The International Science Programme
2001–2021

20 Years of Continued Development
Publication for the ISP 60th Anniversary

Editors: Barbara Brena and Ulrica Ouline
Abstract
In 2021 the International Science Programme (ISP) at Uppsala University celebrated its 60th anniversary. In spite of the Covid-19 pandemic, ISP made its best effort to honor the occasion and organised virtual workshops, meetings, and webinars during the year. This book represents the conclusive item of the jubilee year. Here we want to present the work ISP has performed since the beginning of the new millennium, narrated directly by the voices of scientists from all over the world who are or were part of the ISP family. They can now tell the significance and the impact that ISP has had on their own careers, their institutions and their countries. The book contains also contributions by the ISP staff, describing the historical evolution of ISP during the last 20 years, including for example the investment in gender equality which has raised a large interest in the supported partners.

ISP has a long story, starting in 1961 as the International Seminar for Research and Education in Physics, when fellows from 14 developing countries were invited to Sweden to spend one year performing research work. Today the ISP core programme, which has evolved into three different programmes in physics, chemistry and mathematics, is devoted to assisting and strengthening research capacity building in a number of low and lower-middle income countries in Africa, Asia and Latin America. ISP supports both research groups and international scientific networks, with scientists from different countries.

More recently, ISP has also been engaged as the Swedish coordinator of all Sida bilateral research programmes, as well as in other collaborations with for example Thailand International Cooperation Agency (TICA) and American Institute of Physics (AIP).

The final aim of the book is to express not only the hard work performed by ISP staff and all the partners in the supported research groups and institutions, but especially the success of the efforts and the great enthusiasm that has permeated the ISP work so far.
To all the young pupils from low and lower-middle income countries who will be future researchers in STEM
Acknowledgements

We are very grateful to all the people whose work and engagement have made it possible for ISP to obtain so many results and to be so successful by its 60th anniversary.

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Introduction

Professor Anders Hagfeldt

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Seventeen years ago, I was in Lima, Peru. My two PhD exchange students Maria and Hugo from the International Science Programme were due to defend their doctoral theses. On my first day there, I was invited to listen at a workshop. Being jetlagged, my alertness wasn't the best, and during a lecture on the synthesis of nanoparticles I struggled to keep my eyes open. Then came a study on the effect of temperature on the size of particles and suddenly something happened. The lecturer presented a graph showing the temperature in degrees Celsius and the size in Ångstrom. The analysis was based on the Arrhenius equation. A lecturer I had never met on the other side of the planet was using the *Uppsala graph* and I was filled with a sense of pride – of how special it is to come from Uppsala University.

When I sat down to write about the International Science Programme, that incident came to mind. Without the programme, I would not have been in that situation and nor would my students. We would never have had the opportunities we had then and we would never have started the collaborations that are now part of our shared history and future. Let me add, there are not many examples of cooperation in the academic world that have managed to stay relevant and meaningful for as long as the International Science Programme. I believe the reason it has survived so long is the ability of all those involved to adapt the program to changing circumstances and their ambition to benefit students and researchers. The program has quite simply been conducted for the right reasons.

During the years the International Science Programme has existed, the world has changed. The year the ISP was founded, 1961, was the year when John F Kennedy became president. It was the year South Africa left the British Commonwealth, the United States attacked Cuba in the Bay of Pigs, Dag Hammarskjöld died in an air crash, Yuri Gagarin became the first man in space, Tanzania was established, and the collectivisation of agriculture in China proved a failure, forcing China to buy grain from Canada. Apart from all that, it was the year the Beatles first played at the Cavern Club in Liverpool.

It was long ago, yet not too long ago for us to have a pretty clear picture of how things were. Much has happened since then. The Berlin Wall, which began to be built that same year, in 1961, was torn down in 1989. Old tensions
in the world have eased, new ones have arisen. Power structures have been shaken up and borders moved.

All this time, students have steadily passed through our programme. The commitment to mathematics, physics and chemistry has borne fruit and we now have research groups and networks in Africa, Latin America and Asia. We can’t say exactly how many people have benefited from the programme, but there is no doubt we are talking about large numbers.

So, what has the programme helped to achieve? As far as I am concerned, it has helped make me aware of similarities and differences. I have taught what I know, but learned at least as much in return. I think that over time many people have found their perspectives adjusted; their picture of the world has received sharper outlines and more vivid colours. We have come a long way together in the course of these 60 years. I am convinced we will keep going. Hopefully, just as long again.

Thank you.
ISP in the Third Millennium
The Development of the International Science Programme (ISP) since 2000

Dr Peter Sundin

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What is now ISP started in 1961 as the International Seminar for Research and Education in Physics, after several years of planning activities. In 1970 an International Seminar in the Chemical Sciences followed. The activities were mainly supported by the Swedish International Development Cooperation Agency (Sida)\(^1\) since the inception of this authority in 1965. The first 40 years of development have been described in detail by Lindqvist (2001) along with witness reports from several ISP beneficiaries. In this chapter there is a slight overlap with the later years accounted for by Lindqvist, not the least to cover the starting up of the programme in mathematics, in operation from 2002.

At present, the ISP core programme consists of the programmes in physics, chemistry and mathematics, in order of appearance. Beside these ISP has, over the about 20 years covered here, engaged also in other cooperation and coordination assignments. They are mainly the coordination assignments in Sida’s bilateral programmes for research development support at universities. In addition, cooperation agreements have been implemented with, for example, the National Mathematical Centre in Abuja, Nigeria, the American Institute for Physics, the Thai Development Cooperation Agency and the Al-Baha University in Saudi Arabia.

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\(^1\) From 1975, the Sida support to ISP was channeled through the Swedish Agency for Research Cooperation with Developing Countries (SAREC). However, as a consequence of a reorganisation of “Swedish aid administration”, SAREC was incorporated with Sida 1 July 1995 as the Department for Research Cooperation, among other things managing the continued support to ISP.
ISP core programme development

The development of the core programme 2000 to 2021 can be divided into four time periods:

In 2000–2007 activities continued to be consolidated after the “Uppsala Declarations” 1995 and 1999. An extension of the programme to include biology, geosciences and mathematics was proposed, resulting in the addition of a mathematics programme right after the celebration of the 40th anniversary. Following the Sida-ISP agreement periods 2001–2002 and 2003–2005 Sida committed to one-year extensions 2006 and 2007, indicating that a longer-term agreement could only succeed after a new external evaluation of the programme.

The period 2008–2013 started with a two-year Sida-ISP “phase out” agreement. However, a conference in 2009 to clarify ISP support to scientific networks, and the external evaluation in 2011 reversed the negative development. The initial crisis was also alleviated by several new cooperation arrangements. In 2011 the 50th anniversary was celebrated.

In 2014–2018 the constructive dialogue with Sida was manifested in a new agreement. The monitoring and evaluation system was developed to better match the needs and follow-up studies and evaluations were carried out. An old cooperation agreement with Thai authorities was rejuvenated and brought into operation. The 2018 evaluation forged the benevolent ISP-Sida relationship and provided new inspiration for continued programme development.

In 2019–2021 progress continued with the grand 60th anniversary celebration in sight, but the Covid-19 pandemic widely affected the programme, and activities were severely hampered. New tools for online communication were introduced that provided new opportunities, while travel bans restricted physical interaction.

2000–2007: Consolidation of activities, and a new programme in mathematics

ISP’s development at the beginning of the third millennium took off from the “Uppsala Declarations” 1995 and 1999 (ISP, 1995, 1999) and the declaration resulting from a mathematics workshop in 2001 (Kohi et al., 2001) in preparation for an ISP programme in this field of science.

The declaration in 1995 was established at the *International Conference on Donor Support to Development-Oriented Research in Basic Sciences*, 15–16
June the same year, organised in Uppsala, Sweden, by the Swedish Agency for Research Cooperation with Developing Countries (SAREC) and Uppsala University, “bringing together representatives of recipient institutions, donor agencies, foundations, science academies and organizations promoting basic sciences in the Third World” (ISP, 1995). In short, the 1995 declaration concludes that basic sciences are essential for long-term development and that development-oriented research in the “Third World” should emphasize basic sciences. Moreover, the declaration states that each developing country should articulate a strategy for support to the basic sciences and how they can solve future development needs in the country.

Recommendations for action were, in brief, to build cadres of scientific researchers in the basic sciences since they are required for national development and to include grants to research and higher education in the basic sciences in donor support to applied projects.

The Uppsala Declaration 1999 was established at the Conference on Basic Science for Development in Eastern and Southern Africa, 1–3 March in Arusha, Tanzania, the same year (ISP, 1999), organised by the government of Tanzania in collaboration with the Third World Academy of Sciences (TWAS)

ISP continued its operation following the recommendations of these conferences, as far as applicable and to the extent possible within the frame of the programme. Many of the recommendations for actions were directed to national governments and major donors. However, a few years later the Africa’s Science and Technology Consolidated Plan of Action (NEPAD, 2003) observed the following for research and higher education:

- Still external financial support often targeting short-term activities
- Science, technology and innovation (STI) have not been given serious attention as engines of long-term development
- Low and declining public expenditure on research and development
- Weak links between industry and science and technology institutions

- Research results of public research and development (R&D) activities not used by local industries
- Mismatch between R&D activities and national development goals
- Declining quality of science and engineering education
- Student enrolment in science and engineering subjects falling
- Loss of scientific and technical expertise to other regions of the world
- Infrastructure for R&D has been neglected and is decaying
- Universities and technical colleges are in urgent need of renewal

Thus, ISP’s focus on enhancing the capacity for research and higher education in the basic sciences in its partner countries, by long-term support to institutionally based research groups and scientific networks, remained to be an urgent and well justified necessity.

**The 1999 application to Sida results in a new mathematics programme**

In 1999 the Vice-Chancellor of Uppsala University submitted an application to Sida/SAREC for continued support to ISP 2000–2002, then consisting of the International Programme in the Chemical Sciences (IPICS) and the International Programme in the Physical Sciences (IPPS). The application included a proposed expansion to launch programmes in biology, geosciences and mathematics (ISP, 2000). In 2000 Sida/SAREC arranged for an external reviewer to appraise the application (Wield, 2001). The review was positive, but recommended Sida/SAREC to provide additional funding to establish a programme in mathematics only.

Sida/SAREC awarded continued funding to ISP for 2001 and 2002 on an elevated level to allow for the development of the mathematics programme. Out of the amount allocated for 2001, Sida/SAREC proposed that one million SEK should be used to arrange a workshop in Africa South of the Sahara in order to in detail find out about the situation for mathematics and to come up with suggestions as to what a programme to strengthen mathematics in the region should look like.

The workshop took place in Arusha, Tanzania, 19–21 November 2001. It was arranged in cooperation with University of Dar es Salaam and Tanzania Commission for Science and Technology (COSTECH), with participation also from TWAS and International Centre for Theoretical Physics (ICTP). It attracted approximately 50 participants from 20 countries in the region, and from Italy, France and Sweden. A declaration was adopted (Kohi et al., 2001) that in essence repeated the Uppsala Declaration 1999, but with a stronger focus on the necessity of mathematics research and higher education, and stating the need for a gender equality promotion action.
The workshop gave guidelines and policy for the development of the International Programme in the Mathematical Sciences (IPMS), which was formally launched in 2002. IPMS started with support to a regional network, the East African Universities Mathematics Programme (EAUMP), linking the departments of mathematics at University of Nairobi, Kenya, University of Dar es Salaam, Tanzania, and Makerere University, Kampala, Uganda, as well as support to a project at the National Centre for Mathematical Sciences (NCMS) in Accra, Ghana. From now on, ISP operated three thematic programmes in parallel.

The ISP scientific reference groups consolidation

The ISP physics programme (IPPS) had already in 1989 established a scientific reference group consisting of six renowned scientists from the Nordic countries acting as a scientific advisory unit. However, in Sida/SAREC’s commissioned assessment of the 1999 application, one recommendation was that senior scientists from “developing countries” should be more involved in the planning and evaluation of projects.

In 2001, following Sida/SAREC’s recommendation, IPPS replaced three retiring Nordic scientific reference group members with three new members from Brazil, Botswana, and India (ISP, 2001). The same year ISP chemistry established a corresponding group, consisting of three renowned scientists from the Nordic countries, and three from the South (at that time from Ethiopia, Thailand and Chile).

The ISP mathematics programme (IPMS) initiated its scientific reference group in 2003, consisting of one Sudanese and two Swedish members (ISP, 2003a).

The 40th anniversary is celebrated

In 2001 the 40th anniversary of ISP was celebrated. The anniversary was recognised by the publication of a book, ”International Science Programme, Uppsala University, 1961-2001; Historical Review and Participants’ Experiences” (Lindqvist, 2001). The established partner scientists from “developing countries” who wrote chapters in the book, can be seen as evidence that ISP operational model works; they once started as young fellows of ISP support, but now acted as senior researchers reporting on the scientific progress at their home institutions.

A first strategic plan guides the continued operation

In 2003 a first strategic plan was established by ISP for the years 2003–2007 (ISP, 2003b). In the preface to the plan the Vice-Chancellor of Uppsala
University at that time, Professor Bo Sundqvist – also being Chairperson of the ISP Board – observed that the difference in scientific output between the developed and the developing countries was increasing, not decreasing. He also observed that a scientific base was missing in many developing countries and that the support to the basic sciences was neglected.

The plan describes the operational mode of ISP in perspective of its more than 40 years of experience, as well as the necessity to continue supporting the basic sciences in developing countries because they are needed to give a firm basis for technology-driven development. The following operational strategies were particularly emphasized:

- A long-term commitment to least developed countries, because it “takes time, to build a viable research team, and particularly so in a developing country.”
- A demand-driven support to activities of good scientific quality, where the local ownership of the planned development is a prerequisite.
- Postgraduate education as an essential part of research activities, where “sandwich-type” training in collaboration with advanced groups are initially very important, “but with increased research facilities and experience, the periods abroad can be shortened or eliminated.”
- Donor co-operation, which gives synergistic effects.
- Monitoring and evaluation, and the need to develop indicators to measure contributions to the development of the society in large, besides collection of information on postgraduate theses and dissemination of scientific research results.

Among the initiatives expressed in the strategy plan were:

- Continued focus on “low income” or “low human development” countries using Sida/SAREC funds.
- Continued transfer of ownership, administration, etc., to the supported units, as far as the local situations permit.
- Efforts towards more even gender distributions.
- Introduction of new programmes in biology and geosciences.
- Possibilities to give support towards advanced courses on a regional level.
- Introduction of local fellowships for MSc and PhD studies in close co-operation with the local universities.
- Gradually being able to support more resource groups taking regional responsibilities.
- The possibility to assist with more costly equipment mainly to groups functioning as regional resource groups.

Today, ISP is still working along most of these lines, although the ambition to introduce separate programmes in biology and geosciences has been abandoned for the time being.

In parallel to its operation of the core programme ISP had on request by Sida carried out assignments to coordinate activities and carried out financial transfers in Sida/SAREC’s bilateral cooperation programmes for research capacity enhancement. This assistance to Sida/SAREC dates back to 1984, when the chemistry programme was given the task to administer an “Urgent Spare Parts Fund” for the National Research Council of Sri Lanka, on behalf of SAREC (International Seminars, 1986).

**Sida suggests new directions for ISP**

An application for continued funding in 2003–2005 was submitted to Sida/SAREC in December 2002, together with the draft strategic plan. In the assessment of the application, Sida “stresses the importance that ISP focus activities on the least developed countries”, and that “the cooperation with more developed countries should be phased out.” Consequently, over the agreement period and the following years, 2003–2008, support to 21 research groups in eight countries was terminated, including to a national mathematics network in Cameroon (Andersson & Sundin, 2017). The other countries where ISP concluded support were Colombia, Ecuador, Nigeria, Peru, Sri Lanka, Thailand and Uruguay.

The achievements 2003–2005 were documented in a three-year report to Sida/SAREC (ISP, 2006). Regarding the shift of focus of ISP support to least developed countries, the “phase outs” were accounted for in the report with the addition that “in most cases where projects have not been closed down, ISP is waiting for PhD sandwich programmes to be finished.” Furthermore, it was stressed that “in order to avoid too serious negative consequences to supported projects in Sri Lanka, which has only recently come into the category “lower middle-income economy”, ISP should like to phase supported projects out at a slower pace.” As a matter of fact, two chemistry groups phased out in Sri Lanka in 2003 received continued support through Sida/SAREC until 2010 (Andersson & Zdravkovic, 2017) and physics research group support in Sri Lanka continued until 2010 (ISP, 2010).

In 2004 the conference “Capacity building in Developing Countries with focus on Basic Sciences” was held at the Swedish Royal Academy of Sciences. Four organisations were invited to discuss their effort in this direction, namely the
International Foundation for Science (IFS), The World Academy for Sciences (TWAS), the International Centre for Theoretical Physics (ICTP) and ISP. An important conclusion made was the need not merely to focus on individual scientists, but also to support the development of sciences in line with national and institutional strategies, a track that ISP had already embarked on as evident from the strategic plan 2003-2007 (ISP, 2003b).

After the three-year agreement 2003–2005, Sida decided to provide continued support to ISP for one year only (2006), together with the conclusion that there is a need for an in-depth dialogue between Sida and ISP on direction, modalities and level of future support. During 2006 Sida and ISP had several meetings to discuss the future orientation and support mode. However, the dialogue became delayed, in part due to the extensive evaluation of SAREC that was carried out at that time, taking into account its recommendations. The evaluation report in 2006 proved to be a valuable and interesting reading also at ISP and Sida/SAREC’s cooperation with ISP was addressed to an extent:

“In some of the issues covered under Natural Sciences and Technology, capacity gaps between the poor countries and industrial countries are large. The reliance on old, well established, efficient, and useful international programmes such as ISP are highly appropriate.” (Rath et al., 2006a)

“The International Science Programme is a rather unique and most successful initiative that has had a large and significant positive impact in many poor countries. SAREC support initially, and Sida/SAREC support at a later stage, have been essential for ISP to achieve the results it has obtained for more than 40 years. In addition to providing continued support to ISP, it is important to explore whether it could be expanded into other fields of science and to maintain a flexible approach that allows ISP to engage not-so-poor countries in assisting their counterparts in poorer countries.” (Rath et al., 2006b)

In 2006 Sida requested ISP to submit a short application for support in 2007 at the same level as 2006 (27 million SEK), which was approved in late 2006. In the assessment Sida expressed that ISP’s long experience and insights could be valuable and important in particular to the Sida bilateral research programmes. It was also stressed that ISP’s work in both Sweden and abroad greatly enhanced Sida’s capacity to prepare and implement cooperation. Furthermore, Sida came to the conclusion that “the current situation of ISP independently preparing collaborative programmes will have to change.” Finally, Sida stated that all ISP activities successively would be replaced by bilateral agreements in Sida partner countries and that this new modality of ISP operation would be elaborated in more detail in 2007.
In 2000 ISP had continued major coordination tasks in the Sida programmes with Eritrea, Ethiopia, Sri Lanka, Tanzania, Uganda, Vietnam, and Zimbabwe, and in 2002 the corresponding tasks in a regional programme with Central America were given. In 2007, the assignments covered only Sida’s programmes with Ethiopia, Sri Lanka, Tanzania, and Uganda.

2008–2013: A multiple phase out crisis and a new hope

During the 2008–2010 period the Sida contribution continued to comprise the main funding of the core programme. However, the 2008 agreement with Sida implied a gradual reduction of Sida’s support to the ISP core programme from 27 million SEK per year in 2006 and 2007 to 17 million SEK in 2010. This reduction of funding reflected Sida’s intention – as expressed in the decision 2006 – to phase down its support to ISP’s core programme and increase ISP’s engagement in Sida’s bilateral university support programmes. In this way, Sida argued, ISP would serve Sida better and still maintain its necessary competence in such cooperation. New major tasks were commissioned in the Sida programmes with Ethiopia, Sri Lanka, Mozambique, Tanzania, and Uganda, and in 2008 the corresponding tasks in another regional programme with Central America were given. ISP support to research groups in countries that also had Sida bilateral research programmes was suggested to be phased out at the next new phase of each bilateral programme. Sida expressed the intention that these research groups should instead receive continued funding by being included in the new programme phases.

In 2008 this affected four research groups in Ethiopia, three in Tanzania and three in Uganda, which had to be phased out of ISP core support with a notice shorter than six months. This significantly violated ISP’s normal phase out practices. ISP staff spent considerable efforts to ameliorate this emergency by negotiation interim support in 2009 to the affected groups using surplus funding in the bilateral programmes in the three countries. The Sida programme officers were very helpful in realising this. All these groups were expected to be adopted and supported by the new phases of the Sida programmes that were expected to start in 2010 in the concerned countries. This didn’t happen, as accounted for below.

The gradual decrease of Sida funding to the ISP core programme and the intention to replace it with an increasing degree of coordinative and administrative assignments in the Sida bilateral programmes were of great concern for ISP. It was felt that this might decrease the scientific strength of ISP and reduce the programme to a predominantly administrative unit serving Sida. The contribution from the Faculty of Science and Technology of
Uppsala University continued and from 2009, to help reinforce the programme, at a raised level.

**A new Swedish development policy further restricts ISP operation**

The Swedish government announced a new development policy in August 2007. The policy implied that long-term development cooperation should be confined to twelve “focus countries”; Bangladesh, Bolivia, Burkina Faso, Cambodia, Ethiopia, Kenya, Mali, Mozambique, Rwanda, Tanzania, Uganda and Zambia. The 2008 agreement with Sida had the condition that ISP should adhere to this policy, and stop placing support in other countries.

As expressed in Sida’s assessment, constituting part of the 2008 agreement: “In countries where SAREC is not involved bilaterally, ISP’s support to a limited number of selected research groups could however be relevant.” This “relevance” would remain the case until a Sida bilateral agreement would possibly come into operation. In September 2008, a working strategy 2009–2010 for ISP was laid down (ISP, 2008), with the aim to develop capacity in physics, chemistry and mathematics as far as possible in these countries until bilateral support programmes were to be established with the objective to “contribute to strengthening the capacity in basic sciences in order to provide an as solid base as possible once Sida bilateral support programmes are to be established.”

