The International Science Programme at Uppsala University: 50 years experience of capacity building in basic sciences in developing countries

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Abstract

The International Science Programme (ISP) is devoted to building capacity for scientific research and higher education in basic sciences in developing countries, since 1961 in physics, 1970 in chemistry and 2002 in mathematics. Long-term support is provided to goal-oriented research groups and "sandwich" postgraduate training, with host groups at numerous institutions at Swedish universities and elsewhere. Also regional collaboration and scientific networks are supported. ISP has an internationally constituted Board, and three advisory Scientific Reference Groups. The Swedish International Development Cooperation Agency (Sida) is the main financial contributor to the program, next to Uppsala University. Recently, financial support also by Stockholm University was initiated. ISP recognises that interdisciplinary and applied research, and technology development are important to a number of development challenges. Still, the basic sciences are the pillars on which applied sciences and engineering rest. Increased domestic capacity for research and higher education in basic sciences has a long-term impact on economic growth and poverty alleviation, driven by an increasingly knowledge-based society. The importance of continued support to basic sciences in developing countries was further stressed in a recent evaluation of ISP. The country-based selection of ISP support to research groups has shifted over the years. In 2011, ISP was supporting 30 research groups in total, in Burkina Faso, Ethiopia, Kenya, Mali, Uganda, Zambia, and Zimbabwe in Africa, and in Bangladesh, Cambodia, and Laos in Asia. Support to scientific networking partly compensates for limited resources, facilitating the strengthening of certain scientific fields by south-south collaboration including the sharing of instrumentation and training. In 2011, ISP supported 12 scientific networks in Africa, two in Asia, and one in Latin America.

ISP funding is based on "application by invitation" because support is usually initiated at academic institutions that have not yet reached a degree of excellence that will give them a chance to win grants in open competition. In most cases, ISP support is phased out when an activity has reached a level that will allow for its continued development to be supported by other funding. In the period 2003-2009, ISP phased out support to 33 research groups and four scientific networks not expected to require further ISP funding. These had been supported on average for 17 years, reflecting the time necessary to achieve stability in the conditions for research and higher education in the partner countries. The outcome of ISP support in the last three decades is substantial and consistent with regard to awarded degrees and the dissemination of scientific results by supported research groups and networks. Regardless of subject program and period studied during the last three decades, the outcomes of supported activities per million EUR spent are generally about 12 PhDs, *plus* close to 50 Masters, *plus* around 60 international publications, *plus* more than 100 contributions to scientific conferences, *plus* a substantial number of meetings arranged, *plus* the development of technical resources and scientific contacts to facilitate outcomes. Thus, future ISP support, if operated similarly, can be expected to result in a fairly predictable outcome with regard to the development of academic capacity and the dissemination of scientific findings.

A recent evaluation of ISP concluded that published papers reveal from high to satisfactory levels of research work with a level of citations above world benchmarks. The loss of academics from ISP supported groups and networks to more technically developed countries ("brain drain") has been concluded to be low by studies made so far, although alumni have not been monitored systematically. To document and prove the impact of the program, the monitoring and evaluation system must be further developed to systematically cover quality and use of results achieved by ISP-supported activities, as well as the impact of ISP support including contribution of ISP alumni to development. The gender distribution of participating postgraduate students approaches 50% with the chemistry program, but female participation is less than 20% in the mathematics and physics programs. This is maybe due to structural factors influencing female participation already at earlier stages in the educational systems.

The International Science Programme (ISP) is devoted to building capacity for scientific research and higher education in basic sciences in developing countries, since 1961 in physics, 1970 in chemistry and 2002 in mathematics.

The program originates in ideas conceived in the 1950s when it was observed that, although Uppsala University attracted students and researchers from many countries, few came from developing countries. At the Institute of Physics the idea emerged of forming a special organisation stimulating the participation of scientists from developing countries, and facilitating and providing contacts, travels, fellowships, accommodation, and medical and social care in Sweden (Lindqvist, 2001). As a result, the International Seminar in Physics was launched in 1960, to which were invited scientists, with priority given to developing countries, and a first batch of trainees arrived at the start of the activities in 1961. A similar program in chemistry was started in 1970.

