in Thailand	☐	☐	☐	☐
Collegial support and research networks at your host department of training in Sweden (or other country)	☐	☐	☐	☐
Collegial support and research networks at your home department of training in Thailand	☐	☐	☐	☐

24. What aspects of the research training could have been improved?

25. How did you experience the communication between your local and host supervisor? Did the communication between your supervisors affect you or the development of your research in any way?

26. Describe in short, what did you experience as being the most positive features with of the sandwich model?

27. Describe in short what did you experience as being the most negative features of the sandwich model?

28. At the present, do you have any contact with the former host department in Sweden/other country?
    ☐Yes
    ☐No

29. If yes, what type of contact?
    ☐ Research cooperation, joint research project, co-publishing
    ☐ Lecturing
    ☐ Supervision of PhD candidate(s)
    ☐ Administrative collaboration
    ☐ Other, please specify

30. **ONLY** for students trained to a full extent locally in Thailand: How did you experience the period of training in relation to the following aspects?

	Mostly very good	Mostly good	Mostly difficult	Mostly very difficult
Period of research training in general	☐	☐	☐	☐
Supervision	☐	☐	☐	☐
Resources (equipment and time) for research	☐	☐	☐	☐
Access to information on administrative rules and regulations of the department	☐	☐	☐	☐
Collegial support and research networks at your department	☐	☐	☐	☐

31. **ONLY** for students trained to a full extent locally in Thailand: What aspects of the research training could have been improved?

Part 3: Current employment and working conditions

32. Where is your current principal employment/position?
☐ Same as university of graduation of highest level attained. Please specify below which university
☐ Other university in Thailand. Please specify below which university
☐ University outside Thailand. Please specify below which country and university
☐ Government/public agency/organization/actor in Thailand. Please specify below which agency/organization/actor
☐ Private sector company/organization/actor in Thailand. Please specify below which agency/organization/actor
☐ International donor/aid organizations/ NGOs in Thailand. Please specify below which organization/NGO
☐ Other government/public agency/organization/actor outside Thailand. Please specify below which country and agency/organization/actor
☐ Private sector company/organization/actor outside Thailand. Please specify below which country and agency/organization/actor
☐ International donor organizations/ NGOs outside Thailand. Please specify which country and organization/NGO
☐ Self-employed. Own business/consultant
☐ Unemployed
☐ Other, please specify
Specify

33. What is your current position?
☐ Vice Chancellor/Rector, please specify
☐ Vice Rector/Pro-rector or other higher university post, please specify
☐ Dean
☐ Head of department
☐ Senior lecturer/Lecturer
☐ Professional staff (Medical Doctor, Agronomist, Forester, etc.)
☐ Government Executive (Minister, Director General, etc.)
☐ High official/official government organization, international organization, NGO
☐ Senior management, middle management (private sector)
☐ Consultant
☐ Student
☐ Currently unemployed
☐ Other, please specify
Specify

34. What is your academic title?
    ☐ Professor
    ☐ Associate Professor
    ☐ Doctor/PhD
    ☐ MPhil
    ☐ MSc
    ☐ Other, please specify
35. Do you currently have more than one income generating employment/job/activity?
    ☐ Yes, please specify below
    ☐ No

36. To what extent do you think that your MPhil/PhD degree has contributed to your current position?

Very much	Much	Little	Very little
☐	☐	☐	☐

37. To what extent do you think your current work tasks correspond to your academic qualifications?

To a very large extent	To a large extent	To a small extent	Not at all
☐	☐	☐	☐

38. Please rate your satisfaction with your current position in regards to the following.

	Very satisfied	Satisfied	Dissatisfied	Very dissatisfied
Salary	☐	☐	☐	☐
Working conditions	☐	☐	☐	☐
Job security	☐	☐	☐	☐
Opportunity for career advancement	☐	☐	☐	☐
Intellectual challenge	☐	☐	☐	☐
Level of responsibility	☐	☐	☐	☐
Degree of independence	☐	☐	☐	☐
Contribution to society	☐	☐	☐	☐
Social status	☐	☐	☐	☐
Overall level of satisfaction	☐	☐	☐	☐

39. How long time did it take you to get the first job after obtaining your highest degree? (Months)

Part 4: Research and collaboration

40. If you have a position at an university, or any other institution where research work is possible, to what extent do you conduct research?

Full time	75 % of full time	50 % of full time	25 % of full time	Less than 25 % of full time	Not at all
☐	☐	☐	☐	☐	☐

41. If you have a position at an university, to what extent are you involved in coursework/lecturing?

Full time	75 % of full time	50 % of full time	25 % of full time	Less than 25 % of full time	Not at all
☐	☐	☐	☐	☐	☐

42. If you conduct research, how is it financed? (Multiple options are available)
    - ☐ The government
    - ☐ International research funding/International donor agency
    - ☐ Private funding (business, industry)
    - ☐ Other, please specify

43. Please list the different funding institutions from which you have received financial support since the beginning of your research career, excluding ISP (IPICS & IPPS).

Years	Name of funding organization	Country	Amount in USD

44. In your opinion, please rate the impact of your research funding on:

	Very positive impact	Positive impact	No impact	Negative impact
Scientific productivity	☐	☐	☐	☐
Extent of networking	☐	☐	☐	☐

If you conduct research, how many publications of the following types have you had since graduation:

45. Peer-reviewed international Journals
46. Peer-reviewed national journals
47. University reports (non-peer-reviewed)
48. Other reports (government/ international organizations, NGOs, private sector)
49. Books
50. Teaching material
51. Papers for seminars/conferences/ workshops

52. If you conduct research, why do you choose to publish your research?
☐ Personal satisfaction, please specify
☐ Professional reasons, please specify
☐ I have not published any of my results, please specify why

53. Are you working on joint research with scientists in Thailand in any of the following ways?

	Yes	No
Working on a joint publication	☐	☐
Collaborating at a distance on a joint research project	☐	☐
Fund raising collaboration, joint applications	☐	☐

54. What are advantages and disadvantages of collaborating with Thai researchers?

55. Are you working on joint research with scientists in a country other than the one you are living, in any of the following ways?