In 2008 ISP’s direct support to research groups in countries not included in the new policy for long-term development cooperation was in most cases already scheduled for phase out by 2010. This regarded Cameroon, Ghana, Nigeria, Peru, Sri Lanka and Senegal. However, the phase out of support to research groups in Laos and Malawi had not been planned, and had to be initiated because of the new agreement. ISP decided on a three-year phase out period, until 2010, for the Malawi groups, and support until 2011 for the groups in Laos. Zimbabwe was also outside the group of focus countries, but in later meetings with Sida, ISP was allowed to continue its chemistry support not to compromise the capacity built since 1990 (as partly accounted for by Masimirembwa, 2013, and in his chapter in the present volume).

In 2008 ISP already supported research groups in nine of the twelve focus countries, and these were Bangladesh, Burkina Faso, Cambodia, Ethiopia, Kenya, Mali, Tanzania, Uganda and Zambia. After phasing out support to the groups in Ethiopia, Tanzania and Uganda, six countries remained where ISP could continue developing core support, at that time five with no Sida bilateral university programme: Bangladesh, Cambodia, Kenya, Mali and Zambia. In Burkina Faso the Sida bilateral support phase had been expected to terminate after 2007, when the negotiation of a new phase was foreseen, but finally, Sida
decided not to continue the engagement. Therefore, ISP core support at the University of Ouagadougou (today University Joseph Ki-Zerbo) could continue.

However, not only ISP research group support was affected by the new government policy, but also a Sida bilateral programme, with National University of Laos (NUOL). It had to be closed prematurely with short notice (Kennedy, 2011). Nonetheless, ISP support to research in Laos could continue on other funding, as accounted for below.

Sida’s bilateral programmes in Bolivia, Ethiopia, Mozambique, Rwanda, Tanzania, and Uganda – all being “focus countries” – continued. Furthermore, Sida commissioned a feasibility study of possible new partner countries for bilateral research cooperation with Sweden (Sida, 2010), covering Bangladesh, Cambodia, Kenya, Mali, and Zambia. It was concluded that a future programme in Cambodia would be feasible, because there was a commitment and will at both ministry and university level to develop higher education and research in the country.

Zambia was also concluded to be a possible candidate for a Sida bilateral programme, at the University of Zambia. In Mali, however, while the need was recognized, the report expressed doubts about the feasibility of a programme. Considerable challenges were identified in Bangladesh, where “fragmentation appears to be a major feature of the research system,” and Kenya was found already to have “several higher education and research institutions with good standards and a cadre of highly skilled researchers.”

A conference to clarify the diversity of supported scientific networks

ISP direct support to regional networks was not affected to the same degree by these restrictive conditions and could continue provided that “focus countries” were among those benefiting. However, the Sida support to research development was predominantly of bilateral nature, and during 2008 a discussion came up with Sida on how to create a better understanding of ISP’s support to regional cooperation. As a result of this, Sida agreed to provide a separate contribution for a conference embracing all ISP supported networks at that time, as well as a number of those formerly supported and networks operating without ISP support.

The “International Conference on the Strengthening of Research and Higher Education in the Basic Sciences by Regional and Interregional Cooperation; Relevance for Developing Countries” was organised by ISP, Sida and Addis Ababa University in Addis Ababa, Ethiopia, 1–4 September 2009, under the auspices of the African Union Commission. The event attracted more than 130
participants from close to 40 countries in Africa, Asia, Europe, and Latin America. More than 20 networks – most of them wholly or partly supported by ISP – accounted for their activities (Kiselman, 2011).

Among the recommendations of the conference, as given by the group discussions, were:

- Establishing national and regional disciplinary associations/societies, and seek means of strengthening them.
- Taking steps to create intercontinental cooperation between scientific networks in Africa, Asia, and Latin America, which share common themes and objectives.
- Using the scientific diaspora to reinforce the capacity of scientific networks.
- Using the potential of the networks and regional groups to improve the local training of MSc and PhD students.
- Encouraging universities to create equivalent curricula within a country and region.
- For each scientific network, establishing a website and ensure that it is regularly updated.
- Using internet in teaching and cooperation between the universities.

It was furthermore concluded that scientific networks are very important:

- To share resources available in individual developing countries.
- To address local and regional problems/development challenges.
- To facilitate multidisciplinary research.
- To spread risks and gains in research endeavors.

After the conference and publishing the proceedings, Sida appeared satisfied with the account of ISP scientific network support that had been provided. Sida may also have come to increased comprehension of the value of supporting regional scientific networks, for example between its bilateral programmes in different countries.

**SAREC is replaced**

In July 2008 a reorganisation at Sida implied the replacement of SAREC with a research secretariat, later converted to Sida’s Unit for Research Cooperation. This change implied loss of staff working with bilateral research cooperation at Sida, because the new unit had room for considerably less employees (15) than SAREC that had (40) (Kennedy, 2011). On the longer term, this had implications for ISP’s engagement in Sida’s bilateral programmes, which increased considerably the following years.
A new practice: measuring results

Formal Annual Review Meetings (ARM) between Sida and ISP were introduced with the 2008 agreement. Sida informed ISP that a results based management (RBM) approach would become mandatory, to be implemented following training recommended by Sida. In the case of ISP, RBM can be used as a tool for monitoring and managing the activities carried out by the supported groups and networks. RBM can be used so that involved parties continuously can learn from success as well as failure and adapt when needed.

In addition, ISP was asked to implement a practice of conducting annual audits of funds transferred to supported partners for local use.

ISP supported partners

At the start of the agreement period in 2008, ISP supported 43 research groups and 16 scientific networks.

In 2010 Sida was informed about the fates of the ten research groups forcefully phased out in 2008. ISP had arranged for interim continued support for eight of them through the closing bilateral agreement periods in the concerned countries – Ethiopia, Tanzania, and Uganda – but only five of them were taken up in the new programme phases, all starting in 2010.

The three “left out” were all in Ethiopia, where Sida had introduced a “block grant” model in the bilateral programme with Addis Ababa University (AAU) (Sida, 2022). ISP expressed regret that the inhibited support to these research groups – in chemistry, mathematics and physics (previously supported by ISP since 2002, 2005, and 1990, respectively) – would constitute a great loss of capacity in basic sciences. It would also compromise most of ISP’s investments using Sida funding, with regard to human as well as instrumental resources. ISP therefore stated the intention to invite these research groups to apply for renewed ISP direct support from 2011.

The groups in Tanzania and Uganda, that had been more or less incorporated in the bilateral programmes from 2010, were not kept included in later phases, and were similarly brought back on ISP support, after agreement with Sida.

In the final year of the extension, 2013, 35 research groups and 19 networks were supported. The numbers varied over the years because support was concluded in a number of cases, and support to new activities started. In 2011, only 29 research groups and 14 networks were supported, partly due to the “forced” phase out stipulated in the 2008 Sida agreement.
New collaboration programmes

With the declining Sida funding to ISP during 2008–2010, essentially following the Sida strategy outlined in the assessment 2006, ISP became increasingly concerned over the financial situation and the Swedish policy-imposed restrictions to continued development of the ISP support model. Partly because of this ISP started to investigate new cooperative engagement that did not rely on Sida funding.

Stockholm University (SU), Sweden:
In 2010, one ISP Board member at the Department of Mathematics, Stockholm University (SU) initiated a discussion between ISP and the SU Faculty of Science on a cooperation agreement. The negotiations had a favorable outcome, implying a yearly contribution of one million SEK to ISP in the five-year period 2011–2015, with an option for extension should the cooperation be mutually satisfactory. The SU contribution, albeit relatively modest, was very beneficial to ISP because no conditions were attached, except that it should be used in the ISP core programme.

Part of the contribution was set aside for developing the SU initiative, the Pan African Mathematics Programme (ISP, 2015a). Another use of the SU grant was to save research groups at the Faculty of Science, National University of Laos, from the premature phase out of funding, scheduled for 2011, allowing continued support to chemistry, mathematics and physics in Laos.

Al-Baha University (ABU), Saudi Arabia:
In 2010 a request came from a Sudanese former PhD graduate from the ISP physics programme, who was now employed as the Head of the International Office of ABU in Saudi Arabia. He asked for assistance to develop research at this university, which had been formed about ten years earlier. This was a new concept for ISP – to work in a “rich” country, but still with a need of developing scientific research. After some hesitation, and considering the financial situation, ISP agreed to the cooperation. All costs were to be covered by the Saudi counterpart. A particular request by the then ABU Rector was to strengthen women staff and students at the university, which was something that agreed well with ISP’s gender equality promotion intentions. After an initial “probing” visit by the former Head of ISP and Director of the ISP physics programme, Lennart Hasselgren, Al-Baha visitors were received at Uppsala University. In 2011, a five-year contractual agreement, on university management level, was signed in Al-Baha. ISP was assigned to coordinate the activities.

The main outcomes of the cooperation, were two PhD graduations of ABU staff at Uppsala University, one woman in mathematics and one man in
computer science, in 2018 and 2020 respectively, and arranging the 1st Al-Baha University and Uppsala University Collaborative Symposium on Quality in Computing Education (ABU3QCE), in February 2015 in Al-Baha. Another male Al-Baha staff member was admitted to a PhD programme in mathematics at Mälardalen University, Västerås, Sweden, and is expected to graduate in 2022, while the agreement itself was formally and amicably concluded in 2019.

National Mathematical Centre (NMC) Abuja, Nigeria:
In February 2010, a twenty-person strong delegation from Nigeria visited Uppsala University, led by the Nigerian Ambassador to Sweden. One of the delegates, the Director General of the NMC, approached the Uppsala University Vice-Chancellor soon after the visit and requested for a reception of a smaller delegation from NMC. ISP was assigned to host this visit.

The outcome was an agreement – signed in 2011 at the faculty level and to be coordinated by ISP – focusing on staff and student exchange. The same year, PhD training was requested for a NMC staff member, and after identifying a Swedish host at Luleå University of Technology (LTU), ISP negotiated a five-year three-parties contract for the training and the coordination by ISP, to be funded by NMC. The endeavor was successful in that the PhD trainee defended his thesis and graduated in 2016. However, from 2014 the candidate was supported as an LTU employee, because of somewhat wavering funding of NMC by the Nigerian government. No more candidates were offered education in Sweden, and therefore the cooperation unfortunately ceased after one graduation.

Thailand Research Fund (TRF):
In 2010 the Head of ISP was invited to a meeting in Stockholm about the new strategy of the International Foundation of Science (IFS). Among many participants were two Thai professors who served as advisors to IFS. They were, furthermore, connected with the Thai Royal Golden Jubilee PhD Programme at Thailand Research Fund (TRF). Recalling a Memorandum of Understanding that ISP had agreed with TRF in 2005, a discussion was taken up on how to revive the cooperation. It was concluded at an early stage to offer PhD fellowships to candidates from low and lower-middle income countries neighbouring Thailand, and Bangladesh and Nepal, modelled on a cost-sharing agreement already established by TRF with the French Embassy in Bangkok. In 2012, Thailand International Cooperation Agency (TICA) and Sida (via the Development Cooperation Section of the Swedish Embassy in Bangkok) became engaged, and in 2015 a new five-year MoU was established and signed in February in a ceremony at the Thai Ministry of Foreign Affairs in Bangkok. This development ultimately built on ISP’s earlier contacts and 25 years of support to research groups in chemistry and physics at Thai
universities (Andersson & Zdravkovic, 2017). The agreement implied that the nominally three-year fellowship programme – in the wider fields of basic sciences – should require admittance to Thai universities, with common supervision by the Thai institution and a collaborating Swedish institution, and include up to one year of guest PhD studies at the Swedish institution.

For ISP the activities on the Swedish side became part of the ISP core programme, as agreed with Sida in 2014. Up to 2018, 70 applications from Bangladesh, Laos, Nepal, Myanmar, and Vietnam were commonly evaluated by TRF and ISP. Totally seven candidates (six from Myanmar, including five women, and one man from Laos) were selected for fellowships in the fields of biology, chemistry and physics. However, one woman from Myanmar and one man from Laos canceled their participation for personal reasons.

Figure 1. The Head of ISP with signatories from the Development Cooperation section of the Swedish Embassy in Bangkok, TRF, and TICA, in 2015 establishing an agreement implying cost-shared PhD training of candidates from countries neighbouring Thailand.

An attempt to attract EU funding

In 2010 ISP, in its attempts to attract additional funding, initiated an application to EU, “East African Stakeholder partnerships in deployment of e-infrastructure Lighthouse Demonstrators” (EASTERN-LIGHT), with co-applicants at the Inter-University Council for East Africa (IUCEA), the International Livestock Research Institute (ILRI) in Kenya, Karolinska Institutet and Karolinska University Hospital in Sweden, the Royal Institute of Technology in Sweden, and the Swedish University of Agricultural Sciences in Sweden. However, despite considerable efforts by the team of applicants, funding was unfortunately not awarded.
ISP celebrates the 50th anniversary

In September 2011 ISP celebrated its 50th anniversary with an international full-day workshop in Uppsala – “Experiences and the Way Forward” – with participation by current and former Board members, members of the scientific reference groups, and invited guests (many as speakers). There were more than 200 participants at the event, from Africa, Asia, Europe, and Latin America.

Among the speakers were H.E. Professor Mohamed Gharib Bilal, Vice President of Tanzania, Professor Bo Sundqvist, former Vice-Chancellor of Uppsala University, and former Chairman of the ISP Board, Professor C.N.R. Rao, Jawaharlal Nehru Centre for Advanced Scientific Research, India, and Professor Hans Rosling, Department of Public Health Sciences, Karolinska Institutet, Sweden, along with two representatives from Sida. The celebration, including participants’ travels, was sponsored by – besides Uppsala University and Sida – Luleå University of Technology, Lund University, Örebro University, Stockholm University, the Swedish University for Agricultural Sciences (SLU), Umeå University as well as by “Kjell och Märta Beijers Foundation” and the Swedish Research Council.

The evaluation 2011 confirms ISP’s value

The 2008–2010 agreement required an external evaluation of ISP to be carried before any new proposal could be submitted to Sida. It was commissioned and procured by Sida, and carried out and reported by an external evaluator (GHD 2011), covering ISP’s operations as a whole, and including two case studies of ISP’s support collaboration, in Ethiopia and Kenya.

In the evaluation a number of strengths and weaknesses of ISP’s work were identified. On the positive side, the evaluators found that ISP’s own expertise in teaching and research aspects of science did contribute to building capacity in the collaborating universities in low income countries. The evaluation also found strong programme ownership and commitment both at the partner institutions in low income countries and among ISP staff. It was concluded that ISP’s systems and procedures generally are satisfactory, but that ISP should consider using a more transparent and objective selection process when choosing new partners to be supported.

Regarding the relevance of the supported activities the two case studies found that the activities of ISP partners in Kenya and Ethiopia were highly aligned with the priorities of the respective government. It was stated that the scientific quality of the supported activities varies from country to country but that evidence shows that ISP support has increased the quality of planning and research proposals. It was observed that the published papers reveal a high to
satisfactory level, with citation levels above world benchmarks. Regarding effectiveness and impact the evaluators found reasons to believe that:

“Support to tertiary level sciences in Africa has good development effectiveness and impact. There is also good specific evidence confirming most of ISP’s expected results have been achieved, particularly in terms of expanding student numbers and activities. There is evidence that capacity to plan and manage research activities are improving, although better capturing of trends would make the findings more robust”.

In addition, the evaluation suggested that there is anecdotal evidence that ISP’s activities are contributing to socioeconomic development and poverty reduction. The evaluation did however find ISP’s monitoring and evaluation system poor, lacking a logical framework and a clear results chain. The evaluators also lacked systematic case studies of the effects and impact of ISP’s work, and systematic tracking of alumni and the potential leakage of graduates to OECD countries. The evaluation also pointed to that ISP’s effectiveness and impact could be stronger if it was more explicitly linked to the Sida bilateral programmes. Furthermore, it was noted that ISP would need to invest more in monitoring and evaluation to meet Sida’s requirements for results based management (RBM). ISP addressed the evaluators’ points and in early 2014 a communications officer was recruited, to take responsibility for the monitoring system and to initiate retrospective studies and evaluations.

Regarding efficiency it was found that the sandwich model is an efficient approach to training PhD students. The evaluators concluded that the risk of students remaining or moving overseas are lower for sandwich model students, but it was pointed out that more data are needed to support the analysis. In the evaluation report it was stressed that ISP is too dependent on a single donor, with about 85% of the funding of ISP’s core programme coming from Sida.

In general, recommendations included needs to develop and clarify the operation of ISP. To allow for this, the extensions 2011 and 2012 were negotiated at a rate of 25 million SEK per year, also reflecting the fact that Sida at that time had abandoned the idea to continue phasing down the support to the ISP core programme.

**A Master study in 2012 further supports ISP’s mode of operation**

In 2012 a political science student at Linköping University, Sweden, found ISP to be a relevant subject for her Master thesis on development support models. She used ISP supported chemistry and physics research groups in Bangladesh as a study case of North-South development collaboration (Kuhn,
She found that ISP creates interconnectedness and social empowerment and that ISP can be viewed as a successful example of North-South development assistance. The key success factors pointed out were ISP’s general mode of operation, the application of long-term support, and ISP’s egalitarian way of interacting with Southern collaborators. It was also concluded that ISP-associated scientists in Bangladesh have a wide-reaching and sustainable positive impact on the country.

**Sida extends its contribution and invites ISP to apply for a new agreement period**

In January 2012 Sida invited ISP to apply for continued support 2012–2016, taking a starting point in the conclusions and recommendations of the 2011 evaluation. In the invitation, among the developments Sida asked for, were:

- An improved, systematic and results focus method for follow-up and evaluation, applying an updated logical framework.
- Increased financial independence of Sida.
- Research group support also in countries where Sida has bilateral programmes for support to research development, where synergies can be identified.

ISP’s application resulted in a new agreement for the period 2014–2018.

**Development of the RBM indicators and a new strategic plan 2013–2017**

To monitor the outcomes required to fulfil ISP’s objectives, a results based management (RBM) logical framework was established in 2012. It was first given in the ISP Strategic Plan 2013–2017 (ISP, 2013a), and also published in the ISP Annual Report 2013 (ISP, 2013b).

In the Strategic Plan 2013–2017, ISP expresses the vision “to efficiently contribute to a significant growth of scientific knowledge in low-income countries, thereby promoting social and economic wealth in those countries, and, by developing human resources, in the world as a whole.” In this period, focus was on three specific objectives that essentially aligned with the Swedish government’s strategy for Sida’s support for development research cooperation:

1) Better planning of, and improved conditions for carrying out, scientific research and postgraduate training.
2) Increased production of high-quality research results.
3) Increased use by society of research results and of graduates in development.
A number of RBM indicators of the expected outcomes were selected, related to the objectives above. The plan outlined twelve short- and ten long-term strategies. While most of the strategies in the 2003–2007 plan (ISP, 2003b) were repeated, new strategic approaches included:

- To introduce a more competitive application process at the department and country level, when initiating new support.
- To increase the focus on gender issues, by elaborating and applying a comprehensive strategy to promote gender equality.
- To encourage groups and networks to seek additional funding.
- To regularly evaluate activities and the quality of results, and initiate alumni tracer studies and impact studies.

The importance of the ISP long-term support modality was further emphasized, with the clarification that ISP phases out its support when a research group or scientific network:

a) has reached such a level of excellence that it can be expected to successfully compete for other funding, or
b) has failed to develop over a reasonable period of time.

Considerable efforts were devoted to implement the strategies outlined in the plan, and to achieve the target outcomes.

**2014–2018: Back on track with strengthened monitoring and evaluation**

*The new monitoring system is applied*

A first comprehensive account for the 24 yearly followed RBM indicators of the outcome was presented in the ISP Annual Report 2015 (ISP, 2015b), together with a thorough discussion of the expected value of each indicator.

With minor adjustments, the indicator-based monitoring system continued to be used throughout the agreement period. In 2018, however, the accumulated experience of the system led to a revision (ISP, 2018), where twelve indicators were to be abandoned, and eleven were to be kept for future use, although one after modification.

Since then the monitoring system builds on the following three “planning-related” indicators:

- ISP scientific reference group rating of applications, reflecting the quality of research group and scientific network proposals.
Expenditures related to available budget, reflecting the ability to plan the costs of the scientific activities, and carry them out accordingly.

Share of granting from other sources, from 2015 including institutional co-funding, in relation to the ISP funding, reflecting the ability to draw research funding from other sources, and the ability and willingness of the own institution to contribute to the costs of activities.

The following five “conditions”-related indicators are in use:

- Gender proportion of staff, because gender balance of staff will contribute to favorable working conditions.
- Gender proportion of 1) all PhD and MSc students, of 2) continuing PhD students, and of 3) graduating PhD and MSc students, because favorable working conditions will allow for students of both genders to be admitted and to continue until graduation.
- Duration of studies for “local” and “sandwich” PhD students, respectively, because favorable working conditions will allow students to graduate timely.

The following three “scientific production”-related indicators are in use:

- The number of published scientific articles, and the proportion in quality journals, because it is desirable to publish research results when available, and preferably in journals of adequate quality. (From 2018, ISP also records the instances of publications in journals by “predatory” publishers).
- The number of contributions to scientific conferences, and the proportion international ones, because dissemination of research results to the scientific community at meetings is an important means of communication, and, although contributions to national and regional meetings are important, contributions to international meetings can be seen as a quality measure.
- The number of MSc, and PhD graduations each year, because with increasing scientific capacity, these numbers are expected to increase.

An increased gender focus to promote gender equality

In the early days of ISP operation, gender-based follow-up of students and graduates was practiced, but with the new monitoring system, “gender-sensitive” indicators were expanded to include staff members.

3 Defined by ISP as those listed in Web of Science (www.webofscience.com), or rated as quality publication venues in the Norwegian Register for Scientific Journals, Series and Publishers, https://kanalregister.hkdir.no/publiseringskanaler/Forside
Following the Strategic Plan 2013–2017, a gender equality working group was established in 2014. It included representatives from International Foundation of Science (IFS), Organisation for Women in Science for the Developing World (OSWD), the global unit at the Swedish University of Agricultural Sciences (SLU Global), and Uppsala University’s Centre for Gender Research, with the aim to receive advice and guidance from these organisations. Among important outcomes was to open calls for ISP gender equality grants for gender biased mathematics and physics research groups and scientific networks.