In 1988, major changes in the mode of operation of the programs were implemented, and they were collected under the common name of the International Science Programs (ISP). This development has been described in detail by Liminga (1996) and Lindqvist (2001). In brief, the program was developed to address long-term support to goal-oriented research groups and "sandwich" postgraduate training. The "sandwich" mode of training, mixing training sessions at host groups abroad with work at the home institution, was discussed already in 1967 (Lindqvist, 2001), and was beginning to be applied in the 1970s. Host groups for "sandwich" training were selected to match the needs of the supported research groups, implying a widening of cooperation to a national level comprising numerous institutions at other Swedish universities. When called for, collaboration with host groups at universities outside Sweden, and with leading institutions in the regions, was introduced. Support for regional collaboration and the formation of scientific networks was initiated already in the early 1980s, but this was considerably expanded from 1988.

In 1988, ISP's position at Uppsala University was consolidated by a government ordinance stating that:

> "the task of ISP is to initiate and support long-term scientific research collaboration between foremost Swedish institutions and institutions in the developing countries, with the objective to build research capacity at universities and research institutes in developing countries within different research programs. ISP shall also promote regional cooperation between developing countries in the fields of science addressed by the program."

Thus, the responsibility of ISP to include other Swedish institutions in the collaboration support was emphasised, underpinning ISP's role as a national resource. Furthermore, the strategy to support south-south collaboration and regional scientific networks was encouraged.

In 1999, ISP forwarded an application to the Swedish International Development Cooperation Agency (Sida) proposing an expansion of activities to include biology, geosciences, and mathematics, partly based on recommendations in an earlier evaluation of the program (Edqvist *et al*., 1994). Funding was granted for a workshop in Africa, South of the Sahara, in order to find out about the situation for mathematics in that region and to come up with suggestions as to what a program to strengthen mathematics there should look like. The workshop was organised on 19-21 November in Arusha, Tanzania, following a status assessment earlier that year (Abrahamsson, 2002). It was recommended in the workshop that existing regional centers should be supported and new ones created. The International Programme in the Mathematical Sciences (IPMS) was launched in 2002 (Abrahamsson, 2003), and initially comprised support to a scientific network, the East African Universities Mathematics Program (EAUMP), originally consisting of the departments of mathematics at the University of Nairobi, Kenya, the University of Dar es Salaam, Tanzania, and Makerere University, Uganda, and to the National Centre for Mathematical Sciences (currently the Institute for Mathematical Sciences, IMS), Accra, Ghana.

ISP is governed by an internationally constituted Board, nominally chaired by the vice-chancellor of Uppsala University. From 2001, advisory panels were formalised, in the shape of Scientific Reference Groups, to support the three subject programs with an expanded scientific competence (Sundin, 2012).

The continued operation of the International Science Programme (ISP) is today made possible by funding from the Sida, which took this responsibility from its inception in 1965. Among earlier financial contributors were also IAEA and UNESCO, and NORAD. In 1978, the government agency SAREC took over the main funding. In 1993 SAREC was merged with Sida, but continued to be the main funding entity of ISP until October 2008 when it was resolved as a Sida department. ISP funding was then administered by Sida, through its Secretariat for Research Co-operation.

Sida and SAREC have been the most prominent collaborators, discussion partners, financing bodies, and drivers in developing ISP to its present position.

Uppsala University is the scientific and administrative home of ISP and has also provided substantial funding since 1988. From 2011, Stockholm University started providing financial support to ISP, reflecting the successful cooperation of the program with Stockholm University as one of many Swedish institutions.

Strategy and Operation

ISP support to basic sciences in developing countries in most cases is used for applied research in the fields of chemistry, mathematics, and physics; for example environmental chemistry, mathematical modeling of water resources, and solar cell physics. In some cases fundamental studies are carried out by supported activities; for example, in coordination chemistry, algebraic topology, and magnetism.

The support to basic sciences dates back to the origin of the program, but at a conference in 1995 regarding development-oriented research in basic sciences (Carlman and Strömholm, 1995) it was declared that a foundation in the basic sciences is essential for all research in the applied sciences and for long-term development.