	Yes	No
Working on a joint publication with people in another country	☐	☐
Collaborating at a distance on a joint research project with researchers in another country	☐	☐
Fund raising collaboration, joint applications	☐	☐

56. What are advantages and disadvantages of collaborating with foreign researchers?

57. If you have collaboration with researchers in other countries, which region(s) does it mainly concern?
☐ Africa
☐ Europe
☐ North America
☐ Latin America
☐ Asia

58. To what extent are you involved in following types of research network?

	To a large extent	To some extent	To a small extent	Not at all
International (global) research networks involving researchers from many countries	☐	☐	☐	☐
Pan-Asian or regional research networks involving researchers from Asian countries	☐	☐	☐	☐
National research networks involving researchers from Thai research institutions	☐	☐	☐	☐

59. How do you expand your professional network?
    - ☐ Through PhD students/supervisors
    - ☐ Through colleagues at the same university
    - ☐ Through the Thai Government
    - ☐ Through conferences and workshops
    - ☐ Through sabbatical visits
    - ☐ Through established scientific networks
    - ☐ Through internet
    - ☐ I don't expand my network
    - ☐ Other, please specify

60. To what extent do think your research results have contributed to the following?

	To a large extent	To some extent	To a small extent	Not at all
Policy development (government)	☐	☐	☐	☐
Poverty reduction in Thailand	☐	☐	☐	☐
Advancement of the international research frontline	☐	☐	☐	☐
Advancement of the national research frontline	☐	☐	☐	☐

61. If possible, please provide examples of how your research results have contributed to policy or practice development, the development of national guidelines, poverty reduction or the advancement of the national or international research frontline.

62. Have you been appointed member of any government committee, board or working group based on or related to, the knowledge you have gained from your MPhil/PhD degree?
☐ Yes, please specify below
☐ No

63. Have you received any awards for your research?
☐ Yes, please specify below
☐ No

64. Have you obtained any patents for your research?
☐ Yes, please specify below
☐ No

Part 5: Employments/positions since graduation – sectoral and geographic mobility

65. Besides your current position, how many employment/positions have you held since graduation?
☐ 1 – 2 positions
☐ 3 – 4 positions
☐ 5 – 6 positions
☐ 7 – 8 positions
☐ 9 – 10 positions
☐ More than 10 positions

66. If you since graduation have had employments/ positions outside the university, what type? The selection of multiple options is possible
☐ Other government/public agency/organization/actor in Thailand. Please specify below which agency/organization/actor
☐ Private sector company/organization/actor in Thailand. Please specify below which agency/organization/actor
☐ International donor/aid organizations/ NGOs in Thailand Please specify below which organization/NGO
☐ Other government/public agency/organization/actor outside Thailand. Please specify below which country and agency/organization/actor
☐ Private sector company/organization/actor outside Thailand. Please specify below which country and agency/organization/actor
☐ International donor organizations/ NGOs outside Thailand. Please specify which country and organization/NGO
☐ Self-employed. Own business/consultant
☐ Other, please specify

67. Have you ever worked abroad since graduation?
☐ Yes
☐ No

68. If yes, please provide the name(s) of the country (countries), and duration of stay for each country

69. What kind of work/positions did you have during your stay(s) abroad? Several options are possible
☐ Researcher
☐ Lecturer
☐ Official (government, international organization, NGO)
☐ Employee in the private sector
☐ Consultant
☐ Other, please specify

70. How important have the following aspects been for your decisions to work abroad?

	Very important	Important	Minor importance	Not important at all
Working conditions/ facilities for research	☐	☐	☐	☐
Salary	☐	☐	☐	☐
Career development	☐	☐	☐	☐
Language/culture	☐	☐	☐	☐
Recognition of educational degrees	☐	☐	☐	☐
The existence of leading experts in your field	☐	☐	☐	☐
Existence of alternative employments	☐	☐	☐	☐
Development opportunities for your family members (schools, employment etc.)	☐	☐	☐	☐

Other important aspects:

Part 6: Future plans

71. If you picture yourself three years from now, to what extent do you think that you are doing the following?

	Most likely	Possibly	Not likely	Don't know
Work at your home university as a researcher	☐	☐	☐	☐
Work at your home university as a lecturer	☐	☐	☐	☐
Work at another university/university college in Thailand	☐	☐	☐	☐
Work at an university/research institution in another country in the region	☐	☐	☐	☐
Work at an university/research institution in another country outside Asia	☐	☐	☐	☐
Work for a government agency in Thailand	☐	☐	☐	☐
Work for an international organization/NGO in Thailand	☐	☐	☐	☐
Work for an international organization/NGO abroad	☐	☐	☐	☐
Work for a private business company in Thailand	☐	☐	☐	☐
Work for a private business company abroad	☐	☐	☐	☐
Having my own business (consultant)	☐	☐	☐	☐

72. Would you be interested in positions at universities or other employments abroad?
    - ☐ Yes
    - ☐ No

73. If yes, how do you rate the importance of the following potential obstacles for mobility?

	Very important factor	Important factor	Not so important factor	Not important at all
Lack of employment opportunities/funding	☐	☐	☐	☐
Language limitations	☐	☐	☐	☐
Family situation	☐	☐	☐	☐
Risk of discrimination (gender, age, ethnic and social background, skin color, disability, sexual orientation)	☐	☐	☐	☐

74. What are your ideas about how the ISP's support, as you have experienced it, can be improved?

Thank you for your participation!

As a token of our appreciation for your effort you will receive as a gift an **Uppsala University USB flash drive** will be sent to you, given you have provided your name, email and home/work address. Thank you again.

Appendix 2. Interview guides former students

The below interview guidelines were used when performing the semi-structured, in-depth, follow up interviews with the PhD- and MPhil respondents to the Sri Lanka and Thailand tracer studies. The interview guideline used in the interviews with Thai respondents was slightly revised based on the experiences of interviews with Sri Lankan respondents conducted the previous year. Both interview guides are based on a tracer study carried out by researchers at the Nordic Africa Institute, on mobility and career development of PhD graduates in the Swedish research cooperation with Tanzania and Mozambique (Fellesson & Mählck, 2013).

Sri Lanka

Part 1: Socio-demographics

1. Gender
2. Age

Part 2: Educational attainment

3. Highest obtained degree
4. Year of entering training
5. Reason for starting training
6. Year of examination
7. Country of graduation
8. Exit training before graduating, why?
9. Discipline of science

Part 3: The period of training

10. Why did you choose to join the ISP program instead of going for a fellowship abroad?
11. If you were a sandwich student, where were you trained?
12. Which university and department in Sweden/other country were you affiliated to?
13. How often did you go to Sweden/other country?
14. Can you describe the recruitment process? (E.g. Process of selection, information, discrimination)
15. What do you think are the advantages/disadvantages with the sandwich model?