A spin-off effect of the gender equality grant activities was the establishment in 2018 of a regional network – the Eastern Africa Network for Women in Basic Sciences (EANWoBAS) – joining mathematics and physics researchers from Uganda, Kenya, Rwanda, Tanzania and Zambia. With the belief and slogan “basic sciences for all” the network envisions to be leading in creating gender-balanced representation in the basic sciences on all levels from primary to tertiary education in Eastern Africa. ISP attended their start-up workshop held in Uganda in July 2018. The network was invited to apply for financial support and ISP granted a three-year allocation starting from 2019.

**Confirming ISP’s impact**

Following the recommendations in the 2011 evaluation of ISP (GHD, 2011), and having a communications officer employed, ISP embarked on several retrospective studies in order to highlight the outcome and impact of the programme.

**40 years of chemistry in Africa:**

In September 2010, ISP was invited to contribute to a book on “Chemistry for the Sustainable Development in Africa”. Besides the chemistry programme director summarising the outcome of 40 years of chemistry support in Africa (Sundin, 2013), two chemistry partners contributed with chapters on the successful development of their chemistry research under ISP support (Mammo, 2013; Masimirembwa, 2013).

**Patterns of South-South collaboration:**

In 2014, a research fellow was temporarily employed at ISP primarily to do a study of collaboration patterns of researchers in the basic sciences at five universities in Southern Africa, in perspective of ISP support at these universities (Zdravkovic et al., 2016). Together with participating advisors at SLU and UU, 105 scientists were interviewed and 192 were traced in library databases. Altogether, the scientists had contributed to 623 scientific papers. It was found that in the majority of the cases, funding from the North contributed substantially to increased scientific productivity, and international
co-authorship. The results also showed that collaboration with southern scientists is equally valued as that with northern scientists, but for different reasons.

In general, working with northern scientists meant better funding, more organised research and access to different knowledge, while South–South collaboration meant easier contact, working on equal conditions, and more addressing problems relevant to Africa. Still, scientists in the South had no particular preferences for a co-author as long as they were interested in the same field of science. It was concluded that supporting international and national collaboration is a key factor for capacity building of research in southern African universities.

The International Science Programme in Sri Lanka and Thailand:
In 2014, a retrospective study was started on ISP’s former support to chemistry and physics research groups in Sri Lanka, 1978–2010 and in Thailand, 1982–2007 (Andersson & Zdravkovic, 2017). The study puts these former collaboration endeavors in perspective of ISP’s current operational mode with a number of conclusions and recommendations. Two PhD graduate tracer studies were included in the study, comprising 53 Sri Lankan and 17 Thai graduates. About 90% of them were still actively working in their home countries. Most of them were employed as university lecturers and conducted scientific research to various degrees.

Revisiting formerly supported research groups and scientific networks:
In 2016–2017 a study was carried out of 49 research groups and eight scientific networks that had been phased out of ISP support in the period 2003-2014 (Andersson & Sundin, 2017). The aim was to investigate their continued activities at the time of the study. Ten research groups phased out of support in 2008 were back on ISP support again in 2016. Considering the remaining 39 (20 in chemistry, one in mathematics, and 18 in physics), only three (one in Peru and two in Sri Lanka) were found to be inactive, while one (in Tanzania) couldn’t be traced. The 36 ones still active implied a sustainability rate of close to 90%. Scientific networks were considerably more difficult to sustain after ISP support had been concluded. Six chemistry networks had ceased activities, one of them because its objectives had been fulfilled. Only one chemistry and one mathematics network were still active when revisited.

Tracing ISP graduates 2003–2013:
Concomitantly with the study of the sustainability of research groups phased out of ISP support, all 161 PhD graduates reported 2008–2013 by ISP supported research groups and scientific networks were subject to a tracer study, where 154 of them responded to a distributed questionnaire (Andersson & Sundin, 2016). A majority of the respondents (82%) were found to remain
in their home countries, while 10% had relocated to another country in their home region. Most of them were found to be employed at universities or research institutes while a few were employed at government agencies or at international organisations. The remaining twelve (8%) were found to be in OECD countries at the time, ten of them at universities.

Tracing ISP graduates 2014–2017:
A second tracer study comprised the 259 PhD graduates reported by ISP-supported research groups and scientific networks 2014–2017, and 250 of them responded to the distributed questionnaire (Andersson, 2018). This time 89% were found to be active in their home countries, and another 6% in their regions outside the home country, while twelve (almost 5%) were in OECD countries and China. A large majority was working in the academic sector, while slightly more than 5% of those found in their home countries were employed at research councils, government ministries and national authorities.

Explaining the “sandwich” model:
Following participation in the International Association of Universities 15th General Conference, in Bangkok, Thailand, 13–16 November 2016, and displaying a poster on the “sandwich” model, ISP was invited to explain the model in more detail, resulting in an article in the handbook of Internationalisation of Higher Education (Andersson, 2017).

The sandwich model means that in their training, the research students are alternating between the home institution and a scientific host. The name sandwich is inspired by a multi-layered sandwich, since the participating students build layers of knowledge and capacity from moving back and forth between their home and host institutions.

The sandwich model, which was originally drafted by ISP in 1967 (Lindqvist, 2001), gives students in less developed environments access and exposure to more advanced training facilities, new cultures (both academic and non-academic) and international research collaboration. This is done without having to detach from their home institution (and family) for several years.

All these studies show that the ISP model of support is working very well in building research capacity in low and lower-middle income countries.

Evaluating the performance of ISP’s partners
Besides the yearly reporting of activities, research results, etc., by ISP partners, aggregated in ISP’s annual reports, ISP initiated a practice of deeper evaluation of partners’ performance. During 2016 to 2020 three scientific networks were selected for external evaluation.
**Eastern African Universities Mathematics Programme (EAUMP):**

This mathematics network was launched in 2002 with support from ISP, originally comprising the departments of mathematics at University of Nairobi, Kenya, University of Dar es Salaam, Tanzania, and Makerere University, Kampala, Uganda. The mathematics departments of National University of Rwanda and Kigali Institute of Science and Technology joined in 2008 (and merged in 2013 when these two institutions became part of University of Rwanda). In 2009 University of Zambia joined the EAUMP network. The main activities of the network have consisted of capacity building via training of PhD and MSc students in local and in sandwich programmes; organising mathematics conferences and summer schools, network exchange visits, and coordinator meetings; research visits for postdocs to Sweden and elsewhere, as well as support for building up equipment and for research expenses.

The evaluation team expressed that the EAUMP network has played an absolutely essential and transformative role, at a reasonable and proportionate cost, in building mathematics research and teaching capacity throughout the Eastern African region, introducing new areas of mathematics and strengthening existing ones (Singull, et al., 2017).

**Materials Science and Solar Energy Network for Eastern and Southern African (MSSEESA):**

This physics network is supported by ISP since 2009. It has the objectives to complement the support received at individual nodes at the physics departments of the University of Zambia, Makerere University, Uganda, University of Dar es Salaam, Tanzania, and University of Eldoret and the University of Nairobi, Kenya. The objectives comprise a) strengthening of postgraduate training and research, b) inter-university collaboration in teaching, research and training, c) promotion of gender equity and balance, d) increase of research capacities of individuals and organisations, and e) dissemination of research findings and information. The network’s conception reflected the need for cooperation to share expensive instrumentation available at the different nodes, foster the exchange of junior researchers through travel grants, participation at conferences and workshops, and through the harmonization of study curricula across the participating universities, to intensify the exchange of technicians among universities, and allowing for a regular exchange of senior scientists.

The evaluation team concluded that the network has had difficulties to realise all the self-set goals and objectives, and advised ISP to continue support only under the precondition of a revised strategy and implementation plan following a set of recommendations (Beenken et al., 2019). After following the recommendations, MSSEESA has been very successful in its activities: it
has managed to increase its support to the students, increase collaboration, increase the exchange of senior researchers and students among the nodes and finally increase the number of publications where two or more nodes are involved. MSSEESA also started to organise a yearly workshop on Materials for Solar Energy Conversion, which attracts a large number of students, who have the opportunity to present their research to the whole network in talks and posters.

**Eastern and Southern Africa Regional Seismological Working Group (ESARSWG):**

This is a physics network that serves the collaborative seismological data collection and analysis for the countries along the African rift system. The nine nodes of the network are situated at either universities or government institutes in Ethiopia, Eritrea, Kenya, Malawi, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe. The members of nodes meet regularly for the catalogue creation and the compilation of a bulletin, which they share with the global seismological community. Most nodes operate a national network of seismological stations. In the past thirty years they have used the data they collected and analysed to inform national governments in the case of seismic events, they have provided information for disaster risk management officials in their respective countries and they have raised awareness about seismicity in the region. They have also pursued other geophysics research and used it to provide information to government agencies, societal stakeholders and industry.

The key findings reported by the evaluators were that the regional repository of knowledge at the network level is one of the main strengths, as well as the long-term monitoring and catalogue creation and sharing of data with the international seismic research community, while that the intra-network training on the MSc and PhD level need to be reinforced, as well as the planning and communication (Babyesiza et al., 2020).

**Looking into fundraising possibilities**

Following the conditions given by Sida in 2012 to increase the financial independence, ISP started to prepare for possible fundraising in 2014. In 2016, a professional consultancy was engaged for the purpose, and was commissioned the task to look into the basis for attraction of donor funds to complement Sida funding. Considerable efforts and resources were devoted to identify possibilities to attract supplementary contributions. The conclusion, however, was that ISP has to become better known in the environments were potential contributors move. This would require investment of substantial time, not the least for social interactions. In meetings with the consultancy, it was indicated that far more than 50% of the working
hours of the head of ISP and other staff members dedicated to the task might be required, and the outcome would still be uncertain. Not to jeopardize the operation of the programme the idea of scaling up the investments and efforts to allow for fundraising at such a level, therefore, had to be abandoned.

**A second five-year agreement with Stockholm University**

After a review by the Faculty of Natural Sciences at Stockholm University (SU), based on ISP’s compilation of the achievements in the first five years (ISP, 2015a), a second agreement was established for the period 2016–2020. Besides continued support to chemistry and physics research groups in Laos, the SU funding also facilitated the collaboration with the American Institute of Physics (AIP), which had been initiated in 2014; the multitude of books in various fields of physics that AIP every year receives for review are made available to ISP, and sent to ISP physics partners.

**ISP and the SDGs**

At the Development Research Conference 2016 in Stockholm, Sweden, ISP realised the need to directly relate its activities to the Sustainable Development Goals (SDGs). Soon, a sheet on how ISP’s supported activities are contributing to the SDG’s was published on ISP’s web: “Addressing local challenges – ISP and the Sustainable Development Goals”. From 2017 and onwards, the scientific research findings by ISP partners have been related to the SDGs in the presentations of research results in the annual reports.

**Broadening the skill set of ISP’s Board**

The 2011 evaluation made a recommendation, that "Uppsala University should consider the benefits of broadening the skill set of the ISP Board to include members with experience in development cooperation and in the politics and bureaucracy of the focus countries." In the revision of UU’s instruction to ISP in 2016, a new category of Board member was introduced, “Representing considerable experience of work outside the academic sphere, of relevance to the programme. In May 2017, Hans Corell was appointed in this category. He served as Under-Secretary-General for Legal Affairs and the Legal Counsel of the United Nations between 1994 to 2004.

**The evaluation 2018 introduces new ideas**

In early 2018 Sida commissioned a new evaluation of ISP, to be carried out. The report introduced a concept new to ISP – “Theory of Change”4 – as an important basis for any intervention aiming at improvement and as a

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4 The “Theory of Change” approach describes how and why an intervention at a certain starting point is assumed to lead to a desired result. The method helps to identify risks and solutions to address causes of problems that hinder progress.
complement to RBM (Pain et al., 2018). The evaluators found that ISP does a good job for the public good in its partner countries, that its support to the development of research capacity has been broadly relevant, and that it is aligned with Swedish policies for research in development cooperation. However, the evaluators also raised a number of concerns and gave several recommendations, which were thoroughly considered in the development of a new ISP strategic plan.

**Sida invites ISP to apply for a new agreement period**

In late 2018 Sida communicated its decision to extend the agreement 2014–2018 to include also 2019 and concomitantly invited ISP to submit an application for continued support from 2020, taking a starting point in the conclusions and recommendations of the 2018 evaluation. Sida asked ISP to continue working in low and lower-middle income countries, in particular considering those characterised as “fragile”. Among the developments Sida asked for in the invitation were:

- A clearer time horizon and structure in the support to research groups and scientific networks, with a systematic follow-up of the progress in developing research capacity.
- A clearer, more homogenous and transparent structure in the operation of the ISP scientific reference groups.
- A review of the results framework with the aim to clarify the hierarchy of the goal structure and increase its usability.
- A description of how support to postdocs can be included in the intervention.
- How to best complement Sida bilateral support to research development, in cases where ISP operates in the same countries.

**The founder of the chemistry programme sadly passes away**

In September 2018, to great dismay, the news reached ISP that Professor Rune Liminga, the founder of the chemistry programme, had passed away, at an age of 85. Besides the support to viable research teams, Professor Liminga at an early stage realised the importance of forming connections between scientists in the South in thematic, scientific networks. He was personally engaged in the initiating of several such networks, many of which are still active today. In many respects, Professor Liminga’s visions and work to develop ISP chemistry became a model for what ISP is still today, and many hundreds of researchers and graduates in Africa, Asia, and Latin America have benefited from the implementation of his visions.
2019–2021: Progress continues, but the pandemic hampers the activities

A new strategic plan 2019–2024 and a new agreement with Sida

In the strategic plan 2019–2024 (ISP, 2019), ISP’s operational approach was clarified in a Theory of Change perspective. The basic mode of operation was proposed to remain, while the strategies adopted in the 2014–2017 plan were critically reviewed. A number of new strategies were introduced in response to the recommendations in the evaluation in 2018.

One point of criticism raised in the 2018 evaluation was that ISP didn’t have an established “baseline” for the chronological capacity development, so that the groups’ or networks’ progress could be assessed over time. This was in part a reflection of the concern by the evaluators that the indicator data presented in the annual reports are only at the aggregated level, which obscures the development of the activities of individual partners. However, all individual data are at hand in the annual activity reports and in the applications by ISP’s partners. Consequently, the baseline conditions are well documented in each partner’s first application to ISP. This information, however, had not earlier been systematically compiled. Therefore, as a new strategic tool was proposed, facilitating the follow-up also by the scientific reference groups of the development of individual partners and to permitting periodical planning of progress expectations over a number of support agreement cycles. The “baseline” and development monitoring tool – a retrospective data sheet for each partner – was developed and put to use from 2020.

The evaluators also questioned the lack of a time horizon in the otherwise appreciated, long-term approach of ISP support. In the strategic plan, ISP proposed as a possible modality to plan for a fifteen-year period of support, when initiating (new) support, consisting of five three-year agreement periods. The fifteen-year horizon, as envisioned in the strategic plan, could be stretched for a number of additional three-year agreement periods should an evaluation of the progress point to the need of that.

The application to Sida that was submitted in 2019, including the ISP strategic plan 2019–2024, finally resulted in an agreement for 2020–2023 regarding continued Sida contributing to the operation of the programme.

A pandemic raises challenges and introduces new practices

The corona virus threat emerging in the end of 2019, and spreading over the world to pandemic proportions during the spring of 2020 seriously hampered many activities world-wide. As countries locked down, imposed travel restrictions and bans, and introduced forced or recommended isolation, the
regular operation of ISP with frequent long-distance travel of staff and
programme participants was seriously impaired. Besides staff traveling, in
particular sandwich PhD students were affected, as some of them were stuck
over considerably prolonged periods with hosts and in many cases in isolation,
not able to continue research work.

Still, the introduction of improved tools for online communications, allowing
for group meetings and even conferences, partly ameliorated the situation. ISP
staff as well as partners gradually introduced improved means of online
communication in addition to email and the social media used already in
earlier years. In many cases, ISP partners were urged to use budgets for
traveling to instead improve internet connectivity and computer facilities
allowing for the increasing necessity of online communication. During the
latter part of 2020 and in 2021 facilities and skills improved. ISP staff and
partners participated in scientific, online conferences, and participation
became even easier. During the larger parts of 2020 and 2021 all meetings at
ISP were held online and most staff participated from home. Some meetings,
such as ISP scientific reference group meetings with participation from
countries over a span of twelve time zones, proved to be a challenge but were
finally successfully executed.

A notable development under the pandemic is the African Mathematics
Seminar (AfMS) – a weekly online seminar for the whole of Africa – that was
launched in 2020. It is alternating through different regions, giving different
countries a chance to host the seminar. Also, here the benefits of online
meetings become clear, because among speakers have been many renowned
mathematicians, many of who might be hesitant to the long-distance traveling
otherwise required. In addition, all participation is independent of where in
the world participants sit.

Another example of a successful transformation from physical meetings to
online events, is the digital research management workshops on the necessity
of academic planning and a well-established research culture that Dr Cecilia
Öman, assistant director to the ISP chemistry programme, has held with
supported partners and their institutional leadership and interested staff and
students. On-line events allow for much more frequent contact than was the
case when such activities depended on traveling and physical presence.

**Stockholm University entrusts ISP a continued contribution**

Following a review of the progress of the activities financed by the
cooperation 2016-2019, the Faculty of Science at Stockholm University

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5 https://sites.google.com/view/africa-math-seminar/home
decided to continue the cooperation agreement, which is presently in its third five-year cycle, 2021–2025.6

**The agreement with TICA is renewed**

So far, three of the PhD trainees admitted in the programme with TICA have completed their periods in Sweden, and the man from Myanmar has successfully defended his PhD thesis in Thailand in September 2021.

In 2019, an organisational change by Thai authorities replaced TRF with Thailand Science Research and Innovation, at the National Research Council of Thailand (NRCT), under the Ministry of Higher Education, Science, Research and Innovation. Simultaneously, preparations for a second agreement period were carried out. An updated MoU was signed in 2020. Besides NRCT replacing TRF, the scope of the agreements was expanding the uptake area to “countries outside Thailand in the South and South-East Asian region, of interest to all parties”, which for ISP implies low and lower-middle income countries in general.

![Figure 2. The Myanmar fellow of the “TICA-ISP programme”, Mr Soe Ko Ko Aung (far right), successfully defending his PhD thesis at Sakon Nakhon Rajabhat University, Thailand, in September 2021. The Swedish supervisor and ISP representatives participated online.](image)

**A new agreement with the Thailand Centre of Excellence in Physics (ThEPCentre)**

In a spirit similar to the TICA-ISP agreement, based on earlier ISP support to physics research groups in Thailand, ISP was approached in 2020 by the Executive Director of ThEPCentre (Thailand Centre of Excellence in Physics), with a request for an agreement, which was established in early

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6 Full details of the development of the cooperation are given in ISP (2015a) and ISP (2020).
2021. It implies that ThEPCentre member universities accept receiving ISP associated physics PhD students and postdoctoral fellows for training periods of up to one year, at the expense primarily of the physics group or network sending the student/fellow. ISP commits to establishing contacts in Sweden for Thai physics postdoctoral fellows, as far as possible, at the expense primarily of ThEPCentre or the fellows affiliated member university.

**A new agreement with UNESCO-UNISA**

In response to a request for cooperation from the UNESCO-UNISA Africa Chair in Nanoscience & Nanotechnology of the NRF\(^7\)-iThemba laboratories for Accelerator based science, University of South Africa (UNISA), an agreement was established in 2021. The scope implies that UNESCO-UNISA accepts ISP associated physics PhD students and postdoctoral fellows for training periods of up to one year at the expense primarily of the physics group or network sending the student/fellow.

**A one-year long celebration of ISP’s 60\(^{th}\) anniversary**

In 2021 ISP’s 60\(^{th}\) anniversary was celebrated, unfortunately negatively affected by the pandemic, which still caused travel and meeting restrictions. Three events were conducted:

- The “Building Future Networks” workshop, yearly organised together with Sida since a number of years back, was held online 22 April 2021, as a 60\(^{th}\) anniversary event. The “building future networks” workshops have previously been open for ISP- and Sida-supported students in Sweden, but since the event now was online also ISP supported PhD students from abroad could participate. Among other things, the workshop trained students in presenting their research in an easily comprehensible way.

- A workshop on “Gender, Diversities and Unconscious Bias” was organised together with the Centre for gender research at Uppsala University, Sweden, and held online 9–10 September 2021.\(^8\)

- A “Grand Celebration” event was held online 14–15 December 2021, with the participation and contributions by, among others, ISP staff and ISP Board members, representatives of ISP currently and previously supported partners, and Sida, including a speech by Carin Jämtin, the Director General of Sida.

\(^7\) NRF = National Research Foundation of South Africa.
\(^8\) The workshop is presented in the chapter: “ISP Gender workshop on 9–10 September 2021”.
In addition, throughout the year, fifteen “#ISP60YEARS webinars” were given, where primarily ISP partners took the opportunity to meet a wider audience online.

Finally, the present volume, documenting the latest 20 years of ISP development, up to the year 2021, is the ultimate and long-lasting account for the 60th anniversary.

Anticipations for the nearest future

The operation of ISP is expected to continue, from July 2020 along the development path outlined in the strategic plan 2019-2024 and under the guidance provided by ISP Board, by Sida, and by other cooperation partners. The new habit of meeting and conferencing online, using improved tools for the purpose, will most likely replace many traveling hours, while allowing for more frequent contacts between ISP and partners as distance no longer matters.

As former head of ISP, I am happy to conclude that the ISP core programme continues to thrive and flourish; every year the number of graduated ISP students and quality dissemination of research results increase. Many ISP supported research groups and networks develop their capacity to a level where they can be “self-sufficient”, that is, successfully attract competitive grants, alone or together with scientific partners. ISP can then open new support where such development is still needed.
Sida assignments 2000–2021

This is a brief account of ISP’s engagement as coordinator in Sida’s bilateral and regional programmes for support to scientific research and institutional development in partner countries, as well as other Sida assignments to ISP.