ISP recognises that interdisciplinary and applied research, as well as scientifically based technology development, is important in addressing a number of development challenges, but that basic sciences form the pillars on which applied sciences and engineering rest. Without a proper scientific base it is difficult to sustain research and technology that can contribute well to development and create solutions meeting local needs. Increased domestic capacity for research and higher education in basic sciences has a long-term impact on economic growth and poverty alleviation, driven by an increasingly knowledge-based society. A country's domestic competence in basic sciences is crucial for:

- an increased quality of education, at all levels,
- the development of scientific, critical thinking based on reproducible evidence (promoting rational governance and democracy development),
- the development of applied sciences to meet local needs,
- the development of technology, innovation, and engineering on a local ownership basis,
- the adoption of a sustainable use of natural resources,
- the engagement in business and global trade at a level of knowledge which matches global partners, industry, investors, and suppliers of commodities,
- the development of scientific excellence on own terms giving international recognition and self esteem.

In a recent evaluation (GDH, 2011), the approach of ISP is strongly supported and several reasons are given why capacity for science is needed and relevant to development efforts:

- Most of the flagship breakthroughs in development and poverty reduction have science at their core.
- Research in the [basic] sciences is a "public good", and often a global public good.
- Expenditure on [basic] sciences is low, both by developing country governments and their development partners.
- Market forces are such that OECD research institutes, and companies, rarely invest in research of direct interest to developing countries.
- [Basic] science underpins productivity and international competitiveness.
- [Basic] science provides the evidence base for responding to many of the most basic challenges facing developing countries.
- Research and training need long-term investments.

Also, the Swedish Policy for Development Cooperation, 2010-2014, stresses the need to strengthen and develop scientific research in developing countries as a means for strategically combating poverty (Government Offices of Sweden, 2010).

Regarding Africa, the World Bank (2009) concluded that constraints at the level of tertiary education are now impeding growth in much of the region. This indicates an increased awareness of the significance of support to research and higher education in general, where the basic sciences are fundamental to other fields of science.

ISP support collaboration aims at creating sustainable research groups and scientific networks with strong local ownership, and has a long-term approach. South-north collaboration is an important component in the support modality, based on the needs of the collaboration partner in the south, and relevant to the development strategy in the country where the support is received.

The country-based selection of ISP support has shifted over the years. From 1973, the supported activities were mainly in the least developed countries, primarily Sida program countries (Liminga, 1996). In August 2007, the Swedish government issued a new development support policy (Government Offices of Sweden, 2007). As a result of the new policy, Sida decided in 2008 that ISP's research group support must be shifted to a group of twelve "focus countries". The countries are in Africa: Burkina Faso, Ethiopia, Kenya, Mali, Mozambique, Rwanda, Tanzania, Uganda and Zambia; in Asia: Bangladesh and Cambodia, and in Latin America: Bolivia. This resulted in the phase-out of ISP support, as financed by Sida, for example, to research groups in Laos and Malawi, while new support to groups in Burkina Faso, Kenya, Mali, Zambia, and Cambodia was initiated in 2009-2011. In 2011, ISP was supporting 30 research groups in total in Burkina Faso, Ethiopia, Kenya, Mali, Uganda, Zambia, and Zimbabwe in Africa, and in Bangladesh, Cambodia, and Laos in Asia, using Sida funding.

Support to scientific networking partly compensates for limited resources, facilitating the strengthening of certain scientific fields by south-south collaboration including sharing instrumentation and training. Scientific networks may be fully or partly supported by ISP, operate in a variety of fashions (Kiselman, 2011; Sundin 2011), and are not directly affected by the focus country policy. The Sida position in 2008 was to emphasise the importance of focus countries benefitting from ISP network support. In 2011, ISP supported 12 scientific networks in Africa, two in Asia, and one in Latin America.

A particular feature of the ISP operation strategy is that support to research groups is initiated by selection, following thorough investigation of the local conditions, policies, needs, and preferences, and discussions initially at department and faculty levels. It has been pointed out by Sida, and most recently in the 2011 evaluation (GDH, 2011), that there is a risk for a lack of transparency in this process.