16. What was your research topic, how come you ended up with this topic?
17. Could choose your supervisors?
18. To what extent could you influence these processes?
19. Could you choose dissertation type?
20. What have been most difficult and easy/rewarding with your PhD training?
21. How did you experience your stay in Sweden/other country in terms of:
    a. the administrative arrangements? (E.g. booking travels, housing, salaries, access to university facilities, visa procedures etc.)
    b. social relations? (I.e. integration in formal and informal networks at the department)
    c. day to day life in Sweden? (E.g. social relations outside the university)

22. How did you organize your family life during this period? Did your family life change during the period abroad? How?
23. Did your relationship to your colleagues and your position at the department in your country of residence change as consequence of entering PhD training? How?
24. Have you experienced negative treatment during your PhD training in Sweden/other country and/or at your home university in terms of harassment or subtle discrimination based on your sexuality, gender, age, social class background, ethnicity or skin color? Please describe.
25. What social attributes do you believed is associated with a good researcher?
26. Did the definition of a good researcher differ between the department in Sweden/other country and your home university? Do you believe that the features have changed over time?

Part 4: Employment and mobility

27. Where/what is your current employment/position? How did you get your current position?
28. Do you have more than one employment/position or income generating activity?
29. How much research do you conduct in percentage of full time?
30. What is research for you?
31. Has it been easy to get research funding? From where do you get it?
32. Can you describe your journey from graduation to your position today; does it include mobility (sectorial, geographic, vertical)?
33. What have been the incentives/motivations for your career choices and your mobility?
34. If not being mobile. What are the reasons for pursuing a local PhD, or staying in the same position?
35. What have been most difficult and easy/rewarding with your career development?

36. What have been hindering/impeding factors for your career development – foremost related to mobility?
37. To what extent and in what way has your PhD degree contributed to your current position?
38. Do your current work tasks correspond to your academic qualification?
39. Has your research work been cited or used in any other ways in your country of residence, how?
40. What kind of networks do you currently have? (Types and regions)
41. Do you have any contacts with the collaborating department/researchers in Sweden? What kind of contact, and what have it meant for your career development?
42. Is it easy to establish collaborations outside Sri Lanka?

Part 5: Development of research and higher education

43. How do you view the current development of research and higher education in Sri Lanka? (E.g. development, policy priorities and challenges)
44. Can you describe research policy priorities in terms of fundamental and applied research?
45. Has your research contributed to the development of Sri Lanka in any way, or been important? How?

Part 6: Future plans

46. What are your future plans? (mobility and career development wise)

Part 7: The ISP collaboration

47. Would you like to ask me something, about the study, about ISP or make any adjustments to the answers?
48. What do you think can be improved in the ISP collaboration? Is there anything that needs to be changed within the ISP program?
49. Is your old research group still active? Describe.

Thailand

Part 1: Socio-demographics

1. Gender
2. Age

Part 2: Educational attainment

3. Highest obtained degree with ISP support and in general
4. Year of entering training, years to finalize training, reasons why
5. Reason for starting Lic./PhD training
6. Country of graduation
7. Exit training before graduating, why?
8. Position at the time of starting the Lic/PhD training, obtained with ISP support

Part 3: The period of training

9. Why did you choose to join the ISP program?
10. How was your research training organized? (Sandwich/full time abroad/full time local). How come it was organized this way?
11. If you were a sandwich student or received training to a full extent abroad, in which country where were you trained?
12. Which university and department in Sweden/other country were you affiliated to?
13. How many times and for how long did you go to Sweden/other country? Was it enough?
14. From which university where you awarded your degree?
15. Do you feel that there is a different in the status of degrees awarded from different universities? Has this affected you in any way? (E.g. in search for employment, among coworkers etc.)
16. Can you describe the selection process of sandwich stays and conferences etc. in the research group? (E.g. Process of selection, length of stay, information, discrimination)
17. Do you believe the selection process where fair? Why/why not?
18. What do you think are the advantages/disadvantages with the sandwich model?
19. What are the advantages of doing a PhD to a full extent abroad? If not sandwich student: Would you have preferred the sandwich model?
20. Could choose your supervisors?
21. If you were a sandwich student, how was the communication between your local and host supervisor? Did this affect you or the progress of your research work in any way?
22. Could you choose dissertation type?

23. What have been the most difficult and easy/rewarding things with your PhD training? At home and abroad.
24. How did you experience your stay in Sweden/other country in terms of:
    a. the administrative arrangements? (E.g. booking travels, housing, salaries, access to university facilities, visa procedures etc.)
    b. social relations? (I.e. integration in formal and informal networks at the department)
    c. day to day life in Sweden? (E.g. social relations outside the university)
25. Could ISP do anything to improve your stay in any way? What could have been better?
26. How did you organize your family life during this period? Did your family life change during the period abroad? How?
27. Have you experienced negative treatment during your PhD training in Sweden/other country and/or at your home university in terms of harassment or subtle discrimination based on your sexuality, gender, age, social class background, ethnicity or skin color? Please describe.

Part 4: Employment and mobility

28. Where/what is your current employment/position? How did you get your current position?
29. Do you have more than one employment/position or income generating activity? If yes, why?
30. To what extent and in what way has your PhD degree contributed to your current position?
31. Do your current work tasks correspond to your academic qualification?
32. Can you describe your journey from graduation to your position today; does it include mobility (sectorial, geographic, vertical)?
33. Have you ever worked abroad since graduation? Where and what type of work? What was the reasons behind the choice?
34. What have been the incentives/motivations for your career choices and your mobility?
35. If not being mobile. Why did you choose to stay in the same position?
36. What have been most difficult and easy/rewarding with your career development?
37. What have been hindering/impeding factors for your career development – foremost related to mobility?

Part 5: Research and collaboration

38. How much time do you spend on research and teaching/course work/administrative duties respectively, in percent of full time?
39. What is research for you?
40. Has it been easy to get research funding? From where do you get it? How much was the funding from each source?
41. How do you start your collaborations?
42. What kind of networks do you currently have? (Types and regions)
43. Do you have any contacts with the collaborating department/researchers in Sweden? What kind of contact, and what have it meant for your career development?
44. Is it easy to establish collaborations outside Thailand?
45. If possible, please provide examples of how your research results have contributed to policy or practice development, the development of national guidelines, poverty reduction or the advancement of the national or international research frontline.
46. Have you had any collaboration with industry? How?
47. Have you been appointed member of any government committee, board or working group based on or related to, the knowledge you have gained from your MPhil/PhD degree?
48. Have you obtained any patents/awards for your research?

Part 6: Development of research and higher education

49. How do you view the current development of research and higher education in Thailand? (E.g. development, policy priorities and challenges)
50. Can you describe research policy priorities in terms of fundamental and applied research?