ISP is/has been engaged in the following Sida bilateral research programme:
- Bolivia, 2021 – ongoing
- Cambodia, 2019 – ongoing
- Eritrea, 1997–2005
- Ethiopia, 1987 – ongoing
- Mozambique, 2007 – ongoing
- Rwanda, 2008 – ongoing
- Sri Lanka, 1984–2010
- Tanzania, 1986 – ongoing
- Uganda, 2001–2022
- Zimbabwe, 1999–2003

In addition, ISP was engaged to carry out an evaluation of the Asian Regional Research Programme on Environmental Technology (ARRPET), 2007–2008. (Sundin et al., 2008)

ISP was also assigned to coordinate a post-graduate school on natural disaster mitigation in Central America (NADMICA). This was launched as a 12-year project in 2002, but the final year of Sida support was already in 2003, because “no agreement between Sida/SAREC and the Central American counterpart had been reached” 2002-2003 (ISP, 2003a). Between 2008–2019 it was replaced by a regional postgraduate school on nature-induced disaster mitigation, on the Central American side coordinated by Consejo Superior de Universidades Centroamericanas.9

Since 2012 ISP has also been responsible for the payment of subsistence allowances to participants in the Sida bilateral programmes.

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9 The activity was fully transferred to the ISP core program in 2012, the final year was 2019 when the last participant graduated with a PhD.
References


Sida (2022) AAU on the Go. 40 Years of Research Cooperation between Addis Ababa University and Sweden. Achievements and Challenges


Success Stories:
Learning and Experiences
The Growth of a Fledgling Research Group in Kenya –
The Contribution and Impact of ISP

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Background

The University of Nairobi was established in 1970. It has its roots in the Royal Technical College which started in 1956 and in 1961 became the second university college of East Africa under the name “Royal College Nairobi”, further renamed “University College of Nairobi” in 1964. The University College prepared students for BSc in engineering, and BA and BSc general degrees (in humanities, social sciences, and sciences), in special relations (arrangements) with the University of London that had served as the mentor. The Department of Physics is one of the oldest departments.

From the mid-1980s the capitation from the government to the university, and hence the subventions to teaching departments, rapidly declined against the increasing number of students enrolled. Consequently, research outputs declined due to a paucity of scholarships for postgraduate students, obsolescence, deficiency, and inadequate maintenance of the research facilities. Hardly any new research equipment was purchased in this period, except in 1995 when some were acquired under a World Bank grant. As the government capitation decreased so did the number of scholarships available to postgraduate students, and the value of these few ones was not matching the rise in living and research costs. This is despite the thirst for postgraduate level education evidenced by the growing number of self-sponsored postgraduate students seeking admission into the MSc or PhD programmes. The long-running insufficient funding to the Department of Physics and the research students explains the hitherto low scientific outputs that emanated from the department in the period preceding the year 2000. The weak research support systems and infrastructure formed the basis for applying for ISP funding. This paper gives a short overview of the impact of ISP funding on the success of our group and the achievement of these objectives.
Impact of the ISP funding

Our active interaction with the International Science Programme (ISP) through its physics division – the International Programme in Physical Sciences (IPPS) – started around 1997, courtesy of Professor Lennart Hasselgren (then the Director of IPPS) during one of his visits to our Department of Physics while transiting through Nairobi. At that time our research group comprised three PhD-holding senior lecturers (two locals, including the author, and one expatriate of Indian nationality), and three junior academic staff members. This interaction resulted in us developing and submitting to ISP a proposal that focused on solar photovoltaics (especially the dye-sensitized solar cells). The two key objectives were:

1) To increase the scientific knowledge, and contribute to a higher education sector important to local (Kenya) and global development, and relevant policy advisory through training and research in photovoltaics (PV);
2) To popularize the use of PV technology to provide alternative energy.

In actualizing objective 1, we have directed our photovoltaic research mostly to i) dye-sensitized solar cells (DSSC), ii) all-solid-state dye-sensitized solar cells and the extremely thin absorber (eta) solar cells, and iii) perovskite solar cells.

The ISP support commenced with the skills enhancement of the key personnel of the group around whom the research on the DSSCs would be sustained. Thus, the two local (Kenyans) lecturers and a technologist had a three-month fellowship at Uppsala University in 1998 and 1999 respectively. Despite this positive start, however, one of the lecturers trained in the DSSC, and the Indian expatriate left the services of the University of Nairobi in late 1999. Notwithstanding these setbacks, the first three-year grant from ISP started being released in 2000, which was indicative of ISP leadership’s strong belief in the potential of the budding research group, and subsequent three-year grants have followed.

The three-year grants from ISP cover: i) purchase of equipment/spare parts and service, ii) consumables/literature (journal subscription and publication fees)/fieldwork, iii) conferences/ workshops (attendance and organisation), iv) exchange visits by cooperating scientists (North-South, and South-South), v) support to students, vi) activities for improving gender balance.

Each grant proposal request has been rigorously evaluated by the ISP reference group in physics — rigor which has helped us stay focused and thorough. The execution of the funded proposal, budgeting, and annual
reporting is solely our responsibility, however, ISP monitors, evaluates and ensures accountability. It is worth pointing out that we have often consulted with the cooperating scientists, particularly from Uppsala University to guide us whenever we are procuring expensive research equipment. The freehand and control we enjoy in directing the activities together with the prompt support of ISP whenever requested, e.g., in procuring the equipment, and in the placement of fellows (students and staff), have been very crucial for the success of the project.

The growth in our research group is reflected in diverse ways. Firstly, there has been a notable increase in postgraduate students’ completion rates. Despite the staffing setback we suffered in 1999, the three junior staff members mentioned earlier completed their PhDs: one from the University of Dar es Salaam (1999) and two (whose electron microscopy work at another institution was funded by the ISP as local funds) from the University of Nairobi in 2000 and 2002 respectively, thereby boosting the group’s numbers. Further, between 2002 and 2007 five younger staff members, who had completed their MSc in the group, were recruited for staff development. They subsequently enrolled for their PhD degree in the department in the area of solar cells, and four of them completed their PhD between 2008 and 2010 and the fifth one in 2013. The reasonably faster PhD programme completion rate of about four years was largely due to the ISP grants that facilitated fellowships at Uppsala University, and the availability of consumables and research equipment at the department. Technologists have equally had opportunities to upgrade their skills to support research activities. Eventually, we became the largest research group in the department and in the MSSEESA network. 10 All this has been contingent on strong group leadership, teamwork and mentorship.

Secondly, as the improvement in postgraduate students’ completion rates became more evident, so did the quality of the research work and outputs like theses and journal publications, accompanied by enhanced visibility of our work. Just to mention a few examples of our studies and results on dye-sensitized solar cells (DSSCs) we have studied and published about sensitization using natural anthocyanin dyes (Simiyu et al., 2002, Simiyu et al. 2010); thin films for DSSC photoanodes- nitrogen-doped thin films for use in DSSCs (Lindgren et al., 2003, Mwabora et al., 2004); electron drift in porous TiO₂ (Aduda et al., 2004); all-solid-state DSSC (Dittrich et al., 2005, Ogacho, 2010) and extremely thin absorber solar (eta) cells (Bayon et al., 2005, Musembi et al., 2008); electron transport and recombination in DSSC (Waita et al., 2007, Waita et al., 2008, Waita et al., 2009) and modulation

10 Materials Science and Solar Energy Network for Eastern and Southern Africa (MSSEESA), network supported by ISP.
(Nissfolk et al., 2010); various composite thin films for PV applications (Odari et al., 2013, Nguu et al., 2014, Nguu et al., 2018, Ovino et al., 2020, Odari et al., 2018, Ovino et al., 2019, Okwako et al., 2019); perovskite solar cells (Obila et al., 2021a, Obila et al., 2021b).

In our second objective, we have been promoting photovoltaic energy uptake and sector growth in Kenya through value-added training (the Solar Academy initiated in 2012) in PV sizing, installation and maintenance (Simiyu et al., 2014). The foundation of this programme is human resource trained through fellowships, the equipment and other requisite consumables availed using the ISP funds.

In the Solar Academy programme we offer a rigorous two-week hands-on training to solar PV systems technicians, and Figure 1 shows a typical practice session. Since initiation we have trained over 400 technicians, from within the East Africa region and Somalia, who have gone on to professionalise the design, sizing, installation and maintenance of the solar PV systems – key ingredients to the acceptance of these solar PV devices by the populace. Further, our group members continue to offer consultancies, and participate in training and functions/policy-inclined meetings that promote or regulate the use of solar PV systems (renewable energy). For example, through invitation, we have participated in workshops organised by the Energy & Petroleum Regulatory Authority (EPRA) on Solar Photovoltaic regulations and regulatory impact assessment (RIA). Through such forums we have thus influenced government policies and regulatory frameworks governing the solar PV sector in Kenya.

Figure 1: A hands-on session during the Solar Academy training.
Besides studies revolving around PV solar cells and thin films, we have studied ceramics for thermo-physical applications (Ogachó et al., 2003, Ogachó et al., 2006, Njogu et al., 2006) in order to optimise thermal insulators (refractories) for use in energy conservation in energy-efficient charcoal cooking stoves, and for nano-porous point-of-use water purification (Yakub et al., 2013, Simiyu et al., 2020) targeting rural folks. The high-temperature furnace and ball-mill purchased through the ISP funds are pivotal in processing these ceramics.

The ISP grants have been critical in our human resource capacity enhancement. The research mentioned above has been undertaken mostly by postgraduate students – many of whom have received direct financial assistance (full or partial tuition payment, stipend for female students, and procurement of research consumables) and staff members who have had fellowships in Sweden, in particular at Uppsala University. The fellowships to the academic staff and technologists, together with the financial support to attend and organise conferences, have enhanced their productivity leading to career growth (promotions) and recognitions – both nationally and internationally. Furthermore, virtually all our PhD graduates have been absorbed as lecturers in public universities in Kenya hence contributing to quality higher education.

Access by students from other Kenyan and regional universities (in the MSSEESA network) to our group’s human resource base and research equipment has enhanced our capacity and capability to train more postgraduate students whose completion rates, quality of theses, and confidence have considerably improved. The net effect has been to raise the profile of the research activities of the department which culminated in the University of Nairobi (our group) being competitively selected as an African host university for renewable energy to train PhD candidates by the Regional Scholarship and Innovation Fund-Partnership for Skills in Applied Sciences, Engineering and Technology (RSIF-PASET) programme.

Finally, it is noteworthy that our Department of Physics has been male-dominated for years. The enrolment of female students both at undergraduate and postgraduate levels has been rather low, which is subsequently reflected at the academic staffing level. To address this imbalance, we have used the ISP grants to affirmatively partially support (with stipend supplementation or partial tuition payment) female students in the MSc and PhD degree programmes, or internships to selected female students in the 3rd year of their BSc programme. This affirmative action targeting female students has resulted in a reasonable number of our female students at the BSc level choosing to major in physics, and thereafter enrolling in postgraduate degree programmes. Notably though, the female students enrolled in the postgraduate
Programmes tend to take somewhat longer time compared to their male counterparts to complete their studies – a factor attributed to their starting families while still students.

The outputs and outcomes arising from the ISP support are summarized in the logical framework matrix given in Table 1. These modest outputs would have been much lower without the ISP grants.

Outlook

The significance of the ISP grants to our success and well-being cannot be gainsaid and its absence would definitely negatively affect our research activities, especially concerning research equipment acquisition and maintenance, and support to female students. Whereas we have intermittently obtained grants from other sources, such funds are on-off and the activities they support are narrow and limited.

Conclusion

The ISP funding has helped us develop human resources, research infrastructure, and initiate new relevant courses and training in solar energy, materials and solar PV systems. This capacity and capability have been recognized regionally resulting in greater responsibilities as a regional Centre of Excellence.

The grants have enhanced collaborations, and enabled young and upcoming scientists to attend international conferences thereby increasing their confidence level in both presentation of results and research. The completion rate of postgraduate students has improved considerably, and so has the quality of their research work that has been published in reputable refereed journals. Members of the group have had promotions and professional growth. The group has contributed to the continued growth of PV systems in Kenya.

The contributions from ISP have helped us be founder members and part of the regional MSSEESA network, and also forge international collaborations. Finally, all these outcomes are a pointer to the positive impact of the ISP grants to the hitherto small research group.
Table 1: Summary in the group achievements in the years 2000–2021.

<table>
<thead>
<tr>
<th>Type of Output</th>
<th>Performance indicator</th>
<th>Outcomes</th>
</tr>
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<tbody>
<tr>
<td>PhD &amp; MSc, and solar PV systems technicians trained</td>
<td>12 PhDs (11 males and 1 Female) graduated. 24 MScs (20 males and 4 Females) graduated. More female postgraduate (PG) students’ enrolment (4 PhDs; 4 MScs) as of 2021. PV Technicians trained &gt;400.</td>
<td>- The PhD and MSc graduates mostly work in universities &amp; tertiary institutions thus contributing to improving standards of education at tertiary level; - Dissemination of scientific knowledge on solar PV materials &amp; systems; - Improved gender parity in postgraduate studies; - Better design, installation, maintenance, performance, and acceptance of PV system by Kenyans.</td>
</tr>
<tr>
<td>Journals articles</td>
<td>110 articles published in refereed journals, mostly international.</td>
<td>- Scientific knowledge on PV materials &amp; systems; - High visibility of the group hence competitively being selected to host RSIF-PASET PhD students in “Energy including Renewables”; - Career growth of group members to higher academic positions (8 staff promoted to higher grades).</td>
</tr>
<tr>
<td>Conference presentations</td>
<td>170 presentations made in local, regional and international conferences.</td>
<td></td>
</tr>
<tr>
<td>Conference attendance</td>
<td>Group members have attended 141 local, regional and international conferences.</td>
<td></td>
</tr>
<tr>
<td>Conferences/workshops organised</td>
<td>The group has organised 6 regional conferences/workshops.</td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td>- Several North-South staff and students visits made /received by the group. - The group is a founding member of MSSEESA resulting in several South-South visits. - Over 70 intra-country postgraduate students have used our equipment.</td>
<td>Global community &amp; quality scientific outputs (human resource and publications). Accelerated rate of postgraduate studies completion.</td>
</tr>
<tr>
<td>Policy briefs</td>
<td>- Invitations to solar PV policy-meetings - Consultancies offered to county governments &amp; NGOs on solar PV.</td>
<td>Favorable government solar PV policies at National and County Government levels.</td>
</tr>
<tr>
<td>Gender parity enhancement</td>
<td>More female students have enrolled for PG physics programmes (4/11 in PhD; 4/10 in MSc as of February 2021).</td>
<td>Increasing gender parity in the physics postgraduate programmes.</td>
</tr>
</tbody>
</table>
References

*International Journal of Photoenergy*, 6, 141 – 147;

R. Bayon, R. Musembi, A. Belaidi, M. Bär, T. Guninskaya, M.-Ch. Lux-
Steiner, (2005). Th. Dittrich Highly Structured TiO$_2$/In(OH)$_x$S$_y$/PbS/PEDOT:PSS for Photovoltaic Applications,

Th. Dittrich, H.-J. Muffer, M. Vogel, T. Guninskaya, A. Ogacho, A. Belaidi, 
236 – 243;

Lindgren T., Mwabora J. M., Avendano E. D., Jonsson J., Hoel A., Granqvist 

R.J. Musembi, M. Rusu, J. M. Mwabora, B.O. Aduda, K. Fostiropoulos, M. 

J. M. Mwabora, Torbjörn Lindgren, Esteban Avendano, Thomas J. Jaramilo, 

Electrophoretic Deposition of TiO$_2$/Nb$_2$O$_5$ Composite Electrode Thin Films for Photovoltaic Application. *J. Ener. And Power Eng*. 8, 757 – 764;


J. Nissfolk, K. Fredin, J. Simiyu, L. Haggman, A. Hagfeldt, G. Boschloo, 


Jacinta Okwako. (2010). Optical and Electrical Characterization of Cu₂ZnSnS₄ Deposited by SILAR Technique. MSc. University of Nairobi (2019);


History of Seismology and Impact of ISP Support in Ethiopia

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Background

Seismological observation in Ethiopia started with Wood Anderson and Willmore seismometers and photographic recording just two years after the establishment of the Geophysical Observatory in 1957. A research programme in seismology commenced in February 1959 by the initiative of the observatory, considering Addis Ababa’s location at the rim of the Main Ethiopian rift which is part of the East African Rift System that forms a triple junction in Afar with the Red Sea and Gulf of Eden oceanic rifts. Crustal faulting and deformations by earthquakes and volcanism are considered to be potential hazards in the region as shown with an example in Figure 1.

In 1963, with the establishment of a World-Wide Standardized Seismographic Network (WWSSN) station in Addis Ababa, Ethiopia (AAE), a more systematic study of local earthquakes was made while fulfilling the routine operation of the earthquake recording facility. The first director of the observatory was a French-Canadian Jesuit, Father Pierre Gouin, who efficiently directed the observatory from 1957 to 1978. The routine interpretation of seismograms and the determination of earthquake parameters for local and regional events led to the publication of several research papers and a book, Earthquake History of Ethiopia and the Horn of Africa, by Gouin (1979). The station was one of the very best-operated stations worldwide and produced excellently recorded seismograms, as readers can see in the Seismo Archives of earthquakes with scanned WWSSN seismograms.

In 1982 things started to get better with the observatory getting support to develop its infrastructure and train scientific and technical staff through the support of the Ethiopian Science and Technology Commission and the Swedish Agency for Research Collaboration with developing countries (SIDA/SAREC). SIDA/SAREC funded the observatory to develop programmes geared toward solving development problems of the country, particularly concerning manpower training and natural hazards mitigation which continued until the year 2000. It must be recalled that before 1982, the
research programmes of the observatory were largely determined by the research needs of foreign institutions that came with their own research agenda. Under the new support, the observatory was for the first time given the chance to develop its manpower and infrastructure to solve felt needs in the country. Under this paradigm shift, the programme of the observatory between 1982 and 2000 was largely focused on capacity building in infrastructure and training manpower.

Figure 1: Ruins of Serdo village after the main shock of 29 March 1969 with magnitude 6.3. Nothing was left intact except the wooden shack of the telecommunications board (upper left, plate 1) and a wooden house north of the town. The letter A locates the highway authority compound. B the reinforced concrete water tower leaning about 5° SW, and C the village school that had housed 30-35 students 2 hours before the earthquake. Plates 3 and 4 show the water tower, deprived of its brick facing, but still standing among the ruins of the post office and police headquarters.

The AAE seismic station, as part of WWSSN, was upgraded to a digital station in 1994 with the new SIDA/SAREC support that enabled us to procure one Guralp 3T seismometer and Nanometrics digitizer which revolutionized seismic data analysis in the observatory. At the same time, the excavation and
construction of the FURI station started beneath Mount Furi and the station was commissioned and started its operation in 1997 sponsored by and affiliated with Incorporated Research Institute for Seismology/United States Geological Survey (IRIS/USGS). Other seismic stations namely DESE, ALME, and WEND were established through the same support.

Current status of the Ethiopian Seismic Station Network

The SIDA/SAREC financial support elevated the capacity of the Geophysical Observatory in equipment, field vehicle, and trained manpower with an incredible impact on institutional development. The objective of this project was to build the monitoring capacity of the observatory with the intention that, when the SIDA/SAREC support would start to decrease, the financial gap would be bridged by Addis Ababa University from the Ethiopian side, so that the built capacity would be maintained. However, that was not the case: when SIDA/SAREC support stopped in 2000, foreign procurement for equipment and spare parts was at stake, and the activities could survive thanks to Professor Lennart Hasselgren of Uppsala University who was the then International Science Programme (ISP) director. We convinced Professor Hasselgren to support the seismological activity of the observatory and ISP secured a small grant in 2005 for the maintenance of one malfunctioning Guralp CMG 3T broadband sensor and to purchase a Guralp-made breakout box and handheld control unit. The full-fledged three years duration support of ISP started in 2006 and is still going, and very substantial results have been achieved. The major impacts of this project are the following:

**Monitoring seismic and volcanic activity in Ethiopia and the Horn of Africa**

Afar and the Main Ethiopian Rift (MER) are among the best natural laboratories to study the transition of continental rifting into oceanic rifting, a special conformation that has attracted several earth scientists from Europe and North America over the years. The Atlantic Ocean and many other places beneath the water are the best sites to study rift processes but they are logistically cumbersome and financially expensive. This makes the prototype oceanic rift in Afar, which is located on dry land, the best place to conduct basic research on the development of rifts worldwide. The ISP supported geophysics (seismology) programme has strengthened the Ethiopian Seismic Station Network (ESSN) since 2005 helping to monitor the earthquake and volcanic activity in Ethiopia and the whole rift region at large, bringing a positive socio-economic impact and also galvanizing international collaborations by becoming a proxy of earthquake and volcanic activities. *Figure 2* shows the seismicity of Ethiopia and the neighbouring region with the location of the Ethiopian seismic station network mainly established
through the financial support of ISP. Among these stations, real-time data are obtained only from FURI and AAE while the DESE and HARA stations have some problems due to network and security issues. Meanwhile, to monitor earthquake occurrences, real-time data acquired from stations AAE and FURI are not enough.

Therefore, the institute uses additional real-time stations in Djibouti (ATD), Kenya (KMBO & LODK), Uganda (MBAR) and Saudi Arabia (RAYN). For the same purpose, these countries also use data from IGSSA’s stations. However, the construction industry in the country demands to have more real-time stations in order to deal with the risks posed by earthquakes. We can therefore say that our basic research in earth science could develop so well because of this ISP-supported capacity and we could therefore attract several world-class scientists who published their results in high-profile journals including *Nature*.

![Figure 2: Seismicity of Ethiopia and its neighbourhood, with the red dots showing locations of earthquakes that occurred in our region while the purple triangles indicate the locations of our stations. The seismic stations are all three-component digital with GPS time stamping and almost all are broadband stations.](image-url)
Centre of Excellence for postgraduate and short-term training

IGSSA hosted MSc training in seismology for MSc students who came from the East Africa region. Figure 3 below shows three students who came from the Eastern and Southern Africa Regional Seismological Working Group (ESARSWG) member countries and hosted by Addis Ababa University with the financial support of ISP for their MSc study in Seismology. Several workshops are hosted at IGSSA to train seismic data analysts and field engineers in seismology, open for trainees that come from the East Africa region, and also for some of our staff who actively participate as manpower to contribute to the development of seismological measurements hosted by other countries in the region with the support of ISP. Generations of experts have been trained with this arrangement and some of those who started with this training obtained their PhDs and are now seasoned professionals in their countries.