The basic reason for the ISP practice of "application by invitation" is that support is usually initiated at academic institutions that have not yet reached a degree of excellence that will give them a chance to win grants in open competition. The practice was initiated in the 1980s when funding to an increasing degree would need to suffice for a fewer number of research groups supported on a long-term basis (rather than shorter term training of individual scientists responding to open calls). From 2009 the selection process has been made more transparent, by formally directing the invitation at the department level. It should be pointed out, however, that this approach was essentially applied by the mathematics program from its start in 2002. Following the recommendations given in the evaluation, the practices are to be developed further in order to additionally increase transparency, and to consider introducing competition for grants where feasible.

Throughout ISP collaboration, efforts of supported activities to receive funding from other agencies is encouraged, and the nominal exit strategy is engaged when an activity has reached a level that will allow for its continued development supported by other funding, from the country's own government or awarded in competition with other scientists. A phase-out period will then be initiated.

Results

International Science Programme, ISP

In the eight-year period 2003–2010, support was provided to up to 50 research groups and 21 scientific networks annually, with the total expenditure by supported activities averaging at approximately 2.0 million EUR annually. Over this period the following results were achieved for each million EUR spent by supported activities:

- 12 PhD graduations, *plus*
- 50 MSc graduations, *plus*
- 64 publications in international journals, *plus*

- 34 publications in regional and local journals, *plus*
- 127 conference contributions (40% of which to international conferences), *plus*
- 21 meetings organised (workshops, conferences, summer schools, etc.), *plus*
- development of technical resources within research groups and networks, as well as increased collaboration with scientists at, for example, Swedish universities and in the regions.

The scientific quality of disseminated results and defended theses has so far not been systematically investigated. However, a quality review was carried out regarding the scientific publications in 2010 (ISP, 2011), and considered in the 2011 evaluation (GDH, 2011). It was concluded that published papers reveal from high to satisfactory levels of research work with a level of citations above world benchmarks.

The current mode of ISP operation has evolved over many years and is known to have a very low rate of "brain drain", i.e. loss of trained academics to more technically developed countries, much thanks to the "sandwich" model of postgraduate training. As pointed out in the 2011 evaluation (GDH, 2011), though, the evidence supporting this has not been collected systematically and continuously. An early study, in 1976, covering 263 ISP "fellows", found that only 4% had moved to an "industrialized country" (Lindqvist, 2001). Lindqvist (2001) also stated that "when the programme evolved into giving long-term support to research teams, the brain drain has been even lower." Liminga (1996) observed that brain-drain was a matter of concern in the 1970s, and the chemistry program lost a few participants in particular due to drastic political changes in the participants' home countries. When the program was later developed to address long-term support to goal-oriented research groups and "sandwich" postgraduate training, this problem was largely eliminated. These statements are in agreement with the review of 22 supported research groups in physics as reported in 2009 (van Groningen 2010), where it was concluded that out of 362 people trained only 2.5% stayed in an industrialised country.

In the period 2003 – 2009, ISP phased out support to 33 research groups and four scientific networks (Table 1) not expected to require further ISP funding. Support to another four networks was phased out because their activities came to a halt, or (in one case) ISP support was not longer considered justified. Essentially, all remaining support for activities in Latin America ceased during this period, as well as support in Sri Lanka and in Thailand in Asia. The support phased out in countries in Africa was mainly to research groups in countries no longer classified as "least developed".

Regarding these 37 activities, the number of years of support ranged between 3 and 29, with an average of 17 years, and 19 years being the median. This indicates a bias towards longer term support within the range, which reflects the

time necessary to achieve stability in conditions allowing for continued research and higher education in the partner countries.

Table 1. Research groups (RG) and scientific networks (NW) phased out of ISP support 2003 – 2009 because satisfactory operation on other funding could be expected.