Part 7: Future plans

51. What are your future plans? (mobility and career development wise)

Part 8: The ISP collaboration

52. Is your old research group still active? Describe.
53. What do you think can be improved in the ISP collaboration? Is there anything that needs to be changed within the ISP program?
54. Would you like to ask us something, about the study, about ISP or make any adjustments to the answers?

Appendix 3. Questionnaires host supervisors

The below questionnaires were sent out to host supervisors to students part of the Sri Lanka and Thailand collaboration. The questionnaire sent out to host supervisors of Thai students has been revised based on the experiences of the questionnaire sent to host supervisors of Sri Lankan students the previous year.

Sri Lanka

ISP has initiated an evaluation of the 30-year long collaboration with Sri Lanka. For this reason we are interested in your experiences as supervisor for students from Sri Lanka as well as of the sandwich program in general. The questionnaire consists of eight questions, taking about 5–10 minutes to answer. Your answers will be anonymous.

Thank you for your participation! If you have any questions please contact Rebecca Andersson – Rebecca.andersson@isp.uu.se

1. In your opinion, what has and what hasn't worked well with the sandwich program and ISP students? Do you believe something needs to be changed?
2. What do you/your institution see as the pros/benefits of the sandwich program and students?
3. What do you/your institution see as the cons/drawbacks of the sandwich program and students?
4. Do you believe that students are integrated in a sufficient way in the research groups and at the institution? Why, why not? If no, what could be improved?
5. Have you experienced that ISP students have been discriminated in any way at the institution? (Regarding gender, age, ethnical background, socio-economic background, skin color, sexual orientation, disability, position at the workplace, family situation – caring responsibility for children, parents etc.)
6. Have you visited the research group(s)? If yes, what are your impressions and have you experienced any change over time/effect of the collaboration?
7. Are you/your institution still in contact or in collaboration with the former students and/or research groups? If yes, in what ways and for what purpose? If no, why not?

8. Please provide any additional information you would like to share with us (for example a memory from your time as a supervisor regarding a student or a situation, or general thoughts about ISP etc.).

Thailand

This questionnaire is part of an evaluation of International Science Programme's (ISP) collaboration with scientists and research groups in Thailand. (ISP is also known as the International Programme in the Physical Sciences (IPPS) and the International Programme in the Chemical Sciences (IPICS).

The questionnaire concerns you who have supervised MPhil, Licentiate or PhD students from Thailand within the ISP collaboration. The questionnaire concerns the supervision of Thai students, the collaboration with the department in Thailand as well as your general thoughts about the sandwich program and ISP in general.

It consists of 19 questions taking approximately 10 minutes to answer. We will keep your answers strictly confidential, and you will not in any way be personally identified in the report.

Thank you for your time and participation! If you have any questions, please don't hesitate to contact Marta Zdravkovic – marta.zdravkovic@isp.uu.se

Part 1: Specific to the collaboration with Thailand

1. Have you supervised MPhil/Lic/PhD student(s) from Thailand, funded or coordinated by ISP?
   ☐ Yes
   ☐ No

2. If yes, how many students and when?

3. If yes, were the students: (multiple options are available)
   ☐ Sandwich based, or
   ☐ Full time at the Swedish institution

4. How did you experience the communication between you and the local supervisor in Thailand? Please describe.
   ☐ Very good
   ☐ Good
   ☐ Bad
   ☐ Very bad

5. Where you in touch with the student during his/her period at the home university in Thailand?
   ☐ Yes
   ☐ No, please describe why

6. Did the research work of the student progress as planned during the period at the home university?
   ☐ Yes
   ☐ No, please describe the reasons why

7. What did you see as student's obstacles for doing research?

8. How and why did you start supervising Thai students?

9. In your role as a supervisor, how did you experience the student(s) (In case you supervised more students, you may write the average value):

	Very good	Good	Bad	Very Bad
Capacity to do quality research	☐	☐	☐	☐
Motivation for doing Lic/PhD-education	☐	☐	☐	☐
Attitude towards doing research after finalizing Lic/PhD	☐	☐	☐	☐
Self confidence	☐	☐	☐	☐
Student's ability to network?	☐	☐	☐	☐

Comments:

10. How did the process of the recruitment of the Lic/PhD students look like?

11. Are you/your institution still in contact or in collaboration with the former students and/or research groups?
    ☐ Yes
    ☐ No

12. If yes, what type of contact?
    - ☐ Research cooperation, joint research project, co-publishing
    - ☐ Lecturing
    - ☐ Supervision of PhD candidate(s)
    - ☐ Administrative collaboration
    - ☐ Other, please specify

13. During your time as a supervisor, have you seen any development at the collaborating department in Thailand regarding any of the below items?

	To a large extent	To some extent	To a small extent	Not at all	Don't know
Research climate at the collaborating department	☐	☐	☐	☐	☐
Competence of the Lic/PhD-students	☐	☐	☐	☐	☐
Competence of the Thai supervisors	☐	☐	☐	☐	☐
Environments where research can be conducted	☐	☐	☐	☐	☐
Administration of research, Lic and PhD- education	☐	☐	☐	☐	☐
International research collaborations/ publications	☐	☐	☐	☐	☐
Completion time of degree	☐	☐	☐	☐	☐

Comments:

14. Has the research collaboration in which you have been involved, led to any substantial break-troughs or innovations that have been of importance to the development of the Thai society or industry in Thailand?
    - ☐ Yes, please describe
    - ☐ No

Part 2: The ISP collaboration in general

15. In your opinion, what has and what hasn't worked well with the sandwich program and ISP students? Do you believe something needs to be changed?

16. In your opinion, how did ISP managed the administration/coordination around the student? What can be improved?

17. What do you/your institution see as the benefits of the sandwich program and students?

18. What do you/your institution see as the drawbacks of the sandwich program and receiving students?

Please provide any additional information you would like to share with us (for example a memory from your time as a supervisor regarding a student or a situation, or general thoughts about ISP etc.).

Appendix 4. Interview guides group leaders

The below interview guidelines were used when interviewing former and current group leaders of ISP supported groups part of the Sri Lanka and Thailand collaboration. The interview guideline used in the interviews with Thai group leaders has been slightly revised based on the experiences of interviews with Sri Lankan group leaders conducted the previous year.