Figure 3: Regional MSc students in seismology that have been hosted by IGSSA. From left to right: Mr Baxter C.D. Chimlambe (Malawi), Daniel M. Mutamina (Zambia) and Mr Katumba M. Fredrick (Uganda). Daniel and Baxter obtained their MSc degree in 2008, Katumba moved to South Africa to study medical physics.

Providing earthquake catalogue input for building code revision

The seismology and geotechnical engineering unit serves as a member of the National Building Code Revision Committee, which is supervised by the Ministry of Construction and Urban Development of Ethiopia. In that regard, we have provided high-quality data and managed to produce the third generation building code which has a huge implication of national importance.

The seismic input is provided in terms of the seismic hazard map displayed in Figure 4. A seismic hazard map needs to be renewed every 5-10 years with
the addition of more data, and to this scope, the on-going data collection sponsored by ISP will have tremendous importance.

**Seismic data for strong support for safety issues of the Grand Ethiopian Renaissance Dam project**

Ethiopia possesses a distinctly rugged terrain, and it is a country where some of the highest-elevation areas in the whole of Africa can be found. One striking feature of the country’s topography is the huge disparity between the elevation of different parts of the country, with the highest point, Ras Dejen (Semien Mountains), rising to an elevation of 4,550 meters above sea level, and the lowest point, Dallol (the Afar Depression), descending as low as 125 below sea level.

One result of this stark contrast in elevation is the enormous diversity in the flora and fauna which flourishes in Ethiopia, and the rugged nature of the country, combined with its many perennial rivers, has bestowed another salutary feature: this rugged terrain and abundant river-water supply affords Ethiopia ample opportunity to build dams for hydropower generation and irrigation, both of which could benefit not only Ethiopians but also people in neighbouring countries. Exploiting this potential, Ethiopia has, in the last
couple of decades, aggressively initiated several dam-construction projects for power generation – with the Grand Ethiopian Renaissance Dam (GERD) being the largest and the most ambitious of these. The safety of the GERD site is evident from Figure 5 where no seismicity is reported in the Dam area and this map has been used by the national panel of experts for negotiations with downstream countries who feels uncomfortable about the safety of the GERD.

Figure 5: Seismicity of Ethiopia and the neighbouring region. Red dots: locations of earthquakes with circle sizes proportional to the corresponding earthquake magnitude. The white stars show capital cities in the region, the yellow stars show major towns in Ethiopia and the green rectangle shows the location of GERD.

Conclusion

The ISP support for seismological activities in Ethiopia has a lot of implications of national importance. The built capacity is not only benefiting Addis Ababa University but the country and the region at large. We believe that this culture will be maintained for some time to come with proper transition from ISP support to homegrown support by the Ethiopian side.
Summary of the current and active projects

- Earthquake observation in collaboration with Incorporated Research Institutions for Seismology (IRIS)/United States Geological Survey (USGS).
- General study of earthquake hazards by ESARSWG, of which we are also a part.
- Working with the UN affiliated organisation Comprehensive Test Ban Treaty Organisation (CTBTO) by hosting and collaborating in running two monitoring stations.
- Study of earthquake source processes, seismicity and seismotectonics participation in preparation of a building code for Ethiopia.

Major accomplished projects

- The French (University of Strasbourg & IPGP) broadband seismic experiment (1999-2002).
- The IRIS/PASSCAL broadband seismic experiment coordinated by the Penn State University, USA (2000-2002).
- The Ethiopian Afar Geoscientific Lithospheric Experiment (EAGLE). In this experiment: seismic (both active and passive source), high precision gravity, MT (magneto-telluric) data are collected, analysed and archived (2001-2003). Several universities were involved in this expedition: The University of Leeds, Leicester University, Royal Holloway University of London, University of Edinburgh, Stanford University, University of Texas (El Paso) and State Missouri University.
- A multidisciplinary monitoring of the Dabbahu volcano that erupted in September 2005 is still going on in north Afar using seismic, GPS and Radar Interferometry techniques. The University of Leeds, Royal Holloway University of London, Purdue University, University of Rochester and Lamont-Doherty Earth Observatory are involved in this project.
- RiftVolc Project focused on the volcanoes of the Main Ethiopian Rift in central Ethiopia with collaborations with several UK scientists and universities.
Major Awards

Professor Laikemariam Asfaw and Professor Atalay Ayele won Advancing Earth and Space Science (AGU) prestigious awards for the service they rendered to the scientific community with their seismology profession which is in a way celebrating the impact of ISP in Ethiopia.

**Professor Laikemariam Asfaw**

Laikemariam Asfaw, previous deputy leader of ISP supported group IPPS ETH:02, received the AGU new international award at the 2008 Joint Assembly Honors Ceremony, which was held on 29 May 2008 in Fort Lauderdale, Fla. The award honors “an individual scientist or a small team for making an outstanding contribution to furthering the Earth and space sciences and using our science for the benefit of society in less favored nations.”

**Professor Atalay Ayele**

Atalay Ayele received the AGU 2021 International Award at the 2021 Joint Assembly which was held in New Orleans (Louisiana) in recognition for making an outstanding contribution to furthering the Earth and space sciences and using science for the benefit of society in developing nations.
While working for his PhD in Microelectronics in the UK as a Commonwealth Scholar, the author asked himself, ‘why is the quality of life of the common people in my own country, Bangladesh, a low and middle income country (LMIC), way behind those of their counterparts in UK and other high income countries (HIC)’? He realised that the people in the HICs have easy access to products for their day-to-day life such as cars, air conditioners, refrigerators, microwave ovens, televisions, computers, vacuum cleaners, handy gadgets, etc., and to supporting public facilities and services, all based on relevant modern science and technology, developed by their own scientific and engineering innovators. Extending these thoughts, he realised that the use of technology is behind the progress of human civilisation, right from the day that human beings acquired the knowhow to ignite and control fire.

Figure 1: Pioneers of Medical Physics Research in Bangladesh, 1978 on Bone healing using pulsed electromagnetic field (PEMF). From left to right: Mr Ashraf, Dr M Shamsul Islam, Dr A Sattar Syed and Dr K Siddique-e Rabbani (author). They are studying the induced potential in a piece of raw meat, produced by an applied PEMF.
He also realised that such modern products and facilities, developed in the HICs, are also enjoyed by a few percent of the population in the LMICs, the educated elites, who influence national policies to distribute the income in such a way that they can procure such products, mostly imported (or some assembled locally based on foreign technology) at high price, even higher than that in the HICs. However, in doing so, they remain completely oblivious of the majority of the general masses, whose income levels are naturally pushed low through these elite-driven policies and these general masses remain ever deprived of an enhanced quality of life.

The author interpreted this acceptance of deprivation by the general masses as a sacrifice. What goes behind this acceptance of deprivation is a natural desire that if a few percent of the ‘sons and daughters of the soil’ can be educated in modern science and technology, they will eventually pull the whole population up the ladder of quality of life. A similar thought goes behind the people of some HICs like UK who provide scholarships to talented youths from these LMICs with the hope that someday they will pull up their own population. Unfortunately, most of these scholars tend to settle in HICs after their higher education giving various excuses, so that the general masses of the LMICs remain ever deprived. On the other hand, a few percent who return, hold a perception that they have to carry out research in advanced topics that they have encountered in the HICs; there are no topics worth researching that would enhance the quality of life of their own deprived people. So, they demand further resources from the already poverty-stricken people to establish ‘advanced’ research laboratories importing high-end equipment at exorbitant costs, only to publish some papers in national or international journals, contributing or returning virtually nothing to the lives of the distressed people whose scarce resources they used up.

The author felt that he was a beneficiary of this system, and felt an inner urge to repay the deprived general masses whose sacrifice was behind his education and accomplishments. Therefore, he returned immediately after his PhD, even though he did not have a career job back home which many other scholars had. Fortunately, he was taken at the Department of Physics of Dhaka University as an Assistant Professor. Instead of following the footsteps of his predecessors seeking research in fundamental physics, he was looking for avenues where he could use his knowledge and expertise in physics and electronics to provide at least some benefit to his own people, not giving priority to publishing papers, which he thought as secondary, byproducts of the efforts.

It became clear to the author that technology should be appropriate to each nation or community: one type may not fit the whole world. For this reason, technology developed in the HICs is not giving the desired results in the
LMICs, rather these are draining out their scarce resources and increasing global e-waste. Therefore, research in relevant and appropriate science and technology needs to be taken up indigenously in each LMIC by their own people as they know best their country, the people, their culture and the available local resources. He started research on Solar Thermal projects first, but soon a chance happening at the department diverted his attention to the application of physics in medicine, opening up a huge gateway. Seeing a foreign television documentary in 1978 on the use of pulsed electromagnetic field on bone healing, Dr A Sattar Syed, a Physicist at the Bangladesh Council of Scientific and Industrial Research (BCSIR) thought of initiating research on this and sought the help of Dr M Shamsul Islam, a teacher at the Department of Physics of the University of Dhaka. Dr Islam in turn sought help from the author, who had just joined the department and was a handyman, making useful gadgets through improvisation. Thus, the first Biomedical Physics research team in Bangladesh was formed.

**Figure 2: The author wearing a Pulsed Electromagnetic Field (PEMF) device to relieve his shoulder pain. The prototype was designed and made by his group in Bangladesh in 2019. They sold several thousand similar devices to the common people through a social enterprise, ‘BiBEAT Limited’, founded by the author and his ex-students and colleagues.**

The author was entrusted with designing and fabricating the necessary electronic equipment which was successfully used on patients at an orthopedic hospital for two years. The group also started giving Masters’ theses to students in 1981 emphasizing the development of necessary research equipment indigenously and initiated a theory course on Biophysics and Medical Physics in 1983, the first attempt in this new area of Physics in Bangladesh. Many senior colleagues had expressed concerns about developing research equipment indigenously. They doubted about the precision and accuracy of the equipment and questioned whether the outcomes would meet international standards, etc. Some even expressed concerns that such efforts could eventually make the author a laughing stock, a warning with good intentions. However, the author was not bogged down by such comments, he had his confidence and silently kept on to his mission of doing something for the people through indigenous efforts on appropriate modern technology.
The above work led to an academic link with Sheffield University, UK, during 1983–1992, sponsored by the then British Overseas Development Agency (ODA), coordinated by Professor B.H. Brown in Sheffield and by Professor Islam in Dhaka. Although the link had several projects led by several teachers of the department, none except that of the author was sustained, as the others needed procurement of expensive foreign equipment which was not possible under the link programme. On the other hand, the author chose areas of research where he could possibly develop and fabricate the equipment himself. Seeing his passion and dedication, the scientists at Sheffield University opened themselves up and wholeheartedly helped the author in learning new technologies and in making several modern devices of his choice which included a computer-based EMG/Evoked Potential equipment, one of the most sophisticated modern healthcare equipment.

The progress of the research and the demonstrated capacity prompted the British ODA to extend the funding several times till 1992, when the author decided not to continue the formal link any further in order to consolidate the knowledge and skills already acquired through this collaboration. In the years to follow, the author made several basic innovations that have become well known in the international scientific community, together with real-life implementation of the outcomes, and led many students to carry out the research projects as parts of their Master theses. This success eventually led to the establishment of a postgraduate Department of Biomedical Physics & Technology (BMPT) in 2008 with the author having the responsibility to build it up as its founding chairperson.

The author realised that it would not be possible to get the implementation of research outcomes through Masters’ students only, having a little more than a year for both their courses and thesis. Therefore, he planned to take only PhD students at the beginning at his new department. Initially, it was difficult to get students, as the most talented students usually went abroad for their PhDs, but eventually, the author’s perseverance paid out, and he got some really good and dedicated PhD students who found resonance in his philosophy of doing something for the people through their scientific and technical knowledge and capabilities. He also tried to obtain funds from corporate bodies to pay some allowances to the PhD students and to research fellows continuing after their Masters’ degree, which had however only a limited success.

In 2010 the author could get the University of Dhaka to recruit one of his PhD students as a teacher of the department, Mr Muhammad Abdul Kadir, who was a great help, and the two together tried to lead the department through a path of useful research and education.
At this point an unexpected visit by Dr Ernst van Groningen, the then director of ISP physics at the International Science Programme (ISP) of Uppsala University, to the BMPT department opened up a huge new opportunity. Seeing the work at the department, Dr van Groningen asked the author to apply for ISP support, which he did. Thus, a generous funding support from ISP started in 2011 and is continuing still now. This ISP support was instrumental in expanding the activities of the department, allowing a good number of research students and fellows to be retained, who could contribute effectively to the research outcomes and their field trials.

Some of the research outcomes of the group have achieved national and international reputation and attention. These are:

i. Focused Impedance Method (FIM) [including Pigeon Hole Imaging (PHI), an extension of FIM], with several applications in physiological studies and diagnosis.

ii. Distribution of F-Latency (DFL) – a new nerve conduction parameter that can give early detection of compression neuropathy at the vertebral sites.

iii. A comprehensive model of nerve conduction with the introduction of a new conduction mechanism that can satisfactorily explain an anomalous experimental behaviour of stretched myelinated nerve fibers. This has the potential to modify a century-old cable theory for nerve conduction.

iv. Bone healing and pain relief using Pulsed Electromagnetic Field (PEMF).

v. Low cost and simple to fabricate Solar Water Pasteurisers for providing safe drinking water in rural areas.

vi. Telemedicine with integrated diagnostic devices developed and implemented in the field by this group. This has been very successful and received several national and international awards.

vii. Technologies to face Covid-19 pandemic: Development of devices to protect hospital staff from Covid-19 virus infection, devices to protect patients from hospital acquired infection, UVC devices to sterilize full rooms in hospitals, offices, shops, schools and at homes, some of which are unique.

To mention the publications, which the author conceived as byproducts, the number is not that small. Right from his period at the physics department till now, he has authored or co-authored more than 140 books/book chapters/peer reviewed papers in journals and conference proceedings. The total number including those of Dr M A Kadir and other students will exceed 150.

The author also realised that in Bangladesh there are no industries with the knowledge-base and capacity to take up a new technology-based product, so the author had to turn himself into a part-time entrepreneur and a social mobiliser as well. In order to implement the research outcomes the author had
taken several initiatives together with his ex-students, which went through ups and downs because of not so favorable national policies towards innovative technology-based small initiatives, but the latest attempts are showing potential for success.

![Image](image_url)

**Figure 3.** Focused Impedance Method (FIM), the group’s innovation, in use for localized lungs ventilation study without upsetting the child (crying changes breathing rate).


The last one is a ‘company limited by guarantee’, a social enterprise with no shareholders, where nobody takes the profits. It is possibly a unique effort in Bangladesh. Through the BMPT Department the author spearheaded ‘Dhaka University Telemedicine Programme (DUTP)’ which, starting in 2015 after two years of field trial, represents a direct implementation of the research outcomes by the author’s team. It has advanced features with integrated diagnostic equipment – all developed indigenously – and it has already provided more than 35,000 patient consultations to rural people with city based qualified doctors. DUTP won several national and international awards and BiBEAT won two national awards recently. Through BMPT, RSTS and BiBEAT, the author’s group has created a triangular model for successful research in science and technology and the implementation of the outcomes, which they want to promote throughout the LMICs.
Take home points

The above story points out a few important issues for scientists of low and middle income countries (LMICs):

(i) They should choose research topics that can solve local problems and can enhance the quality of life of the common people.

(ii) They should acquire the capability to design and develop equipment themselves, otherwise the efforts are not sustained.

(iii) They should turn themselves into entrepreneurs or social mobilisers in order to deliver the benefits of their research outcomes to people. Others cannot succeed in doing this.

(iv) External funding support can only be of use when it is given to individuals or groups who have initiated efforts themselves with whatever they have.
Contribution of ISP to the Promotion of Mathematics and Digital Technology in Sahelian Africa

Professor Mary Teuw Niane

President of the Board of Senegalese Petroleum Company, Former Minister of Higher Education and Research in Senegal

Introduction

I would like to congratulate ISP for the celebration of sixty productive years at the service of universal access to high-level science and for the contribution to building strong human capital in mathematics and digital technology in Sahelian Africa.

The Partial Differential Equations (PDE), Modelling and Control Network relies on the partnership forged with ISP to achieve its objectives of:

- Promoting a critical mass of active mathematics researchers, in the field of the PDE, Modelling and Control.
- Strengthening the doctoral programmes in applied mathematics and maintaining a good management of young researchers.
- Maintaining active scientists in the Sub-Saharan region, overcoming their isolation, fighting brain-drain and maintaining good links with the international scientific community.

The network’s member universities are situated in Burkina Faso, Mali, Mauritania, Niger, Senegal, and other countries at the edge of the Sahel. The network has also established other partnerships, however the collaboration with the ISP is unique.

In an approach which is very respectful towards its interlocutors but also very rigorous and long-term, ISP made it possible to establish the basis for mathematics research development and to strengthen scientific relations between West Africa and the international scientific community. ISP has given a chance to the young people in Sahelian Africa, thirsting for scientific knowledge and eager to show what they can do, to make their dream come true.
ISP has built a reassuring partnership that respects its partners. For example,

- The beneficiaries give the initiative for project ideas, not ISP;
- The partnership with ISP does not come at the expense of African integrity;
- The partnership between ISP and our network is built on not compromising scientific quality.

It is a rare North-South partnership approach that emphasizes respect for - and ownership by - the partner of the South.

The network’s research themes

The research themes touch on mathematical questions related to ordinary differential equations, linear and nonlinear partial differential equations, control of distributed systems, bio-mathematics, mathematical questions related to ecology, mathematical questions of water, mathematical modelling in general, etc. They also affect ICT issues such as information systems, the internet of things, and artificial intelligence.

All these themes are important for the strengthening of scientific culture and for the intensification of scientific production along with the raising of the quality level in Sahelian Africa.

The networks´s achievements in numbers

a. Theses from 2015 to 2021:
   - Sandwich PhD theses: 18
   - Local PhD theses: 41
   - Local MSc theses: 41

b. Publications from 2016 to 2020:
   - Publications in international journals: 148
c. Registrations in the African and Malagasy Council for Higher Education (CAMES)\textsuperscript{11} from 2018 to 2021:
   - Full Professors: 7
   - Associate Professors: 10
   - Lecturers: 23

d. Contributions to countries' strategic decision-making:
   - Government Ministers: 3
   - Presidents of universities: 5
   - Numerous high levels staff

Moreover, our network members are active in the Mathematics, Computer Science, Communication and Information Technology (MITIC) at Gaston Berger University in Senegal, and this centre was selected as an African Centre of Excellence by the World Bank in 2014.

Conclusion

Large doors are now open in Sahelian Africa: mathematics and digital technology as high-level teaching and research subjects are now recognized. The network has, with the help of ISP, built African human capital to an international level in mathematics and digital technology. The network and ISP have also strengthened the scientific integration of Sahelian Africa into the international scientific community. Young people of today know that they can be trained here, flourish here and fully realise their dream of becoming a pure or applied mathematician without abandoning their home country!

Thanks to the partnership with ISP, the dream from twenty years ago has become a reality. ISP has demonstrated that it is possible to share knowledge, science and skills. It's a new future that ISP has helped us to build!

\textsuperscript{11} The African and Malagasy Council for Higher Education (CAMES) coordinates higher education and research systems in Francophone Africa (in total 19 countries) in order to harmonise the higher education and research in Africa. It also accredits Bachelor's, Master's and Doctoral degrees of the higher education institutions and evaluates the Professors-researchers of the member countries.
Genomics and Pharmacogenetics Research in Zimbabwe - Impact of ISP’s Sustained Support

Professor Collen Masimirembwa

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Introduction

Interindividual and interpopulation variation in genes that influence a patient’s responses to medicines gave rise to the field of pharmacogenetics where the choice of medicines and doses administered are based on an individual’s genetic status. A deficit in genetic data on African populations quickly became apparent by 1990, with only a handful of publications on the subject in Africa or on people of African ancestry. In 1990, the International Science Programme (ISP) awarded Professor Julia Hasler a grant to study the genetic polymorphism of drug metabolising enzymes in Zimbabwe, that included a PhD fellowship to Collen Masimirembwa to work on the subject.

Genetic polymorphism of drug metabolising enzymes in Africa

The aim of the research was to determine the level of interindividual variation in drug metabolism among Zimbabweans and to investigate the molecular genetic basis of any such variation. Between 1990 and 1996, we conducted a number of studies in healthy volunteers that involved administering subtherapeutic doses of drugs that had been established to be mainly metabolised by key drug metabolising enzymes, CYP2C19 (mephenytoin) and CYP2D6 (debrisoquine and metoprolol).

Measuring the concentration of these *probe drugs* and their metabolites in urine gave us an indication of enzyme activity in each individual, referred to as the *phenotype*. The frequency distribution of the metabolic rations (drug concentration/metabolite concentrations) revealed important patterns. First, unlike similar studies that had been done in populations of European ancestry, for CYP2D6, there were very few people with the poor metaboliser (PM) phenotype, 2% compared to 5-10% in Europeans. Secondly, the Zimbabweans had more people of the intermediate metaboliser (IM) phenotype, an observation similar to what had been observed in people of Asian ancestry but
not in those of European ancestry. Thirdly, whereas the use of different probe drugs for CYP2D6, such as debrisoquine and metoprolol was highly correlated in Europeans ($r>0.8$), the correlation was poor in the Zimbabwean populations ($r=0.67$) (Masimirembwa et al., 1996). We turned to molecular investigations to shed light on these observations.