Type	Field of Science	Location	Region	Initial year	Final year	No. of years
NW	Biochemistry	Interregional	Interregional	1999	2008	9
RG	Biochemistry	Cameroon	Africa	1988	2008	20
RG	Natural products chemistry	Cameroon	Africa	1991	2008	17
RG	Mathematical sciences	Ghana	Africa	2002	2010	8
RG	Laser spectroscopy	Ghana	Africa	2005	2010	5
RG	Natural products chemistry	Nigeria	Africa	1977	2004	27
RG	Food chemistry	Nigeria	Africa	2002	2005	3
RG	Geophysics	Nigeria	Africa	1984	2010	26
RG	Meteorology	Nigeria	Africa	1997	2009	12
RG	Laser spectroscopy	Senegal	Africa	2005	2010	5
RG	Biochemistry	Tanzania	Africa	1981	2005	24
RG	Natural products chemistry	Bangladesh	Asia	1977	2004	27
RG	Medicinal chemistry	Bangladesh	Asia	1995	2008	13
RG	Crop protection	Sri Lanka	Asia	1981	2003	22
RG	Biotechnology	Sri Lanka	Asia	1985	2004	19
RG	Food chemistry	Sri Lanka	Asia	1995	2009	14
RG	Atmospheric physics	Sri Lanka	Asia	1978	2010	32
RG	Mass Spectroscopy	Sri Lanka	Asia	1981	2010	29
RG	Instrumental development	Sri Lanka	Asia	2005	2010	5
RG	Materials science	Sri Lanka	Asia	1984	2010	26
RG	Materials science	Thailand	Asia	1982	2004	22
RG	Geophysics	Thailand	Asia	1987	2007	20
RG	Biochemistry	Colombia	Latin Am	1987	2004	17
RG	Food chemistry	Colombia	Latin Am.	1992	2004	12
RG	Materials science	Colombia	Latin Am.	1976	2004	28
RG	Materials science	Colombia	Latin Am.	1985	2005	20
RG	Food chemistry	Ecuador	Latin Am.	1984	2007	23
RG	Materials science	Ecuador	Latin Am.	1992	2006	14
NW	Food Chemistry	Latin Am.	Latin Am.	1994	2007	13
NW	Biochemistry	Latin Am.	Latin Am.	2003	2007	4
NW	Biochemistry	Latin Am.	Latin Am.	1994	2006	12
RG	Materials chemistry	Peru	Latin Am.	2002	2006	4
RG	Chemical ecology	Peru	Latin Am.	2003	2007	4
RG	Materials science	Peru	Latin Am.	1983	2009	26
RG	Materials science	Peru	Latin Am.	1982	2006	24
RG	Biochemistry	Uruguay	Latin Am.	1978	2005	27
RG	Biotechnology	Uruguay	Latin Am.	1974	2003	29

The gender distribution of staff and students in supported research groups and scientific networks has been monitored throughout the history of the program. In the period 2003 to 2010, the average proportions of female PhD students were 39%, 11%, and 13%, in the chemistry, physics, and mathematics programs, respectively. The corresponding figures for MSc students were 54%, 18%, and

18%, respectively. In this eight-year period, the only tendencies have been a decline in the proportion of female students in the chemistry program, which is most likely because of the phase-out of support to research groups in Latin America and Asia, which attracted a large proportion of female students. The relatively low proportion of female students in the physics and mathematics program may be due to structural factors influencing female participation already at earlier stages in the educational systems, and seems difficult to improve by stimulating female participation only at the postgraduate level.

International Programme in the Chemical Sciences, IPICS

The results of the chemistry program in the years 1970-1995 have been accounted for by Liminga (1996), and in 1996-2009 with respect to Africa by Sundin (2012). From the mid-1980s to 1995 support was provided to eight research groups in Africa. To allow for comparison with the results of ISP in total in 2003-2008 (see above), SEK was converted to EUR at a 10:1 rate (although the EUR currency did not exist at that time). Calculated this way, the outcome in the early years of support to African research groups was eight PhD graduations, *plus* 40 MSc graduations, *plus* 93 international publications, *plus* 47 conference reports, per "million EUR".

In the period 1996-2009 support was provided to between six and 14 research groups in Africa, resulting in 14 PhD graduations, *plus* 27 MSc graduations, *plus* 59 international publications, *plus* 12 other publications, *plus* 11 arranged meetings, per "million EUR".