Sri Lanka

Background and historical overview

1. Background (education, number of year at the university, number of years as a group leader).
2. How did the ISP collaboration start?
3. Describe the situation at the institution before/at the beginning of the ISP-collaboration in terms of equipment, capacity, and available programs etc.
4. What would you say that the ISP support has contributed with? (Both in material and immaterial terms)
5. What has the ISP support meant to you? Which consequences of the collaboration have had most value to your research group and for you personally?
6. What have been the:
   a. Challenges during the time of the collaboration? (Internal and external)
   b. Weaknesses?
   c. Tensions? (Internally and with ISP)
   d. Strengths?

7. How has the ISP support benefited your research group in comparison to other groups who did not receive ISP support at the university?

Capacity building

8. To what extent and how has the research training contributed to the intended research capacity building?
9. Has the program been successful in delivering outputs such as the number of students enrolled and the number of graduated PhD and MSc students?
10. Did you have difficulties with students leaving the program? If so, what were reasons for any difficulties to finalize studies or for leaving the program?

11. Did many students go abroad after finishing their degree? Do you have any contact or collaboration with them? Do you keep track of the alumni?
12. Has the sandwich model been an effective way of achieving results?
13. Can you describe the selection process of the sandwich students?
14. How did you experience the Swedish and Sri Lankan PhD supervision within the program, including communication between supervisors, and supervisors and students?
15. Do you believe that ISP collaboration contributed to improved gender equality? Describe.
16. has the ISP support contributed to:
    a. Increase the capacity to formulate research problems, projects and proposals?
    b. Attract external research funding?
    c. Publish articles? If so, how?

17. Has the ISP support had any influence outside the research group?
18. How has the program impacted and influenced the:
    a. Academic quality?
    b. Research culture?
    c. Research environment?
    d. MSc and undergraduate training?
    e. System for academic promotions at the university?
    f. Policy, collaboration with ministries, industry and civil society? Give examples.

19. Are there any positive and negative unintended or intended effects from collaboration?
20. Have support been given in a way that enhances innovative processes and innovative thinking?
21. Has the program resulted in new products? New or changed practices? Describe the research groups' developments with regard to produced scientific innovations and links to private sector development and private-public partnerships.

Sustainability

22. Have research and postgraduate education activities continued after collaboration with ISP has ceased? Describe.
23. What funding do you currently have?
24. Do you have sufficient institutional capacity and mechanisms to maintain what is built up? Is anything missing?
25. Does your university have all preconditions to handle massive in-house postgraduate training? (E.g. critical mass of supervisors, infrastructure and management capacity)
26. Are there any bottlenecks for increased research capacity? What?

Relevance

27. How does the ISP collaboration fit with the policy and development priorities, needs and institutional capacity of the university? Would the university have preferred other arrangements for research cooperation?
28. Has the research conducted in your research groups been relevant to the overall development of your country? How? (Economy, health, technology advancement, gender equality, environmental sustainability etc.)

Funding

29. Have you had other funding partners (donors)?
30. If so, can you describe ISP compared to other international funding partners? Good/bad things?
31. To what extent has the university/faculty administration been involved in the funding?
32. How did you experience the ownership of the grant received by ISP and the handling of the budget?

ISP as a donor

33. Do you believe that the ISP phase out period was done in a responsible manner that promotes sustainability?
34. Did you get sufficient information of why the support was ending? Describe the reasons for the phase out.
35. Did ISP provide your research group with the sufficient tools on how to become more independent and self-reliant?
36. What would you say are the positive/negative consequences of the phase out period?
37. What are your suggested indicators for phase out of a research group?
38. In general, how can future ISP collaborations be improved?
39. What has been missing in the support?
40. What are your thoughts on the reporting mechanisms? Have they been adequate? (I.e. activity and progress reports)
41. If you look back, would you have done something different? Could better outcomes have been achieved if resources were used in a different way?
42. Could the Swedish partner universities play additional roles within the program or collaborated in a different way?
43. Anything you would like to add or ask?

Thailand

Background and historical overview

1. Background (education, number of year at the university, number of years as a group leader).
2. How did the ISP collaboration start?
3. Describe the situation at the institution before/at the beginning of the ISP-collaboration in terms of equipment, capacity, and available programs etc.
4. What was the nature of ISP support? How did it look/include for your group?
5. What would you say that the ISP support has contributed with? (Both in material and immaterial terms)
6. Have any additional activities developed as a result from the ISP support? (E.g. graduates or staff members from the groups have started up research groups or institutes elsewhere, etc.)
7. What has the ISP support meant to you? Value to the research group or personally?
8. What have been the challenges your group has faced during the time of the collaboration? (Internal and external)
9. How has the ISP support benefited your research group in comparison to (any) other groups who did not receive ISP support at the university?

Capacity building

10. What has been the overall objective of your group during the ISP period?
11. Have far do you believe you came in the fulfilment of that objective?
12. To what extent and how has the research training contributed to the intended research capacity building?
13. Has the program been successful in delivering outputs such as the number of students enrolled and the number of graduated PhD and MSc students?
14. Has the program impacted and influenced the academic quality? research culture? research environment? Or MSc and undergraduate training? In what way?
15. Did you have difficulties with students leaving the program? If so, what were reasons for any difficulties to finalize studies or for leaving the program?
16. Did many students go abroad after finishing their degree? Do you have any contact or collaboration with them?
17. What are your thoughts on the sandwich model?
18. How did you select sandwich students? And who gets to go to conferences and the number and length of abroad periods?

19. How did you experience the Swedish and Sri Lankan PhD supervision within the program? Including communication between supervisors, and supervisors and students.
20. Have your research group/network come to any interesting research findings since the phase out of support that you would like to share?
21. Have any of the research findings from your group/network had any influence on policy or practice in your country?

Relevance

22. Has the research conducted in your research groups been relevant to the overall development of your country? How? (Economy, health, technology advancement, gender equality, environmental sustainability etc.)

Funding

23. Have you had other funding partners (donors) at the same time as ISP?
24. If so, can you describe ISP compared to other international funding partners? Good/bad things?
25. To what extent has the university/faculty administration been involved in the funding?
26. How did you experience the ownership of the grant received by ISP and the handling of the budget?
27. Has your group/the university collaborated with the industry in any way? Describe.
28. Has the program resulted in new products? New or changed practices? Describe the research groups' developments with regard to produced scientific innovations and links to private sector development and private-public partnerships.

Sustainability

29. Have research and postgraduate education activities continued after collaboration with ISP has ceased? Describe.
30. What funding do you currently have?
31. Do you have sufficient institutional capacity and mechanisms to maintain what is built up? Is anything missing?
32. Does your university have all preconditions to handle in-house postgraduate training? (E.g. critical mass of supervisors, infrastructure and management capacity)
33. Are there currently any PhD students in your research group/network?
34. Approximately how many PhD graduations have your group/network had since the end of ISP support? And approximately how many publications in peer-reviewed international journals have your group/network had since the end of ISP support?