We extracted DNA from the blood collected from the volunteers and genotyped individual for the then-known genetic variations associated with the ultrarapid metaboliser (UM), extensive metaboliser (EM), the intermediate metaboliser (IM), and the poor metaboliser (PM) phenotypes. The low prevalence of PM-associated variants such as CYP2D6*4, helped us explain why there were few PM in the Zimbabwean population compared to Europeans (Masimirembwa et al., 1993), an observation also shown in African Americans (Evans et al., 1993). Genotyping the known variants at that time could not explain the high prevalence of volunteers with the IM status. We, therefore, sequenced the CYP2D6 gene in volunteers carrying different phenotypes. This led to the discovery of a novel variant, which strongly correlated with the IM status. We initially named the variant, CYP2D6Z in recognition of its discovery in the Zimbabwean population but is now referred to as CYP2D6*17 based on the international nomenclature that was adopted at that time (Masimirembwa et al., 1996).

Many subsequent studies in African American and African populations confirmed our finding that CYP2D6*17 was the molecular genetic basis of the IM phenotype in people of African ancestry. Population genotyping studies in people of European and Asian ancestry did not find this variant, hence it is now being known to be uniquely African population specific. This landmark discovery added to the emerging body of knowledge that variability in drug metabolism and pharmacokinetics was not only at inter-individual level but also at inter-population level. This was now pointing to potential inter-population differences in drug response. Given that current drugs on the market were discovered and optimised for safety and efficacy in European populations, our studies further heightened the concern that safety and efficacy data from such studies might not be generalisable to other populations, including African populations, for some drugs.

The years 1990–1996 saw us put Zimbabwe and Africa at large on the map with respect to the emerging field of pharmacogenetics (Figure I). ISP supported the programme in Zimbabwe including fellowships for Collen Masimirembwa to travel to Sweden to work on samples from Zimbabwe in the laboratory of the world leader in Pharmacogenetics, Professor Magnus Ingelman-Sundberg at Karolinska Institutet, Sweden. The collaboration was important for this work since the University of Zimbabwe did not have the laboratory capacity for the bioanalysis and the genetic analysis required for
this project. ISP supported this collaboration, which become a template for other Africa-Karolinska Institutet collaborations, that helped increase the number of scientists working on pharmacogenetics. Subsequent PhD students from Professor Julia Hasler’s group, funded by ISP, Collet Dandara and Tashinga Bapiro, continued the work to address the observed lack of correlation between CYP2D6 probe drugs. They demonstrated that CYP2D6*17 metabolised CYP2D6 substrates differently (Wennerholm et al., 2002, Bapiro et al., 2002).

This finding marked the end of phase 1 of ISP support, which was channelled through Professor Julia Hasler’s group at the University of Zimbabwe, because members of the group pursued different careers. Collen Masimirembwa joined the medical company AstraZeneca as a Principal Scientist for the 1998–2007 period in Sweden. He was later to establish the African Institute of Biomedical Science and Technology (AiBST) and return to Zimbabwe to run this institute in 2007.

Figure 1: Historical development of pharmacogenetics and precision medicine in Africa (above the timeline) relative to international development (below the timeline). The development of the field in Africa was mostly championed by research at the University of Zimbabwe and at the African Institute of Biomedical Science and Technology (AiBST) with sustained funding from ISP.

Clinical pharmacogenetics in HIV treatment

In 2008, Dr Collen Masimirembwa resumed pharmacogenetic studies in Zimbabwe, now at the African Institute of Biomedical Science and Technology, with a mission to translate laboratory findings to clinical solutions. ISP funded this initiative over a 12-year period (2008–2020). This translational genomics programme started by investigating the possible role
of pharmacogenetics in the safe use of the antiretroviral drug, efavirenz, in HIV patients. It had been shown that the enzyme CYP2B6 is responsible for the metabolism of efavirenz and that about 3-5% European patients had a low activity CYP2B6 enzyme variant and were at higher risk of experiencing neuropsychiatric adverse effects. Clinicians observed that more Africans in the diaspora in Europe and African Americans were at risk of neuropsychiatric effects (reviewed in Masimirembwa et al., 2016) compared to Europeans. We therefore conducted an observational study in a cohort of HIV patients on efavirenz-based antiretroviral treatment regimen, which showed four important findings: (a) that over 50% of the patients had concentrations of efavirenz above the maximum safe concentration of 4 ug/mL; (b) that there were no patients below the minimum effective concentration limit of 1 ug/mL; (c) that the frequency of the homozygous genotype for reduced enzyme activity variant CYP2B6*6 was very high, at 20%, compared to the lower frequency, at 3%, in Europeans; and (d) that women had higher efavirenz plasma concentrations than men (Nyakutira et al., 2008).

With additional funding from the European and Developing Countries Clinical Partnership (EDCTP), we reproduced these findings in another cohort of HIV patients on efavirenz-based treatment (Dhoro et al., 2015), in which we also showed the high prevalence of neuropsychiatry adverse effects in patients taking efavirenz (Nemaura et al., 2013). Using these two datasets, we developed a pharmacogenetic and pharmacokinetics-based dosing algorithm to predict patient dose requirements based on their genotype and other factors (Nyakutira, et al., 2008, Nemaura et al., 2012, and Dhoro et al., 2015). The algorithm indicated that those who were homozygous for the CYP2B6*6 need a dose of 200 mg instead of the standard dose of 600 mg/day; that among those who are heterozygous, females weighing below 62 kg, 400 mg a day was sufficient. Our findings and dosing algorithm were reproduced in Tanzania, Uganda and South Africa (reviewed in Masimirembwa et al., 2016). During the same period a randomised case-control trial demonstrated the non-inferiority of a 400 mg/dose to the 600 mg/day. These collective findings contributed to WHO recommending an efavirenz dose reduction from 600 mg/day to 400 mg/day.12

At the same time, we also worked with an international consortium, the Clinical Pharmacogenetic Implementation Consortium (CPIC) to develop clinical guidelines for the use of CYP2B6 genotype to adjust efavirenz doses (Desta et al., 2019). This was the first case where laboratory bench genetics research culminated in a clinical intervention in Africa! We can proudly highlight the role of ISP’s sustained support over the years that enabled this

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to happen, starting with funding the work behind the seminal paper on the subject (Nyakutira et al., 2008).

One of the resources created during the 2008 to 2015 period was a biobank of DNA samples from more than 10 major populations groups from Nigeria (Ibo, Yoruba, and Hausa), Kenya (Masai, Kikuyu and Luo), Tanzania (mixed populations), Zimbabwe (Shona, Ndebele, and San) and South Africa (Venda) (Matimba et al., 2008). Genome-wide analysis of these populations demonstrated the great genomic diversity of African populations in contrast to the more homogenous populations of Europe and Asia (Masimirembwa et al., 2014). We also showed that this diversity was moreover high for pharmacogenes (Rajman et al., 2017). Each time we sequenced some of these pharmacogenes, we continued to discover novel genetic variants, some of which are associated with loss of function and others whose functional effects we do not know yet (Matimba et al., 2009).

As early as 2004, FDA had approved a pharmacogenetic test, AmpliChip for genetic variations of CYP2D6 and CYP2C19 for clinical use. More pharmacogenetic tests continued to enter the research and clinical market. It quickly became apparent that these genetic tests didn’t include any of the uniquely African-specific genetic variants such as CYP2D6*17 and CYP2D6*29. It also became apparent that the clinical guidelines, which don’t cover drugs metabolised by some of these polymorphic enzymes, are commonly used in Africa. We, therefore, turned our attention to addressing this gap in diagnostic tools that were essential for translating genomic research to clinical solutions relevant to the African clinical setting.

**Pharmacogenetic diagnostic test inclusive of African populations' genetic diversity**

The discovery of novel variants unique to people of African ancestry and the demonstration of the clinical relevance of some variance occurring at high frequency in the African population, motivated us to design a pharmacogenetic test that was more relevant to patients of African ancestry. AiBST designed an open array, GenoPharm®, that can test for 120 variants in 46 pharmacogenes. The test is run on a multiplex RT-PCR platform such as the QuantiStudio12K to produce genotype data that can guide doctors in the safe and effective use of over 100 medicines on the market. The analytical validation of this test has been completed and a manuscript submitted for publication (Kanji et al., submitted). To our knowledge, GenoPharm® is the only pharmacogenetic test that is developed and registered for clinical use in Africa and is inclusive of the genomic diversity of African populations. It is
registered with the South African Health Regulatory Authority (SAHPRA) (registration number 00001229MD). This innovation has won many national, regional and international awards for both its potential to be a game-changer in precision medicine for Africa and in recognition of the capacity for genomic research that now exists in Africa.

Some leading international pharmaceutical companies have been quick to realise the potential of this innovation and the research capacity at AiBST and have contracted the institute to conduct some clinical pharmacogenetic studies to inform the use of their products in people of African ancestry. This array is also supporting current clinical pharmacogenetic studies in people of African ancestry, which include clinical pharmacogenetics of rosuvastatin, tamoxifen, anti-tb drugs and anti-hypertensives. These studies are being funded by different organisations attesting to the growing buy-in by the local and international research and funding community.

The GenoPharm® innovation coincided with the end of many years of support by ISP, it was a good ending on a high note!

Building capacity for genomic research

At the heart of ISP support was the aim to build sustainable capacity for advanced research in developing countries. That capacity was needed in various key areas such as skilled manpower, technology platforms, and collaborative networks for a biomedical research ecosystem. In the process of supporting the Genomic Medicine programme at AiBST over the years, ISP support has resulted in the training of over ten PhD students and five MSc students from Zimbabwe, Kenya and Nigeria. The many years of support have enabled us to build a robust global faculty that has supported us in launching the first MSc degree in Genomics and Precision Medicine in Africa. This programme had its first intake in 2021 of nine students from Benin, Nigeria, Kenya and Zimbabwe. Funding for it is from the EDCTP13.

With respect to laboratory capacity, the ISP support has seen us evolve from sending our sample to Europe for analysis to us having capacity for bioanalysis and genetic analysis in our laboratory. Towards creating collaborative networks, ISP has enabled the organisation of workshops and supported student exchange programmes that have now seen pharmacogenomics research being done in many African countries. Looking

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13 EDCTP (European & Developing Countries Clinical Trials Partnership) is an EU funded partnership between institutions mandated by the governments of 14 European and 18 African countries.
back to where we started from, it’s like we are now on a hill built from years of gained experience, skill and capacity. This is enabling us to conduct one of the most ambitious studies since our formation. With seed funding from the Bill and Melinda Gates Foundation (BMGF) for the Calistous Juma Science leadership award, we will conduct a multinational implementation study to determine the effectiveness and feasibility of clinical pharmacogenetics in the African clinical setting. This study will involve five countries; Zimbabwe, South Africa, Kenya, Egypt and Nigeria (Figure 2).

![Figure 2. Implementation of pharmacogenetic testing for effective care and treatment in Africa (iPROTECTA). The multinational study will be run in the 2022-2026 period. As much as the programme will address the genomic diversity of African populations, it will also address the diverse clinical setting across the continent that is likely to affect the effectiveness and feasibility of implementing clinical pharmacogenetics.](image)

The future

Even as funding from ISP came to an end in 2020, AiBST still feels part of the ISP family, because that is what it is. AiBST will continue to collaborate with ISP in various ways that can include hosting fellows from other institutes supported by ISP. This is possible because AiBST has built a state-of-the-art biomedical laboratory and a highly active global faculty of experts who assist in supervising and mentoring young scientists. The year 2022 marks the 20th Anniversary of AiBST, we have grown in experience and have a better understanding of how to navigate the challenging research environments in most developing countries. ISP has been a supporting partner on this 20-year journey hence a friend always.
References


Comfort Kanji, Bianza Mbavha, Collen Masimirembwa, Roslyn Thelingwani. Analytical Validation of GenoPharm® a clinical genotyping open array panel of 46 pharmacogenes inclusive of variants unique to people of African (manuscript submitted)


Masimirembwa C, Hasler J, Bertilssons L, Johansson I, Ekberg O, Ingelman-Sundberg M. Phenotype and genotype analysis of debrisoquine hydroxylase (CYP2D6) in a black Zimbabwean population. Reduced


ISP in Ethiopia - Another Name for Empowerment

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There are two pivotal points in my life: The day I left for my PhD studies about 9,000 km away from my grandmother’s warm, protective home, and the day I returned back as a mature woman with a PhD, two kids and a grant to start my own research group at home. This story narrates the path between these two important points and beyond. There will be personal stories embedded between the scientific success stories because I believe the latter could only be achieved when the former is duly addressed.

The beginning

I was one of the four PhD students from the School of Pharmacy, Addis Ababa University (AAU), Ethiopia, who were selected to perform their PhD under a Sida bilateral agreement grant. Even though Sida already had more than half a century old collaboration with other departments at AAU, the collaboration was the first of its kind between the School of Pharmacy and Sida. My other colleagues had left six months earlier, and started their respective studies before I traveled to Sweden in October 2005. My story with ISP began when I set foot at Arlanda Airport and met ISP staff, Mr Hossein Aminaey, holding my name sign. From that moment on, ISP did everything they could from logistics to social networking, to make the landing soft. My PhD project was to study a class of peptides (mini proteins) called cyclotides, from the Ethiopian flora. The project required travels between home and Uppsala at least once a year. Organising the trip and taking care of all logistics in between was executed by ISP.

Gender advocacy, as we all know, is the agenda of the day. A lot of initiatives are out there to curb the burdens of girls/women so that they could be where they aspire to be. Despite the initiatives, the inequality in higher education between men and women still remains. One of the main reasons is that situations force women to choose between career and family, and in cultures like mine, the tendency is that most would go for the latter. I would consider myself one of the few who were not forced to make such a choice. I was able to have both, i.e., got married and gave birth twice during the course of my PhD studies. The Swedish culture and family-friendly system enabled me to
go through this, no doubt. ISP, however, was the pillar in the process: I stayed in the programme because they advocated my case to Sida, even when it meant more work for them. They also swiftly managed to comfortably keep my two daughters and me in Uppsala. Thanks to ISP’s effort, my case is today beyond an individual success story, it is positively affecting my own daughters and many young girls who seek to see a champion in this particular rally. What ISP did clearly demonstrate that gender advocacy is not something institutes pick just to be politically correct; it requires ground-level work, creating an enabling environment for every individual woman who comes in their reach, so that she escapes the leaky pipeline.

The sequel

Fast forward to 2012, I returned back home to complete my PhD. Three of my colleagues either left the programme earlier due to personal reasons or went to other countries. We joked, that the bilateral programme with the School of Pharmacy was 25% successful. But what made even that 25% possible? Was it because there was a special arrangement for me back home? Or because I loved my country more than my colleagues did? Not really. One of the reasons why many scholars taught abroad do not return back to their home institutions, even when they have a secured position, is because they do not have the conditions, mainly funding, to continue their research work in the caliber they have become used to. Hence, they turn their faces to postdoc or other positions in the global North. In this regard, countries in the global South are not benefiting from such collaborations but rather are constantly feeding the brain drain. To improve the situation, in my view, collaboration need to be extended into providing the early career scholars with working conditions when they return home. ISP’s model once again comes as an example here: they provided me with a seed grant to start my own research group at my home institution. It is important to note here that ISP’s research grant application is by invitation only. I was a few months into finishing my PhD when I received the invitation to apply. The sense of responsibility and will to serve this created in me as a young novice researcher at that time was immense. I submitted a proposal, and our research group BaSIL (Bioactive Secondary Metabolites for Improving Life) was born of the seed grant from ISP.

BaSIL, as the name implies, studies biologically/pharmacologically active molecules from nature, mainly plants. About 76% of today’s drugs on pharmacy shelves are derived from natural products. The search for new drugs in general is mainly dependent on nature. Particularly in areas such as the anti-infectives and anti-tumors production has been and still is almost fully dependent on natural products. The discovery of these active natural products
for drug development in turn is led by knowledge from traditional medicines. Indeed, one can explore nature by random screening and also there are discoveries of serendipity; however, data shows that traditional medicine knowledge-led studies result in a 20-fold hit rate than the other two methods combined. BaSIL is situated in a country that has a rich traditional medicine practice where nearly 70% of its population relies on traditional medicine for their primary health care, and 90% have used traditional medicine at least once in their lifetime. Moreover, Ethiopia is a country of rich biodiversity. It is located within two of the World’s biodiversity hotspots namely the East African Biodiversity hotspot and the East Afromontane Biodiversity hotspot. This, combined with the rich, time-tested traditional medicine knowledge provided BaSIL with a fertile ground to start our research.

Our national government in its Growth and Transformation plan set goals for the development of active pharmaceutical ingredients (APIs) from Ethiopian traditional medicine; and also on making traditional medicine part of the primary health care system. Research on the chemistry and biological activity of products employed in traditional medicine is required for these goals to be achieved. Therefore, the relevance of BaSIL’s research focus is also well established.

Having all these foundations, however, we wouldn’t have been able to carry out our activities without the steady support of ISP. During nearly a decade of support from ISP, we could manage to study a number of Ethiopian medicinal plants; from ethnobotanical data and plant material collection on the field to laboratory studies either in our own or our international collaborators’ laboratories. More than 15 Master’s students, associated with our group, defended their theses and we published our findings in peer reviewed journals. We fostered regional collaborations; as a result, we hosted students and also sent our students to our new partners in the region. The capacity we built with ISP’s support enabled us to write successful grant applications; we won a thematic research grant twice and now we secured a ‘women researchers’ grant’ from AAU. BaSIL members have become faces of the field who are called for public education by the media and also by government bodies. For example, during the advent of the Covid-19 pandemic, we were active participants in the public awareness panels organised by the Ministry of Science and Higher Education, where we presented on the various aspects of Ethiopian traditional medicine in relation to overcoming the pandemic.

It is worthwhile to here mention two success stories of our department. The first one is the launching of an in-house PhD programme in Pharmacognosy. The curriculum for the programme has been running for long years as a draft. The ISP support provided the missing part of the cake to launch the programme. The second story is the gender balance. Traditionally the
department was considered to be a men’s club; all graduate students and staff members being men except one. Now we have nearly as many women as the men within the department. ISP’s role is instrumental in achieving this balance; it empowered a role model to start, and we also learned from its tradition of empowering each woman based on her need.

ISP is successful in empowering the groups it supports because the support goes much beyond mere financial grants. They are concerned not only with the end results but also with the process. They go on the journey with us, sharing each challenge, instead of waiting at the destination point. For example, the first challenge we had to overcome as a group was to get big instruments installed - including an NMR - that have unfortunately been sitting in boxes for years. These are instruments used to study the chemical composition of the medicinal plants we study. When we shared this challenge with ISP, they extended their support from networking us with people who could do the technical work to advising us on how we could manage the funds to cover the cost of installation. Other examples would be their immense support for us to adjust to the new norms of the pandemic; and also their concern and encouragement during the past years when our country passed through times of unrest. In general, the application and reporting formats show the concern ISP has for the journey we take and to make it successful and worthwhile.

For us, ISP is not a funding agency. It is friends whom we know by name: Peter Sundin, Linnea Sjöblom, Hossein Aminaey, Cecilia Öman and many more. And the first word that comes to our minds when we think of ISP is Empowerment. We look forward for many more successful returns of years of collaboration.
Perspectives
Sida and ISP - Strengthening Research Capacity to Combat Poverty

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Research cooperation is Sweden’s most long-term means of combating poverty. It is also one of the oldest. Several organisations and countries have received research support from Sida for 30 years, some as ISP, for as long as 60 years, while others are just starting the cooperation. When the Physics Department at Uppsala University in 1960 sent a proposal for support for its newly started seminar, it was to Sida’s earliest predecessor the Central Committee for Swedish Technical Assistance. The Committee gave a grant of 250 000 SEK and what would become a long and fruitful cooperation between Sida and ISP begun. Research takes time. In return, its impact on people’s lives can be immense and enduring.

Both Sida and ISP support research capacity building in low income countries, and research of high quality that is relevant to reducing poverty and to sustainable development. Our two organisations support research in, by and for low income (LICs) and lower-middle income countries (LMICs), with a focus on in and by. We complement and strengthen each other’s work.

So why do we do this? Through the Agenda 2030, global efforts are dedicated to ending poverty through various means. However, in low income countries, which are mostly affected by poverty, the current capacity is insufficient to produce the knowledge required to address poverty and development-related issues. In Sub-Saharan Africa, the number of researchers is less than 100 per million inhabitants, in Central and South Asia it is just under 290 while the global average is slightly over 1,200.\(^\text{14}\) The contribution from other countries’ research to address problems specific to poor people in LICs is also limited. The majority of researchers who live and work in high income countries (HICs) carry out research related to problems in their own countries. Thus, LICs and LMICs do not only have limited access to scientific knowledge, but also to the benefits that research and innovation bring.

Capacity is not only about the number of researchers, but also about structures to support and sustain a conducive environment and culture for research and

innovation. Another challenge is the limited resources in LICs and LMICs that are allocated to research, technology and innovation. Investments in research in these countries are still very modest, despite the fact that investment in research and development (R&D) globally has almost doubled since the financial crisis in 2008. In Sub-Saharan Africa, 0.4 percent of the GNI is invested in R&D, in Central Asia only 0.15 percent, compared to, for example, 2.5 percent in North America and Western Europe.\textsuperscript{15}

For low income countries, and also lower-middle income countries, to be able to transform their societies, to contribute to global knowledge production and to have a fair chance to compete in the “global knowledge market”\textsuperscript{16}, they will require sustained investments in higher education, research and innovation systems, in adequate infrastructure as well as policies that guide and support evidence-based development. Thus, enabling environments and strong research/knowledge institutions are needed.

The Swedish research strategy and our objectives

Higher education and research are important for sustainable development and poverty reduction. A country’s research capacity may improve living conditions and promote economic growth. This happens through several mechanisms, including improved human capital, exploration of development-relevant findings and innovations, and evidence-based critical analysis to inform national debates, policies and practices. Sweden has been engaged in support of research of relevance for development since 1975 and in the strengthening of national research capacities in low income countries since the early 1980s. ISP however, started almost 20 years before that…

Altogether, Sida has had bilateral research cooperation programmes in 25 countries. In 2021, we are involved in Bolivia, Cambodia, Ethiopia, Mozambique, Rwanda, Tanzania, and Uganda, while potential research cooperation is being explored in several new and fragile countries. The approach has evolved. From modest support of national research councils in partner countries, to the substantial Research Training Partnership Programmes (RTPPs), implemented in collaboration with numerous Swedish universities. ISP is coordinating the Swedish universities in the seven bilateral research cooperation programmes.