International Programme in the Mathematical Sciences, IPMS

The Mathematics program celebrates its tenth anniversary in 2012. One of the activities supported from the beginning of the program, EAUMP, celebrating 10 years of successful networking, will arrange a scientific conference in Arusha, Tanzania, 22-25 August, 2012. The conference proceedings are planned to, among other things, account for the first 10 years of the mathematics program.

The IPMS support has so far (up to May 2012) resulted in 15 PhD graduations, the first ones in 2008, after six years of operation of the program: three students from Cameroon, two from Ethiopia, two from Ghana, one from Kenya, three from Senegal, two from Tanzania, and two from Uganda. About another 20 PhD students are currently being trained, and some of them are expected to graduate in 2012 or 2013. With the exception of those from Ghana, who were in Sweden full time, these students, selected by the institutions supported, have been trained in "sandwich" programs, that is, they have spent yearly periods with scientific hosts (being collaborating supervisors) abroad. The expenditures by the supported activities in the period 2002-2011 were about 27 million SEK. Thus, the number of PhD graduations from the start of the program was close to 6 per million EUR spent.

The collaborating supervisors to the mathematics program are at 11 Swedish institutions of higher education, including Uppsala University, and at institutions

in Austria, Ireland, Norway, and the UK.

International Programme in the Physical Sciences, IPPS

The results of the physics program have not yet been comprehensively compiled since the start in 1961, but have been recorded in so-called Project Catalogues (1992, 1994, 1995, 1995/96, 1997, and 2002), written by the former director of IPPS, Lennart Hasselgren, or Activity Catalogues (van Groningen, 2010).

In the period 1961-2002, fellowships were issued by IPPS or, in the later part of the period, by supported research groups to 575 individuals to spend one month or more with 17 host groups at Uppsala University, 33 at other Swedish universities, 14 in Europe (in Denmark, Finland, Germany, France, Spain, Switzerland, and the UK), one in the USA, and 45 in the regions (in Africa in Botswana, Ethiopia, South Africa, and Tanzania; in Asia in Bangladesh, India, Thailand and Vietnam; and in Latin America in Argentina, Brazil, Cuba, Chile, Ecuador, Mexico, and Uruguay), (Hasselgren, 2004). Of the fellowship holders, 107 came from Africa, 266 from Asia, 108 from Latin America, and 24 from Europe. (East European participation was the case in the early years of the "seminar" program).

Table 2. Research groups in Physics in Africa, Asia, and Latin America (Lat. Am.) supported by the International Programme in the Physical Sciences (IPPS) in 2002. The outcome is listed in terms of PhD and MSc graduations, international peer-reviewed publications, and reports at scientific meetings, per "million Euro" funding. The average duration of support to the groups in each region is given.

Region	No. of groups	Average support duration, years	PhD grad. per MEUR*	MSc grad. per MEUR*	Internatl. Publ. per MEUR*	Conf. Reports per MEUR*
Africa	11	15	11	48	63	85
Asia	5	21	11	28	44	114
Lat. Am.	5	19	15	28	115	214
Total	21	17	12	46	69	122

*converted by 10 SEK = 1 EUR

The results of 21 supported research groups as reported in 2002 (Hasselgren, 2004) indicated, for example, in total 100 PhD and 140 MSc graduations since the start of support to each group. It was pointed out that 17 of the groups started "from scratch", meaning that several years of support would be expected to be needed before the first results were published and the first students graduated. The total funding to the 21 groups was about 86 million SEK. To allow for comparison with the results of ISP in total in the period 2003-2008 (see above), SEK was converted to EUR at a 10:1 rate (Table 2).

The results of 22 supported research groups as reported in 2009 (van Groningen 2010) covering the period 1998-2008, similarly corresponds to 14 PhD graduations, *plus* 47 MSc graduations, *plus* 55 international publications, *plus* 61 local/regional publications, *plus* 108 conference reports, per "million Euro" of funding.