35. Approximately how many contributions to conferences/workshops/courses/meetings have your group/network had since the end of ISP support?
36. Has your group/network organized any conferences/seminars since the end of ISP support?
37. Are there any bottlenecks for increased research capacity? What?
38. At the present, do you have any contact with the former host department(s) in Sweden? If yes, what type of contact?
39. What are the future prospects and plans for your research group/network?

ISP as a donor

40. Describe the reasons given by ISP for phasing out support to your group/network?
41. Did you get sufficient information on why ISP decided to phase out support?
42. How far ahead were you informed by ISP that the support would end?
43. Was the time period given for phase out sufficient?
44. What would you say are the positive/negative consequences of the terminated ISP support?
45. Did you or your group have contact with ISP in any way after the end of support?
46. Based on your experience, how can ISP improve the phase out process?
47. Do you believe that the ISP phase out period was done in a responsible manner that promotes sustainability?
48. Did ISP provide your research group with the sufficient tools on how to become more independent and self-reliant?
49. What would you say are the positive/negative consequences of the phase out period?
50. In general, how can future ISP collaborations be improved?
51. What has been missing in the support?
52. What are your thoughts on the reporting mechanisms? Have they been adequate? (I.e. activity and progress reports)
53. Could the Swedish partner universities play additional roles within the program or collaborated in a different way?
54. Anything you would like to add or ask?
55. Would your group/network like ISP to issue a certificate of the ISP funding period? If yes, the responsible Program Director will contact you to discuss the content of the certificate.

Appendix 5. Collaborating host institutions

Table 1 and 2 list collaborating host institutions where Thai and Sri Lankan fellows and postgraduate students have spent periods of their research training.

Sri Lanka

Table 1. Collaborating host institutions Sri Lanka

Country	Institution	
Bangladesh	BIRDEM	Bangladesh Institute of Research & Rehabilitation in Diabetes, Endocrine and Metabolic Disorders, Bangladesh
Brazil	-	Unknown institution
Canada	U of M	University of Manitoba
Denmark	DTU	Technical University of Denmark
Denmark	KU	University of Copenhagen
Denmark	SDU	University of Southern Denmark
Finland	-	Finnish Meteorological Institute
India	BARC	Bhabha Atomic Research Centre
Italy	ICTP	International Centre for Theoretical Physics
Kenya	ICIPE	International Centre for Insect Physiology and Ecology
Pakistan	UOK	H.E.J. Research Institute of Chemistry, Karachi University
Sweden	CTH	Chalmers University of Technology
Sweden	KI	Karolinska Institutet
Sweden	LU	Lund University
Sweden	MIUN	Mid Sweden University
Sweden	KTH	Royal Institute of Technology
Sweden	SU	Stockholm University
Sweden	SLU	Swedish University of Agricultural Sciences
Sweden	UMU	Umeå University
Sweden	UU	Uppsala University
Switzerland	ETH	Swiss Federal Institute of Technology
Thailand	-	Mahidol University
UK	CWC	City of Westminster College
USA	UF	University of Florida

Thailand

Table 2. Collaborating host institutions Thailand

Country	Acronym	Institution
Germany	UB	University of Bremen
Sweden	CTH	Chalmers University of Technology
Sweden	LiU	Linköping University
Sweden	LTU	Luleå University of Technology
Sweden	LU	Lund University
Sweden	NFA	National Food Administration
Sweden	KTH	Royal Institute of Technology
Sweden	SU	Stockholm University
Sweden	GU	University of Gothenburg
Sweden	UU	Uppsala University
USA	IDD	Institute for Drug Development

Appendix 6. Expenditures Sri Lankan research groups

The expenditures of ISP funds of each group are presented here. In addition the amount of funding gained from other sources than ISP is also listed both during and in some cases also after the end of ISP support. The amount of other funding has been converted from the original currency to SEK, to be able to compare the share of funding received from other sources with the ISP expenditure. Due to the conversion the amounts are approximations and not exact numbers.

University of Colombo

Table 1. Expenditures IPICS SRI:02, Biochemistry, molecular biology and gene technology

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
1979–1987	1,337,000	-	-
1987/88	288,000	Sida/SAREC	515,000
1988/89	155,000	Sida/SAREC	750,000
1989/90	32,000	Sida/SAREC	340,000
1990/91	-	Sida/SAREC	270,000
1991/92	293,000	Sida/SAREC	642,000
1992/93	56,000	Sida/SAREC	727,000
1993/94	130,000	Sida/SAREC	780,000
1994/95	-	Sida/SAREC	1,000,000
1995/96	203,000	Sida/SAREC	800,000
1996/97	4,000	Sida/SAREC	2,250,000
1997/98	1,000	Sida/SAREC	1,900,000
1999	35,000	Sida/SAREC	2,000,000
2000	10,000	Sida/SAREC	2,500,000
2001	-	Sida/SAREC	2,500,000
2002	-	Sida/SAREC	2,000,000
Total	**2,544,000 SEK**		**18,974,000 SEK**
2003	-	Sida/SAREC	2,000,000
2004	-	Sida/SAREC	
2005	-	Sida/SAREC 2004–2007	5,000,000
2006	-	Sida/SAREC	
2007	-	Sida/SAREC	

Table 2. Expenditures IPPS SRI:01/1, Atmospheric physics and lightning

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
1978	61,000	-	-
1979	74,000	-	-
1980	19,000	-	-
1981	72,000	-	-
1982	2,000	-	-
1983	32,000	-	-
1984	93,000	-	-
1985	235,000	-	-
1986	207,000	-	-
1987	313,000	-	-
1988	74,000	-	-
1989	92,000	University of Colombo	3,000
1990	173,000	-	-
1991	291,000		
1992	214,000	JICA	7,900
		NARESA	600
1993	153,000	NARESA	10,900
		JICA	N/A
1994	52,000	NARESA	9,600
		UGC	20,000
1995	260,000	-	-
1996	756,000	NARESA	154,100
		UGC	17,400
1997	548,000	NARESA	183,400
1998	470,000	-	-
1999	126,000	University of Colombo	2,900
		NSF	37,200
2000	255,000	-	-
2001	235,000	NSF	33,600
		University of Colombo	2,600
2002	572,000	University of Colombo	1,000
		NSF	14,600
2003	825,000	ADB	242,700
2004	720,000	NSF	9,800
2005	873,000	NSF	54,700
2006	528,000	NSF	54,700
2007	449,000	NSF	6,500
2008	379,000	EU - EURECA	102,200
2009	474,000	-	-
2010	213,000	-	-
Total	**9,840,000 SEK**		**969,400 SEK**
2011	-	-	-
2012	-	NRC 2012–2015	233,300
		Higher education for twenty first Century (World Bank) 2012–2015	344,100
		Erasmus Mundus	1 PhD Fellowship
2013	-	University of Colombo 2013–2016	166,700