\textsuperscript{15} Global Investments in R&D UNESCO 2020 - Fact Sheet 59, \url{uis.unesco.org/sites/default/files/documents/fs59-global-investments-rd-2020-en.pdf}
ISP’s long-time, devoted work to strengthening basic sciences is quite unique, and important since basic sciences are an often overlooked area by other organisations. Sida is among the few donors supporting basic research, a prerequisite for applied research. From a long-term perspective, a country's capacity for basic science in mathematics, physics and chemistry is necessary to build a strong local knowledge base and research capacity. For example, mathematics is a basic tool in statistical analysis, which in turn is important for measurements of poverty prevalence or building local tax systems. The presence of teachers that are active researchers in the basic sciences is a prerequisite for the quality of higher education in engineering, medicine, computer science, and many other subjects.

**Sida’s perspectives**

The five perspectives that shall permeate all development assistance in Sweden in general also apply to research cooperation. They are the poverty perspective, the rights perspective, the gender perspective, the conflict perspective and the environment and climate perspective. Regarding all of them, Sida aims at going beyond *do no harm*. The questions Sida always asks can be summarized as *what are the opportunities of the contribution to strengthening the situation* (e.g. environment in a contribution regarding health research), *what risks are involved* (e.g. will the contribution lead to biodiversity losses) and *how might the context* (e.g. environmental degradation) *affect the contribution*.

**Poverty**

The poverty perspective permeates research cooperation. A guiding principle for which research organisations and research areas receive Sida's support is that the research is relevant to people living in poverty. Research support is also aimed at institutional development. The trained researchers add new knowledge, strengthen the quality of higher education and contribute to better-functioning education systems. More analytically trained people can potentially contribute to better decision-making in public administration and society in general, through for example, more knowledge-based regulations and more sustainable production. This institutional development is a prerequisite for combating poverty. By strengthening research capacity, there is also a channel for more critical thinking and an open debate that further drives societal development. This perspective goes well with ISP’s modus operandi.
The rights perspective concerns the conditions for researchers and research, as well as the conditions for the people involved in research. Not least, the issue of academic freedom is important in this context. Academic freedom is about researchers’ freedom of expression, but also about the independence of research and the researchers' responsibilities. In many parts of the world and in several countries, Sida and ISP work, freedom, democracy and human rights are under pressure. And so is academic freedom.

Academic freedom is an indispensable aspect of quality learning, teaching and research as well as of democracy. It is a necessary condition for higher education institutions to produce and transmit knowledge as a public good for the benefit of society. To achieve high-quality knowledge, science needs to have the freedom of inquiry, because paradigms that are not critically examined and continuously challenged and tested, risk becoming dogma. Researchers and students must have the right to freely decide on what to seek knowledge about and what to conduct research on, without risking political pressure or selective defunding. This is closely related to freedom of opinion and freedom of movement which are essential in a democratic society. The scientific system must be open to continuously revitalise and improve knowledge. A scientific system can only remain open if scientists and students are entitled to inquire, question, and test freely. And it is also essential that they are allowed to communicate information, findings and ideas openly through publications and teaching. What is also important to Sida is the notion that the prevalence of academic freedom and political democracy is highly compatible, and mutually reinforcing through critical thinking and questioning of dogmas.

Another issue of rights concerns quality in education, which is about pedagogical methods but also about the education offered to be in harmony with the current state of knowledge. For universities to be up to date, university teachers must have research experience and be able to orientate themselves in the research literature. That research and higher education are inclusive, processes fair and transparent, and that there is clear accountability are other cornerstones.

As far as the conflict perspective is concerned, it is a matter of research cooperation to assess whether a research effort contributes to or counteracts conflicts. Research can often constitute a neutral platform for dialogue, where data and evidence can meet misinformation and shed light on a conflict issue from several angles. The research can in some cases dampen ideologically influenced positions by producing scientific evidence. At the same time, power relations in research can create conflicts or risks for the individual
researcher, informants and people in local communities where the research is carried out, and the risks for this are important to assess in different supports.

**Gender**

From the gender perspective, there are two different aspects. The first is about the content of the research: the extent to which the research programmes take into account gender aspects and are relevant to men and women respectively. The second aspect is an assessment of who is allowed to do research, which is highly relevant in Sida's research cooperation as well as in ISP’s work, which often takes place in environments and research areas with significant male dominance. This is linked to the broader issue of equality in research. Not infrequently, research is an exclusive activity for the top strata of society, those who have had access to good basic education and have access to the existing structures. There is a risk that research cooperation maintains prevailing imbalances both in terms of gender equality and equality, which must be met with awareness, dialogue and follow-up.

Of all the world’s researchers, only 29% are women. To increase this number Sida has research support specifically targeting women, and we collaborate with partners to increase the number of female researchers. In the basic sciences, numbers are even lower with the situation in mathematics and physics especially dire and dropping at every stage of the educational system. Female Rectors, Heads of Science Councils and Journal Editors of Chief are even rarer.

The active work with gender issues done by ISP with context analyses, gender capacity building, promoting gender policies at cooperating institutions and much more is highly relevant and urgent. A wonderful example is the regional Eastern Africa Network for Women in Basic Sciences (EANWoBAS) whose founder Dr Betty Kivumbi Nannyonga, has been part of Sida’s bilateral research cooperation with Uganda.

**Environment and Climate Change**

The environmental and climate perspective also involves several aspects. It is partly about the extent to which a research effort contributes to knowledge that can potentially lead to positive effects for the environment and about understanding the complex and often globalised driving forces that undermine local ecosystems and/or climate goals, and/or other sustainability goals. It is also about whether the research is carried out with concern to environmental effects, for example how laboratory waste is handled or which travel policies are applied. Ensuring relevant management of these aspects is part of the continuous follow-up of research cooperation. ISP has a monitoring system in
place to look into how the supported groups and networks handle laboratory waste and how they work with climate goals.

Research capacity building

The support to building research capacity, by supporting national research systems, with an emphasis on local ownership and local research priorities, makes Swedish research support unique in the world. Other donors often give money to limited earmarked research projects targeting the donor country’s priorities. Sweden has a long-term system approach, with core support and strong local ownership, because we strongly believe it leads to sustainable change. ISP with its 60 years of experience has been working along these lines for a long time (even before Sida did).

Many of the problems and challenges in today’s world are not confined to national borders but are shared across regions as well as globally. Hence, in research cooperation Sida has opted for a system-oriented approach to strengthen research and research capacity in and for LICs and LMICs. The overarching approach is to provide support to institutions and organisations that target these challenges at national, regional and global levels. What unites the three levels of support concerns first of all their contribution to a common goal i.e. “Strengthened research of high quality of relevance to poverty reduction and sustainable development” the overall objective of Swedish research cooperation.

An added value to this approach is the synergies that it creates. In the bilateral research cooperation and in ISP’s core programme researchers that are trained at national institutions produce research that is also relevant at regional and global levels. They participate in regional and global fora to make their research available to others, influencing regional and international policies etc. The experience gained from participating in such activities is brought back to their countries and institutions who can benefit from new knowledge. Global and regional institutions and organisations, apart from producing research, may also support countries and national institutions to develop research capacity and provide funding for research generally scarce in low income countries.

In bilateral research cooperation, universities are seen as hubs of national research systems. Therefore, in almost all cases Sida has cooperation with at least one university in the partner country. Sida aims to support building up or strengthening research and innovation systems within these organisations comprehensively: the support targets research training, research management
and infrastructure for research in a way that combines human resource development with institutional development. Areas of support have to be relevant in one way or another to the aim of strengthening the research and innovation system. The entire university benefits from the support provided to research in terms of improved laboratories, infrastructure and quality of education through PhD training of academic staff.

**Sandwich model**

ISP was pioneer in supporting basic sciences, locally and in a collegial manner, and has continued to lead in the area. Already in the 1960s ISP invented the Stick man model that developed into the sandwich model still used by ISP and Sida today. In collaboration with Swedish universities PhD students have a supervisor both in their home country and in Sweden. It has proved to be a successful tool in research cooperation, that gives students international experience and networks while creating opportunities and building a solid foundation at home. The PhD students make part of their training at their local university and part of their training in Sweden. Currently there are a total of 3,600 PhD students in different stages of research training within Sida’s and ISP’s research cooperation.

ISP is through its solid experience and high capacity also a highly valued partner in Sida’s bilateral research cooperation, coordinating our Swedish partners and supporting the PhD students when in Sweden. The social context ISP provides to ISP and bilateral PhD students alike, such as seminars on Swedish culture or ice skating, is so important for their well-being far away from home and contributes to their successful studies. Most of the students get very well taken care of by their Swedish universities, but ISP brings together students with similar experiences from the whole spectrum of disciplines and from all over Sweden.

**In conclusion**

The relationships that are cultivated through Sida bilateral research cooperation and ISP core programme are an enduring resource for producing new knowledge and mutual understandings across cultural and political divides. In the longer term, the professional ties and friendships that are built through cooperation are resilient foundations from which we can tackle some of the world’s most pressing challenges together.
ISP 60 years: A Physics Perspective from Bangladesh

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Introduction

Uppsala University's International Science Programme (ISP) provides a platform where dreams come true. It gives me great pleasure to spend a few words on the occasion of this altruistic organisation's 60th anniversary.

On September 1, 1961, ISP began its activity as The International Seminar for Research and Education in Physics, which was designated as an international school. By that time, the requirements had arisen to meet the demand for fellowships in economically challenged countries, where feeding people had to be prioritised upon offering scholarships/fellowships for research-based education. Academics, faculties, and the Swedish government all felt compelled to focus on the plights of the world's least developed countries. The worldwide scientific community had reached the consensus that science cannot advance at the necessary rate if all the contributions of the many least developed countries lag. Nobel Laureate Professor Kai Siegbahn and the Institute of Physics of Uppsala University set out for an international event to gather international scientists and researchers together as soon as the conceptualization was completed. Then, during the above-mentioned international events, ISP was born. When learning about the ISP initiatives in Bangladesh, we must keep this perspective in mind.

In Bangladesh, ISP works in the physical sciences through the International Programme for Physical Sciences (IPPS) and our research group, specifically the IPPS BAN:02, was initiated in 1987. Martial law was in effect at the time, and science and technology priorities were viewed as a burden. As a result, the research funding was very limited. ISP arrived in Bangladesh with the substantial promise to raise Bangladeshi research to international standards at a time when this was desperately needed.

Initially, the group consisted of the Department of Physics at Bangladesh University of Engineering and Technology (BUET) and the Materials Science Division (MSD) at the Atomic Energy Centre Dhaka (AECD). The group was led by Professor M. Ali Asgar at BUET and Mr M. A. Mazid, Chief Scientific Officer and Head at AECD. With ISP financing, Mr Mazid was able to build
one vibrating sample magnetometer (VSM) with oven in-house. The VSM's precision was excellent. In partnership with the late Professor Nguyen Chau, a prominent scientist from the Vietnamese University of Natural Science Hanoi's Centre of Materials Science, ISP also helped perform in-house temperature-dependent impedance/inductance measurements.

In order to undertake Mossbauer Spectroscopy in those days, ISP assisted the group in developing a collaboration with professors Bipin Srivastava and Anjali Krishnamurthy. ISP also funded a research partnership with late Professor Leif Lundgren and Professor Per Nordblad, both at the Division of Solid State Physics, Department of Materials Science and Engineering, Uppsala University (UU), Sweden, which expanded the horizons of Bangladesh's scientific community. Late Professor Olof Beckman, also at the Solid State Physics division at UU must be mentioned in this regard, as he travelled all the way to Dhaka, Bangladesh, and visited AECD and BUET, and other physics laboratories in Bangladesh. Professor Nordblad, late Professor Krishna Garg, and Professor Nguyen Chau significantly contributed to the research group’s programmes as ISP reference group members and experts, with their valuable advice. Dr Lennart Hasselgren led ISP till the turn of the millennium in a very active and efficient manner. According to legend, Dr Hasselgren was a demanding taskmaster who battled backwardness, sluggishness, and slowness in order to prepare Bangladeshi scientists for the millennium's challenges. We will be eternally thankful to him for advancing science in Bangladesh and instilling the vitality that was sorely needed to keep up with sophisticated research at an international level.

Foundation of the group laid by the first PhDs

Dr Hakim at AECD, and Professor Feroz Alam Khan at BUET first enrolled for their physics PhDs under the ISP sandwich PhD programme at Uppsala University in the early 1990s. They completed their doctorates in the mid-1990s. The professors in Uppsala University's Solid State Physics Division instilled physics in these two young researchers so profoundly that, later, when I joined them, I was astounded by their enthusiasm for the subject. Professor Khan and Dr Hakim completed their PhDs using equipment such as Professor Lundgren's SQUID magnetometer, which he conceived and built. The culture of science they encountered was then passed on to other Bangladeshi researchers.
BUET had achieved the status of Bangladesh's finest institution, where the country's top students enrolled. Postgraduate programmes, on the other hand, were given virtually little weight. Professor Asgar had to deal with this circumstance and met a lot of difficulties in his effort. Because of the ISP support he could maintain his postgraduate programme and graduated eight PhDs.

Professor Asgar and veteran AECD scientists Dr Amanullah Choudhury, Dr Hakim, Dr Dilip Kumar Saha, and Dr Shireen Akhter collaboratively supervised students. Practically, a vibrating sample magnetometer with high-temperature oven was built in-house along with a high temperature oven for the measurement of temperature dependent impedance properties and dc electrical resistivities for magnetic ceramic materials. In addition, extensive sample preparation techniques with planetary ball mill, high-temperature furnace (up to 1600°C), vacuum set-up, hydraulic press, and dies, micro
polisher, metallographic microscope belonging to the AECD, provided great support to the entire materials science research throughout Bangladesh.

Later, X-ray diffraction, scanning electron microscope, vibrating sample magnetometer, high temperature furnaces, ball mills, extended sample preparation facilities were added to the existing facilities through a grant from Bangladeshi Ministry Science and Technology at the beginning of the millennium and further enriched the group activity.

Introduction of nanotechnology research

In 2003 Mr Mazid, Head of MSD at AECD, and Professor Asgar, Dept of Physics, BUET, retired, Professor Nordblad, Professor Krishna Garg, and Professor Nguyen Chau visited the group as ISP expert members. As they interacted with group members, young researchers, and students, they were pleased to realise that the group had a flock of students. Based on their recommendations, ISP continued supporting us. Until 2004, ISP used to provide funds based on the group's needs. From 2005, ISP began providing regular grants upon evaluating grant applications for three years at the time. Dr Khan and Dr Hakim were selected as the leaders of the group and Dr Sheikh Manjura Hoque (the author) performed duties as deputy leader.

Under the leadership of Dr Hakim and Dr Khan there was a quantum jump in the group activities, with the introduction of nanotechnology research, which quickly became the primary activity. The pioneering contribution to establish indigenous research in nanotechnology and other innovative topics were carried out by Sheikh Manjura Hoque, Shafiqul Islam, Saroaut Noor and Sultan Mahmud who enrolled in the sandwich PhD programme of ISP under the supervision of Dr Khan, Dr Hakim, and Dr Shibendra Shekhar Sikder. All three supervisors were ISP fellows and PhD students of Professor Asgar and worked under Professor Nordblad's guidance. Professor Nordblad was once again of great support to the researchers, fostering zeal and perseverance in their work.

Later on, a huge number of students joined the group both at BUET's Department of Physics and at AECD's Materials Science Division. Several male and female students were awarded MSc/MPhil/PhD degrees, with female students receiving special attention.

A partnership was established between the Vietnamese University of Natural Sciences' Centre of Materials Science, Hanoi University of Technology's Institute of Materials Science, Rajasthan University, India, and Uppsala
University's Division of Solid State Physics. Through this collaboration, a very solid ground of research in solid state physics, nanoscience, and nanotechnology was built up between the three institutions.

Through the collaborations, training, and academic programmes the group fellows and research scholars learned skills like preparation of METGLAS, amorphous/nanocrystalline alloys, synthesis of nanoferrites, nanoperovskites, ultrasoft/ultrahard magnetic materials, giant magnetoimpedance, colossal magnetoresistance, multiferroic, exchange-spring, and advanced characterisations. Importantly, the research advancement was not limited to the group, rather, it spread throughout Bangladeshi physics, chemistry, and materials science research.

Many former pupils went on to work as professors and scientists in public universities and research institutions. They applied for projects and built similar labs at Dhaka University, Chittagong University of Engineering and Technology (CUET), Khulna University of Engineering and Technology (KUET), Shahjalal University of Science and Technology, and so on.

From the interactions of group’s founders Professor Khan and Dr Hakim, two further ISP physics groups were born in Dhaka. Dr Hakim and Professor Khan remained to run the organisation until 2013 when Dr Hoque took over as the AECD group leader.

**Nanobiotechnology research**

The idea of incorporating research in the topic of nanobiomagnetism came from a suggestion from ISP. During 2009–2010, some preliminary work was done at AECD, which included the chemical synthesis, the functionalisation, and characterisation of nanoparticles. During my visit for the Centenary Fellowship at the Indian Institute of Science in Bangalore, India, the research was consolidated using Nuclear Magnetic Resonance (NMR). The T1 and T2 relaxation of surface-functionalized nanoparticles as MRI contrast agents were studied extensively, resulting in multiple publications.

On my NIH\(^{17}\)-funded postdoctoral fellowship at Yale University's Magnetic Resonance Research Centre (MRRC), USA, I performed studies on the cytotoxicity of functionalized nanoparticles, MRI contrast agent utilising phantom and in-vivo investigations, and thermo-therapeutic extermination of 9L gliosarcoma cancer cells using a hyperthermia procedure. I successively applied my nanomagnetism skills gained during my two-year postdoctoral

\(^{17}\) NIH = National Institutes of Health, USA
studies back home in the group work. During this time, ISP had generously contributed to the purchase of dynamic light scattering, hyperthermia setup, impedance analyser, lamellar hood, autoclave, CO₂ incubator, vacuum distillation system, centrifuge, and chemicals/consumables.

Since 2016, ISP has advocated for the creation of two new groups for better monitoring; one group for the Department of Physics at BUET and other for the Materials Science Division at AECD. I, as Project Director, was awarded with an Annual Development Project that allowed the new group at AECD to incorporate a transmission electron microscope with STEM mode and EELS spectroscopy, a physical property measurement system (PPMS) up to 9 Tesla and 1.9-1000 K, research MRI for rodent studies, Raman spectroscopy, FTIR, zeta potential, single and poly crystallographer, HPLC, PE loop tracer, histopathology, ultrahigh-speed centrifuge. Nanobiotechnology research is currently in full swing in the group at AECD, which is gifted with a plethora of innovative facilities. Lately, the group's nanobiotechnology research was expanded to include drug loading/drug release, bone and skin scaffold preparation, dental materials, food packaging materials, and nanotechnology in agriculture.

Why ISP support is needed for Bangladesh

On the 50th anniversary of the independence of Bangladesh, World Bank said:

“Bangladesh has an impressive record of accomplishment of growth and poverty reduction. It has been among the fastest-growing economies in the world over the past decade, supported by a demographic dividend, strong ready-made garment (RMG) exports and stable macroeconomic conditions. Continued recovery in exports and consumption will help growth rates pick up to 6.4 percent in the fiscal year 2021-22.”

Since the last decade, the country has been on a spectacular development path. Bangladesh continues to have significant issues in feeding a big population, providing food, shelter, education, and health care. As a result, research remains a low priority and government funding for research remains scanty. However, the number of students enrolled in higher education is increasing as a result of a steady economic growth. There are 53 state universities and 80 private institutions in Bangladesh, compared to less than 15 in the past, towards the end of the twentieth century. Students' desire to conduct research

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18 Annual Development Projects are five years projects of Planning Commission of Bangladesh to augment and continue developments programs.
is growing by the day, and undergraduate students also strive to publish journal articles. Along with the growing demands of students and so many innovative facilities possessed by our research group, financial aid from ISP is more important than ever regarding spares, accessories, chemicals and consumables. Without ISP funding, the six-million-dollar project's facilities will be endangered because there would be no money for minor urgent repairs, low-cost accessories, reagents, and consumables. As a result, ISP support to us is more crucial now than ever.

Figure 2: Top-left: Visit of Dr Manjura Hoque to Uppsala University, with professors Per Nordblad, Peter Svedlindh, Carla Puglia; Top-right: presentation of the grant application in Sigtuna, Sweden; Bottom-left: Some staff members and collaborators to BAN:02/2; Bottom-right: Postdocs and students of the group.
Conclusion

Bangladesh has always been a creative and technology-loving society, dating back to the time of Roman civilisation as many archeological excavations in the country have revealed. However, invaders from other countries and colonial exploitation hampered the development of local technologies over the centuries. Collaboration with ISP is beneficial to the advancement of basic research and technology. ISP collaboration already helped a large section of Bangladeshi scientists to be on par with scientists at the international-level.

Bangladesh looks forward to continued ISP support, and together, we will face the challenges of the twenty-first century.
Implementation of a Research Culture in Food Science in Ecuador with the Support of ISP

Professor Jenny Ruales

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Introduction

Ecuador is crossed from North to South by the Andes mountains, dividing the country into three continental regions with different microclimates. There is also an insular region, Galapagos, which belongs to Ecuador. The biodiversity in Ecuador is huge.

In spite of the natural resources, there are nutritional problems among the population, especially in children, pregnant women, and lactating mothers, and the natural products are to a large extent unknown or underutilised.

Escuela Politécnica Nacional (EPN) is a technical university founded in 1869, and it is placed in Quito, Ecuador. At the Department of Food Science and Biotechnology, we work together with the society, the local industry, and the national government. We try to give alternatives to solve problems related to food safety and food security. Following the national policies, we oriented our research to the wellness of the population. Environment-friendly processes and green technology are applied in our research.

Cooperation with ISP

The cooperation between ISP chemistry (IPICS) and the chemistry group at EPN started in 1985, after a technical visit in 1984 by Professor Kersti Hermansson, at that time a staff member of ISP. There was a previous collaboration between EPN and ISP with a physics research group. Taking that collaboration as a reference, the need was seen for a chemistry group working in food science to start collaboration with IPICS and to build up research capacity.