Discussion

Table 3. Outcome per "million EUR" by IPICS, IPMS, IPPS, and ISP as a whole, calculated on data regarding partly overlapping time periods 1985-2010. nd = no data

Program and Period	PhD grad. per MEUR*	MSc grad. per MEUR*	Internatl. Publ. per MEUR*	Local/Reg. Publ. per MEUR*	Conf. Reports per MEUR*	Meetings arranged per MEUR*
IPICS (1985)**-1995	8	40	93	nd	47	nd
IPICS 1996-2009	14	27	59	nd	nd	11
IPMS 2002-May 2012	6	nd	nd	nd	nd	nd
IPPS (1985)**-2002	12	46	69	nd	122	nd
IPPS 1998-2008	14	47	55	61	108	nd
ISP 2003-2010	12	50	64	34	127	21

*converted by 10 SEK = 1 EUR; **approximate starting year of period (see Table 1).
The similarity in the relative outcomes of the individual programs, independent of time period considered, with ISP in total in 2003-2010 is striking (Table 3).

As argued by Hasselgren (2004), there may be a lag phase until a supported activity yields outcomes in terms of, for example, publications and graduations, depending on the situation at the beginning of support. This may partly explain the relatively low rate of PhD graduations within the chemistry program until 1995 (although a high rate of international publication is observed), and surely that of the mathematics program, which started in 2002 and saw the first PhD graduates resulting from the program in 2008.

However, the compiled results collectively point at a general picture regarding the results of ISP support, where the outcomes of supported activities per million EUR spent are about 12 PhDs, *plus* close to 50 Masters, *plus* around 60 international publications, *plus* more than 100 contributions to scientific conferences, *plus* a substantial number of meetings arranged, *plus* the development of technical resources and scientific contacts to facilitate outcomes. Thus, ISP support can be expected to result in a quite predictable outcome with regard to the development of academic capacity and the dissemination of scientific findings.

The consistent outcome of activities supported by ISP falls well in the cycle of support, where at a given time support is provided simultaneously to activities being in the initial stages of academic and scientific development, to activities that have reached a productive level but are still dependent on ISP support, and to

activities that have reached a degree of excellence where ISP funding becomes less and less important. In the latter case, an ISP phase-out of support is to be initiated, releasing ISP financial resources in favour of support to new activities at the beginning of the cycle.

The recent evaluation of ISP (GDH, 2011) points to important directions for future development, most notably with regard to a more comprehensive system for continuous monitoring and evaluation of the program, focusing on outcome and impact.

ISP particularly sees a need to develop follow-up to also include the scientific quality of results obtained and degrees awarded by ISP-supported activities, the application and use of results, and the broader impact of ISP support, including activities of alumni. GDH (2011) puts particular emphasis on the importance of tracking alumni:

> ISP alumni could, for example, be systematically surveyed on a periodic basis to identify specific examples of how they had been able to use their scientific discipline and skills to influence broader public policy and contribute to poverty alleviation.

Conclusion

ISP has evolved over its 50 years of existence from a "seminar program" in physics to a program of development support to scientific research and postgraduate education in the basic sciences, chemistry, mathematics and physics. The outcome of ISP support in the last three decades is substantial and consistent with regard to awarded degrees and the dissemination of scientific results by supported research groups and networks. To document and prove the impact of the program, the monitoring and evaluation system must be further developed to systematically cover quality and use of results achieved by ISP-supported activities, as well as the impact of ISP support, including contribution of ISP alumni to development.

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Abbreviations and Acronyms

EAUMP Eastern African Universities Mathematics Programme

EUR Euro (currency units)

IAEA International Atomic Energy Agency

IMS Institute for Mathematical Sciences (Ghana)

IPICS International Program in the Chemical Sciences

IPMS International Program in the Mathematical Sciences

IPPS International Program in the Physical Sciences

ISP International Science Programme

No Number

NORAD Norwegian Agency for Development Cooperation

NW Network

MEUR Million EUR

MSc Master of Science (here including Master of Philosophy, MPhil)

OECD Organisation for Economic Co-operation and Development

PhD Doctor of Philosophy

RG Research group

SAREC Swedish Agency for Research Cooperation with Developing Countries

SEK Swedish crowns (currency units)

Sida Swedish International Development Cooperation Agency

UNESCO United Nations Educational, Scientific and Cultural Organization

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PROCEEDINGS