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
2014	-	University of Colombo 2014–2017	163,400
		Erasmus Mundus	1 PhD Fellowship

Table 3. Expenditures IPPS SRI:01/2, Molecular desorption mass spectrometry (PDMS)

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
1981	68,000	-	-
1982	145,000	-	-
1983	151,000	-	-
1984	26,000	-	-
1985	244,000	-	-
1986	66,000	-	-
1987	217,000	University of Colombo	1,000
1988	311,000	University of Colombo	1,187
1989	180,000	-	-
1990	0	-	-
1991	163,000	-	-
1992	254,000	University of Colombo	1,500
1993	23,000	NARESA	15,600
1994	208,000	TWAS	38,600
1995	388,000	-	-
1996	604,000	NARESA	70,000
1997	478,000	NARESA	22,900
1998	723,000	NSF	31,800
1999	430,000	NSF	33,100
		UGC - PhD student award	8,270
2000	778,000	NSF	9,200
		UGC - PhD student award	9,200
2001	451,000	NSF	8,300
		UGC - PhD student award	10,300
2002	330,000	UGC – PhD student award	9,700
2003	315,000	-	-
2004	615,000	-	-
2005	876,000	-	-
2006	413,000	-	-
2007	47,000	-	-
2008	89,000	-	-
2009	54,000	-	-
2010	197,000	-	-
Total	**8,844,000 SEK**		**270,657 SEK**

Table 4. Expenditures IPPS SRI:01/3, Strengthening of the activities of the Centre for Instrument Development (CID)

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
2005	99,000	NSF	29,900
		NSF	33,400
2006	61,000	NSF	59,100
		Fees from MSc Program in Applied Electronics	177,400
2007	60,000	NSF (three years)	176,000
		NRC (two years)	58,700
2008	75,000	-	-
2009	172,000	-	-
2010	77,000	-	-
Total	**544,000 SEK**		**534,500 SEK**

University of Peradeniya

Table 5. Expenditures IPICS SRI:03, Bioactive compounds in the control of plant diseases (from 1993)

Year	ISP funding spent (SEK)	Other sources of funding		Amount (SEK)
1981–88	779,000	-		-
1989	248,000	-		-
1990	56,000	-		-
1991	278,000	-		-
1992	251,000	-		-
1993	206,000	-		-
1994	407,000	Sida/SAREC		
1995	213,000	Sida/SAREC	1994–1996	2,500,000
1996	112,000	Sida/SAREC		
1997	50,900	Sida/SAREC		
1998	27,000	Sida/SAREC	1997–1999	6,300,000
1999	-	Sida/SAREC		
2000	44,000	Sida/SAREC		
2001	54,000	Sida/SAREC		
2002	26,000	Sida/SAREC	2000–2004	4,900,000
Total	**2,752,000 SEK**			**13,700,000 SEK**
2003	-	Sida/SAREC		
2004	-	Sida/SAREC		

Table 6. Expenditures IPPS SRI:02, Condensed matter physics

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
1984	96,000	-	-
1985	199,000	-	-
1986	242,000	-	-
1987	206,000	-	-
1988	283,000	-	-
1989	352,000	-	-
1990	327,000	-	-
1991	523,000	EU - EEC	606,000
1992	431,000	-	-
1993	625,000	-	-
1994	609,000	-	-
1995	512,000	-	-
1996	1,363,000	EU - EEC	13,400
		University of Peradeniya	
			33,500
1997	450,000	-	-
1998	528,000	-	-
1999	822,000	-	-
2000	670,000	-	-
2001	826,000	University of Peradeniya	51,700
		Post Graduate Institute of Science	51,700
		NSF	155,000
2002	703,000	University of Peradeniya	58,300
		Post Graduate Institute of Science	29,200
		NSF	48,600
2003	296,000	University of Peradeniya	32,400
		Post Graduate Institute of Science	16,200
		NSF	40,500
2004	738,000	University of Peradeniya	14,700
		Post Graduate Institute of Science	14,700
		NSF	51,500
		Grenoble Institute of Technology	58,800
2005	488,000	University of Peradeniya	3,800
		Post Graduate Institute of Science	3,800
		NSF	44,900
		Grenoble Institute of Technology	7,500
2006	188,000	University of Peradeniya	3,700
		Post Graduate Institute of Science	3,700
		NSF	73,900
2007	109,000	University of Peradeniya	3,300
		Post Graduate Institute of Science	3,300
		NSF	65,200
2008	252,000	NSF	71,400
		University of Peradeniya & Post Graduate Institute of Science	7,100
2009	1,037,000	-	-
2010	238,000	-	-
Total	**13,113,000 SEK**		**1,567,800 SEK**

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
2012	-	NSF	132,700
2013	-	HETC grant	63,900
2014	-	-	-

University of Jaffna

Table 7. Expenditures IPICS SRI:04, Biotechnology of starch and sucrose (palmyrah) based products

Year	ISP funding spent (SEK)	Other sources of funding		Amount (SEK)
1985/89	49,000	-		-
1989	221,000	-		-
1990	1,000	-		-
1991	52,000	-		-
1992	259,000	-		-
1993	187,000	-		-
1994	176,000	-		-
1995	307,000	-		-
1996	203,000	-		-
1997	162,000	-		-
1998	-	-		-
1999	33,000	-		-
2000	316,000	Sida/SAREC		
2001	150,000	Sida/SAREC	2000–2002	2,000,000
2002	229,000	Sida/SAREC		
2003	87,000	Sida/SAREC		
2004	69,000	Sida/SAREC		
2005	14,000	Sida/SAREC		
2006	15,000	Sida/SAREC	2003–2010	6,000,000
Total	**2,530,000 SEK**			**5,000,000 SEK**
2007		Sida/SAREC		
2008		Sida/SAREC		
2009		Sida/SAREC		
2010		Sida/SAREC		
2011		Fonterra Sri Lanka	2011–2012	55,600
2012				
2013		NRC	2013–2015	228,200
2014				
2015				

University of Sri Jayewardenepura

Table 8. Expenditures IPICS SRI:07, Nutritional biochemistry

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
1995/96	141,000	-	-
1996/97	327,000	-	-
1997/98	264,000	-	-
1999	492,000	-	-
2000	281,000	-	-
2001	55,000	-	-
2002	256,000	-	-
2003	342,000	-	-
2004	284,000	-	-
2005	281,000	NSF	120,700
2006	192,000	NRC	76,100
2007	232,000	IFS	76,300
2008	181,000		
2009	86,000	Improving Relevance and Quality of Undergraduate Education	11,200
Total	**3,414,000 SEK**		**284,300 SEK**
2010	-	-	-
2011	-	NSF	207,200
2012	-	NSF	166,500
		University of Sri Jayewardenapura	205,400
2013	-	University of Sri Jayewardenapura	38,900
2014	-	University of Sri Jayewardenapura	65,400

Appendix 7. Expenditures Thai research groups

The expenditures of ISP funds of each group are presented here. In addition the amount of funding gained from other sources than ISP is also listed for the period of ISP support. The amount of other funding has been converted from the original currency to SEK, to be able to compare the share of funding received from other sources with the ISP expenditure. Due to the conversion the amounts are approximations and not exact numbers.

Chulalongkorn University

Table 1. Expenditures IPPS THA:01, Semiconductor physics/Chalcopyrite semiconductors and applications

Year	ISP funding spent (SEK)	Other Source of funding	Amount (SEK)
1985	11,000	-	-
1986	20,000	-	-
1987	65,000	-	-
1988	45,000	-	-
1989	102,000	-	-
1990	284,000	-	-
1991	166,000	-	-
1992	92,000	Chulalongkorn University	50,000
		MTEC	4,000,000
1993	18,000	-	-
1994	144,000	Chulalongkorn University	N/A
		MTEC	N/A
1995	-	-	-
1996	52,000	Chulalongkorn University	20,100
		MTEC	804,000
		NRC	80,400
1997	68,000	Chulalongkorn University	76,400
1998	3,000	-	-
1999	24,000	-	-
2000	56,000	-	-
2001	54,000	-	-
2002	71,000	MTEC	80,900
		Ministry of the University Bureau	202,300
		Chulalongkorn University	40,500
2003	10,000	-	-
Total	**1,285,000 SEK**		**5,354,600 SEK**

Chiang Mai University

Table 2. Expenditures IPPS THA:03/1, Plasma, neutron and ion beam technology

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
1982	36,000	-	-
1983	114,000	-	-
1984	114,000	-	-
1985	136,000	-	-
1986	231,000	-	-
1987	293,000	NRC	41,300
		IAEA	15,900
		ISTRD	6,400
		Royal Thai Army	15,200
		Royal Thai Army	14,700
1988	333,000	Royal Thai Army	15,500
1989	134,000	MTEC	177,900
1990	329,000	MTEC	181,800
1991	365,000	Chaiyong Limthongkul Foundation	70,800
1992	164,000	MTEC	233,600
		IAEA	408,800
		NRC	98,300
1993	152,000	IAEA	308,400
1994	109,000	MTEC	385,500
		NSTDA	154,200
1995	197,000	IAEA	285,200
		MTEC	356,500
		NSTDA	144,600
1996	28,000	IAEA	33,500
		TRF	134,000
		MTEC	67,000
1997	4,000	TRF	458,400
		MTEC	229,200
		NRC	76,400
1998	54,000	TRF	477,000
		MTEC	95,400
		NRC	47,700
1999	29,000	TRF	413,500
		MTEC	206,800
2000	159,000	-	-
2001	22,000	TRF	550,200
		MTEC	256,800
		NECTEC	159,000
		IAEA	45,900
2002	108,000	TRF	486,000
		MTEC	330,500
		NECTEC	488,400
2003	70,000	TRF	404,500
		MTEC	202,300
		NECTEC	202,300

Year	ISP funding spent (SEK)	Other sources of funding	Amount (SEK)
2004	6,000	TRF	367,500
		MTEC	367,500
		NRC	2,572,500
2005	24,000	TRF	374,000
		MTEC	374,000
		NRC	2,618,000
		Thailand Textile Institute	374,000
		TRF	142,100
TOTAL	**3,211,000 SEK**		**15,469,000 SEK**

Price of Songkla University

Table 3. Expenditures IPICS THA:03, Trace metals and trace organics in the outer Songkla Lake and in natural water

Year	ISP funding spent (SEK)	Other Source of funding	Amount (SEK)
1984/88	344,000	N/A	N/A
1989	134,000	N/A	N/A
1990	337,000	N/A	N/A
1991	159,000	N/A	N/A
1992	310,000	N/A	N/A
1993	176,000	N/A	N/A
1994	221,000	N/A	N/A
Total	**1,681,000 SEK**		**N/A**

Table 4. Expenditures IPPS THA:04, Geophysics

Year	ISP funding spent (SEK)	Other Source of funding	Amount (SEK)
1987	110,000	-	-
1988	72,000	Prince of Songkla University	6,500
1989	246,000	-	-
1990	189,000	Prince of Songkla University	132,800
1991	159,000	-	-
1992	495,000	Prince of Songkla University	67,700
1993	258,000	EGAT	561,600
1994	398,000	Thai Government	246,700
1995	77,000	-	-
1996	322,000	Thai Government	201,000
		Prince of Songkla University	26,800
1997	394,000	Thai Government	226,400
		Southern Culture Institute	19,100
1998	196,000	Southern Culture Institute	19,900
		Prince of Songkla University	39,800
1999	337,000	Prince of Songkla University	378,500
2000	525,000	GFE Company	52,700
		TTSF	64,200

Year	ISP funding spent (SEK)	Other Source of funding	Amount (SEK)
		Prince of Songkla University	605,200
2001	339,000	IRDC Exploration and Mining Co., Ltd.	72,300
2002	11,000	Health System Research Institute	29,200
		IRDC Exploration and Mining Co., Ltd.	49,600
2003	455,000	Prince of Songkla University	77,700
		IRDC Exploration and Mining Co., Ltd.	39,600
2004	503,000	Department of Fine Arts	11,000
		Prince of Songkla University	51,500
2005	696,000	Prince of Songkla University	65,500
2006	279,000	TTSF	37,000
		Prince of Songkla University	18,500
		Swedish Research Links	64,700
2007	127,000	TTSF	32,600
		Prince of Songkla University	16,300
		Swedish Research Links	88,000
2008	9,000	-	-
Total	**6,197,000 SEK**		**3,302,400 SEK**

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