Under the support of ISP, training people was necessary as the first step in order to create a critical mass of scientists. The training started at Lund University, Sweden, and there I began to study a native crop from the Andean
region, quinoa (*Chenopodium quinoa*, Wild). My Licentiate exam came by studying the chemical and nutritional characteristics of that crop, and after that I finished my PhD graduation. An infant product was developed with quinoa seeds. The research was carried out between EPN and Lund University under a sandwich training programme.

After completing the PhD programme in Lund, I returned to Ecuador, where I got a permanent position at EPN as researcher in the food science group, and I started to lead the research group at the school with support from ISP.

There are maybe international institutions which provide support for the development of science groups, but if the local authorities do not support recently trained local researchers, it is very difficult or even impossible to continue with any collaboration. A recognition from the authorities of EPN, who understood that success requires continued development of research groups and collaboration, and integrating new researchers as part of the university.

Under the ISP support, our laboratory got equipment like a High Performance Liquid Chromatograph (HPLC) provided with three different detectors, an atomic spectrophotometer, an UV-detector, a protein analyser, one unit for dietary fiber analysis, three different types of mills and spare parts, as well as consumables. Technicians were trained in different skills in Sweden and also in regional laboratories in Argentina, Chile, Mexico, Uruguay and Venezuela.

A sandwich Master programme was developed with the collaboration of Swedish universities, and the degree was given at EPN. There were students working at Lund University, Chalmers University of Technology, Uppsala University and in the Swedish University of Agricultural Sciences (SLU).

The areas of research were native products, to know their characteristics and based on that, to develop applications. Native roots and tubers were studied and the starch was the main component of interest. This field of work was performed at Lund University taking the advantage of the great expertise of their researchers at the Department of Food Technology. At Chalmers University of Technology, an Ecuadorian Master’s student was also working with quinoa, to increase the iron availability by using different process, where the fermentation with enzymes was the one which gave better results. In the same field of food security, there was another Master student who worked with pro-vitamin A, studying the effect of different processes to increase the availability of beta-carotenes.

Local fruits were also studied, like babaco (*Vasconcellea × heilbornii*), where amylolitic and lipase enzymes were identified and characterised, interesting
for food and pharmaceutical applications. Around 20 fruits were studied by another Master student, regarding the total phenolic content and antioxidant activity in the pulp and in the peel. After the student got the MSc diploma in Ecuador, she continued her studies and got her PhD degree at SLU. This was the beginning of a new research area of the group in Ecuador, and we are still intensively working on that. Nowadays, we are also working with a combined omics and bioinformatics research approach to improve food processes.

Figure 1: The research group in the 1990’s.

In relation to gender, 75% of the students who took part in the fellowships sponsored by ISP, were female.

Figure 2: The research group in the 2020’s.
The culture of publications started with the collaboration with Sweden. We learned that if we do not publish, we do not spread our findings, and we do not contribute to science and to the society. If we do not publish, we are isolated from the scientific community. An individual sandwich PhD programme was also established at EPN, and it was one of the first postgraduate programmes at high level in the country. One student, after working on her MSc project, continued her studies on solid phase protein biotechnology and immobilised enzymes in collaboration with the University of the Republic of Uruguay.

Establishment of a research network under the auspices of ISP

With ISP support, a network called LANFOOD was founded in 1994, and we lead the network from EPN. The members of LANFOOD were mainly young Latin American scientists with some relationship with Sweden, or Latin American scientists who came back to their countries, after doing their PhD studies abroad. The network was running until 2008. Minor equipment was provided to the laboratories, but the exchange of students and scientists were the main activity of the network.

Some of the former members of LANFOOD were working together as partners in research projects and networks such as the CYTED\textsuperscript{20}, and the ISEKI-Food association\textsuperscript{21}.

The former members of LANFOOD are natural partners when we submit research proposals looking for funds. They are often members of the evaluation committees for the PhD thesis of the students in our postgraduate programme, or are reviewing the research plans and being opponents in our PhD dissertations.

The research group of EPN in food science organised seminars, workshops at national and international level, with ISP support, and our Swedish and Latin American partners mainly from LANFOOD were active participants in those events.

\textsuperscript{20} CYTED = Ibero-American Programme on Science & Technology for Development. https://www.cyted.org/en

\textsuperscript{21} The ISEKI-Food Association is an independent European non-profit organisation, established in 2005 by representatives of university institutions, research institutes, companies and associations related to food, coming from all over the world. https://www.iseki-food.net/
We are deeply grateful to the ISP mentors, Professor Rune Liminga, or as we called him in the LANFOOD network, Papa Rune, for all his wise advice and recommendations, and to Dr Baboo Nair who was a scientific supervisor and a good friend forever. As a research group, we also owe thanks to Dr Malin Åkerblom and Dr Peter Sundin for the support to the Ecuadorian research group and to the network LANFOOD. The long-term support from ISP was one of the main reasons for the success of the development of the research group.

Figure 3: LANFOOD founders, 1994.

After ISP support

The research group continued to work with the contacts established under ISP support, research proposals were submitted and granted, and that way we could continue our research activities, renewed and updating equipment.

A PhD programme in Food Science and Technology is on-going, coordinated by the Department of Food Science and Biotechnology at EPN. It is one of eight PhD programmes authorized by the National Council of Higher Education in Ecuador.

With the support to research projects from European Union, Inter-American Development Bank, German cooperation, French cooperation, IRD, World Bank, International Foundation of Science (IFS), National Foundation for Science of Ecuador, and from EPN, and in the last five years by VLIR-UOS programme, the MSc and PhD students have had the opportunity to do part of

their research work in the laboratories at our partners in Europe and in Latin America. In applying for grants from the international sources mentioned above, the work and results of the cooperation with ISP was our cover letter.

The research group now has 100% PhD members and at the Department of Food Science, 90% of the docents are PhD graduates. When we started the cooperation with Sweden by ISP, we did not have a single PhD in the research group.

The number of publications produced at the Department of Food Science and Biotechnology is one of the highest at EPN, and during the last five years, at least one of the researchers of the department have been awarded for the number of high impact scientific articles worldwide. The award-winning researchers, not by coincidence, are former students who were trained in cooperation with ISP. One of them was in 2021 nominated for the national award in science, and she was one of the three finalists. Before the ISP support, few local publications were written, mainly published in the journal of our university.

The Master students as well the PhD students are recommended to publish their results in journals of international impact and we teach and lead them as academic supervisor to achieve that goal. Critical thinking is other important ability to pass on as tutors of our PhD students. Around 75% of our students are teachers coming from our and other universities in the country, and it is our responsibility to train them as scientific research leaders. New researchers are at the department, and they will continue working, following the school we have learned from the ISP cooperation.
ISP as a Building Block for Mathematics in East Africa and Beyond

Professor John Mango Magero

Department of Mathematics, Makerere University
Kampala, Uganda

Introduction

Since the year 1999 ISP has supported mathematics studies and research in the Eastern Africa region. Evidence for the claim can be found in living history, scanty documents, photographs, as well as in the testimony of people living in Eastern Africa and Sweden – the witnesses.

Dr Leif Abrahamsson from the Department of Mathematics, Uppsala University, daringly led in those years the project to visit Tanzania. A picture taken in Arusha, Tanzania in 2001, shows one of Dr Leif’s memorable trips on the mission to explore opportunities for ISP support to mathematics in Tanzania, a region overwhelmingly affected by weak mathematical training. Note that at the time, mathematics was not yet one of the ISP core subjects.

Although Dr Abrahamsson braved it alone, one wonders whether he could foresee the results of his mission twenty years later. To date, ISP support to mathematics in the region ranges from visible capacity built at PhD, MSc and postdoctoral levels to very successful summer schools, just to mention a few achievements.

Resting on the structures built by ISP in the region, Sida support has seen mass training of MScs in mathematics in Rwanda, and of PhDs and postdocs in Rwanda, Tanzania and Uganda. As part of this effort, PhD curricula have been developed in Rwanda, Uganda and Tanzania and have greatly cemented local PhD training in the region. In the recent past, ISP has started supporting PhD training on the Sida-developed curricula in the region, which will go a long way to ensure the sustainability of the ISP and Sida support for mathematics. The Sida support of 39 million SEK to mathematics in Uganda under the Sida bilateral research programme with Makerere University, in the years 2015-2022 with the training 21 PhD students among other activities, stands tall of all the Sida support to mathematics in the region. The Sida evaluators 2022 at Makerere University, ranked this mathematics project as the most well managed and impactful project among all the Sida supported projects at Makerere University.
All this could be brought into existence thanks to the efforts of ISP strong actors and African mathematicians like Dr Sylvester Rugeihyamu in Tanzania and Dr Minani in Rwanda, under the two project coordinators Dr Bengt Ove Turesson, then at Linköping University, Sweden, and Professor John Mango Magero at Makerere University, closely assisted by Professor Paul Vaderlind at Stockholm University, Sweden.

Some of the African mathematicians to be thanked worked closely with Dr Leif Abrahamsson and gave confidence and courage to him in his mission in the early years of 2000. They include Professor Masanja, Dr Sylvester Rugeihyamu and the late Professor Alphonce Baruka from the University of Dar es Salaam, Professor Luboobi and Dr Ssembatya Vincent from Makerere University, Professor Wandera Ogana, Professor Odhambo and the late Professor Owino Okoth from University of Nairobi, and the late Professor Francis Allotey from University of Ghana among others.

Figure 1: Dr Leif Abrahamsson, second from the left in the first row, at a meeting in Arusha in 2001 with among others, several African mathematicians mentioned in the text.

Eastern Africa Universities Mathematics Programme

A result of Dr Abrahamsson´s visits to the region in the early months of 2001, was the birth in 2002 of a very successful network called Eastern Africa Universities Mathematics Programme (EAUMP). In the same year, mathematics became one of the ISP core programmes. The network was set
up with key objectives aimed to improve the state of mathematics in the region, and especially pure mathematics, through MSc and PhD training.

In terms of its development, the network has lived up to its expectations and even gone beyond what was projected, including, for example, providing support to postdocs, research groups, women networks in basic sciences.

In the beginning, the membership of EAUMP was limited to the Department of Mathematics of the University of Dar es Salaam, Makerere University and the University of Nairobi. Successively, the then Kigali Institute of Science and Technology (KIST) and National University of Rwanda (NUR) were admitted in 2008 and the University of Zambia Department of Mathematics and Statistics was admitted in 2009. The EAUMP network has close scientific cooperation with other ISP supported regional networks in mathematics, e.g. in Ethiopia and Mozambique. In addition, it has collaboration with the PDE, Modelling and Control, an ISP supported network in West Africa, as well as the ISP supported SEAMaN\textsuperscript{23} network in South-East Asia.

The state of mathematics in the three departments of mathematics in 2002

One can describe the state of affairs of the Department of Mathematics in the three departments at the time of starting to receive ISP support in 2002 in the following terms:

- A handful of PhD holders on staff, about four on average.
- Teaching mathematics as a part-time job.
- Solely two programmes in the departments, i.e. one graduate and one undergraduate.
- Low number of publications; about one to three papers per year per department.
- Scarcity of computer labs for research and teaching.
- Little and most times no concern on where to publish.
- Lack of expertise in mobilisation of academic resources.
- Very little – or total lack of – external collaborations.

To face this situation, the typical budget activities in the early years of ISP support to EAUMP focused on equipment, collaboration, dissemination and training. The needed equipment included computers, projectors, generators to

\textsuperscript{23} SEAMaN (South-East Asia Mathematical Network) is a network between the departments of mathematics at Royal University of Phnom Penh (RUPP) in Cambodia, National University of Laos (NUOL) and University of Mandalay (UM) in Myanmar. ISP support to the network started in 2015.
aid teaching and research and books for departmental libraries. Cooperation South-South, South-North and North-South were considered. Importance was also given to scientific meetings and conferences (starting with one every three years), and very importantly to MSc and PhD training. At a later stage, also summer schools were considered with the help of the late Dr Maurice Ouma from Nairobi, and the formation of research groups in epidemiology and insurance maths.

EAUMP resources mobilisation drive

Some resources have been mobilised outside ISP support over time. This outside support normally happens during the EAUMP schools and conferences and hardly support to build capacity at MSc and PhD levels. The organisations that have provided this support include among others: the International Centre for Theoretical Physics (ICTP), The World Academy of Sciences (TWAS), London Mathematical Society/ African Mathematics Millennium Science Initiative (LMS/AMMSI), the German Academic Exchange Service (DAAD), International Centre for Pure and Applied Mathematics (CIMPA), Sida (mostly through joint activities), Foundation Compositio Mathematica, the International Mathematical Union/Commission for Developing Countries (IMU-CDC) and local universities. The EAUMP summer schools have been one of the most successful activities of EAUMP. Professor Balazs Szendrői formerly at the University of Oxford, has recently been instrumental in resource mobilisation for these schools. The early teachers/promoters in the EAUMP summer schools e.g. Professor Paul Vaderlind and Professor Rikard Bøgvad, both at Stockholm University, Sweden, deserve recognition.

Conclusions: The current state of mathematics in the East African Region

After two decades of ISP support and 15 years of Sida support (since 2007, starting in Rwanda) mathematics in East Africa has accomplished several important achievements.

Starting from the student and staff training, local PhD curricula were developed in Uganda, Rwanda and Tanzania together with local PhD training led by qualified persons. Thanks to these developments, about 100 PhDs have been supported under both Sida and ISP. In addition, the support of more than 20 postdoctoral fellows could be achieved. The MSc curricula were reviewed and over 200 Master students were engaged. With increased local capacity built, sandwich training has been on the decline. Also, when the bilateral
programmes started in Tanzania and Uganda, fewer sandwich PhD students have been supported with ISP funding from these EAUMP nodes.

Benchmarks for the Bachelor, Master and PhD students in mathematics, applied mathematics, and mathematical statistics were in 2020 developed under the framework of the Inter-University Council for East Africa (IUCEA).

Furthermore, mathematics has reached a higher recognition in the region, and more research groups have been created and this has also led to joint research projects (e.g. Norad, Norwegian Agency for Development Cooperation) and increased collaboration.

Other important areas of development have been the dissemination, and the volume and quality of the publications, with about 20 articles per department per year. Summer schools have been financed and training in supervision skills has been performed.

The main actors who have driven the activities of EAUMP in the region are dedicated mathematicians, most of them trained with ISP support. They are Dr Sylvester Rugeihyamu, Professor Mureithi, Dr Makungu from Dar es Salaam, Professor Patrick Weke and Professor Wandera Ogana from Nairobi, Dr Jared Ongaro from Nairobi, Dr Frodoard Minani, Dr Celestin Kurujyibwami and Professor Banzi from Rwanda, Dr Isaac Tembo, Dr Ngwengwe, Dr Mulombe and Dr Mervis Kikonko from Zambia and the author, Professor John Mango Magero from Makerere University, Uganda together with his colleagues Dr Ssembatya, Professor Kasozi, Professor Kakuba and Professor David Ssevviiri. Of course plus many others from the region.
Equal Opportunities
ISP Gender Equality Work: 2011–2021

Professor Carla Puglia

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Uppsala, Sweden

Gender equality as a prerequisite for a sustainable development

We all know that there cannot be sustainable development if there is no gender equality: sustainable and stable societies are societies where all people, regardless of their gender, have the same rights and responsibilities, the freedom to express their own opinion, equal access to economic resources and decision-making leadership and are allowed active participation in social and political life. In activities and collaborations addressing, like in the case of ISP, research capability building, equal opportunities and, in particular, gender equality have often been overlooked. After many years of studies, discussions, fights and policy developments, we have finally decided that equality should permeate all our activities because it intersects all our actions and goals. Sida, Uppsala University and ISP, like many other organisations, have adopted the gender mainstreaming approach. This has become our working method since 2016, and it means that the gender dimension should be included in all the steps of any intervention, considering the gender perspective and the relationship between and among genders, in the whole cooperation process.

In the following chapter, we will first give a short review about how the work for improving the gender balance at ISP has evolved during the last 10 years, and then we will describe the coming developments, what ISP has learned and what and how we are planning to work in the future.

Gender balance in ISP supported groups and networks

The gender distribution among staff and students in the ISP supported research groups and scientific networks has been monitored throughout the whole history of the programme. In the years 2003 to 2010 the average percentage of female PhD students was 39%, 11%, and 13% in the chemistry, physics, and mathematics programmes, respectively. The corresponding figures for MSc students were 54%, 18%, and 18% with very few changes over the
The low proportion of female students in the physics and mathematics programmes can be linked to structural reasons that influence female participation already at the earlier stages of the educational system: thus, these factors cannot be improved merely by encouraging female participation at the postgraduate level, despite the continuous efforts of the staff at ISP.

In 2014 ISP decided to undertake specific actions focused on improving the gender balance in the supported groups. We began actively working for a more equitable distribution between male and female researchers not just in research groups and with group leaders, but also in undergraduate education. The gender-based indicators, which are shown each year in the ISP Annual Report and the overall compilation of the data, showed that ISP’s efforts to promote equality between genders had not apparently had much success to that date (see Table 1 for the years 2008 to 2020).

ISP became aware that a new strategy was needed to guide future efforts to promote gender equality. Of course, for implementing significant measures with considerable impact, ISP needed to get a clearer picture of the situation and the reasons behind the gender imbalance.

Table 1: Gender distribution in ISP supported research groups since 2008.

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<th>Year</th>
<th>% Female Staff</th>
<th>% Female PhD students</th>
<th>% Female MSc students</th>
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<td>2020</td>
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<td>43</td>
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</table>

In this eight-year period, the only tendencies have been a decline in the proportion of female students in the chemistry program, which most likely is because of the phase-out of support to research groups in Latin America and Asia.
ISP gender equality strategy

Analysis of the local situation at the supported institutions and improving students’ competence

ISP recognized the need to increase its own awareness about the real situation and the barriers affecting women’s careers, for implementing the most suitable measures towards a more balanced gender distribution in the supported groups. Many of the obstacles to women's scientific careers are global, but there are also local and cultural obstacles that need to be identified to implement effective measures in the different contexts.

In 2012 ISP started to ask the supported groups and networks to describe in their annual activity reports the local gender situation and their strategies to improve the gender balance. Many of the groups within ISP physics and mathematics programmes answered, giving possible explanations for the present situation and also suggesting possible activities for improving the gender balance. The inputs were extremely valuable in identifying some important points raised by the groups, analysing the frequency of some answers/suggestions, and gaining some useful insights into how to promote gender equality.

ISP wanted to more actively contribute to improving the overall gender balance at the supported institutions, among students, staff and group leaders, which is why it aimed to maintain women's participation in undergraduate and postgraduate programmes, as well as support them in developing their professional scientific careers. It was for this reason that in late 2014, a working committee composed of members from other organisations like SLU Global25, OSWD26 (TWAS), and IFS27 was formed. Since the gender work needed to be founded on a solid competent basis, ISP established a collaboration with the Centre for Gender Research at Uppsala University. In addition, we considered involving gender researchers at the overseas supported institutions.

On December 10, 2014, ISP together with the gender working committee defined the visions and goals of its gender equality promoting programme, according to the points described in the following.

26 OSW = Organisation for Women in Science for the developing World, http://www.owsd.net/; OSWD is part of TWAS=The World Academy of Sciences
Vision

Women and men in developing countries (amongst the networks’ partner countries) must have equal opportunities to achieve their full potential in scientific research.

Goals

1) To raise or create awareness of the gender issues affecting women’s participation in scientific research.
2) To increase women’s competence and participation in scientific research.

Outcomes

Responding to goal 1) “To raise or create awareness of the gender issues affecting women’s participation in scientific research”

i. Gender equality measures implemented by research environments

Responding to goal 2) “To increase women’s competence and participation in scientific research”

i. Increased recognition of women scientists of developing countries at national, regional and international level.
ii. Increased number of international publications by women from developing countries.
iii. More women from developing countries obtaining MSc and/or PhD in science subjects.

Outputs and Activities

Relating to goal 1) and outcome 1)

I. Investigate what problems exist
    Activities
    - Conduct seminars/workshops, surveys
II. Intervention to raise awareness
    Activities
    - Workshops
    - Coaching and mentoring
III. Identify and report necessary measures (like flexible working time) and implement them.

The gender working group worked together for one more year and, although the collaboration did not continue, we are still in contact and hope to organise
future common events/activities. The visions and goals are still valid and are the basis of the ISP strategy for the gender promotion work.

The ISP gender grant: from individual grants to three-year activity funds

In 2015 ISP started a more focused work to promote gender balance by inspiring the supported partners to work more actively to include women in education and research activities. ISP announced two grants of 50,000 SEK each, the Gender Equality Grants, for local activities for promoting gender balance targeting supported groups and networks within the mathematics and physics programmes. Eighteen applications were received, giving an overview of the different situations that the female students and researchers met in their environments. The funds were finally granted to Dr Betty Nannyonga (Department of Mathematics, Makerere University, Uganda) and Dr Edward Jurua (Department of Physics, Mbarara University of Science and Technology, Uganda), among many other very good applications. The funds were used at Makerere University to organise two workshops open to Bachelor students to positively influence their choice toward natural science and mathematics for their major studies. At Mbarara University, the grant was used for an outreach programme involving three selected secondary schools in Western Uganda, for conducting a baseline survey and for organising a final conference. The aim of the school visits was to motivate more girls into pursuing science careers. Before meeting the students, a survey was conducted in these schools using a simple questionnaire to establish the feelings and thoughts of the girls about science courses and careers. The conference was based on the findings of the school visits and the survey. Some of the key topics discussed during the conference were:

- Gender and science;
- Gender perspectives in natural sciences;
- Curriculum-related issues and how they affect the empowerment of females in science and technology;
- Perceptions, attitudes, and performance in physics;
- Being accomplished in sciences;
- Female empowerment in science and technology and academia.

Most of the conference facilitators were female scientists.

At the same time, ISP obtained funds from the Equal Opportunity Executive Committee (Arbetsgruppen för lika villkor) at Uppsala University for a workshop for female students (PhD and Master students). The funds were used for inviting five female students/researchers from ISP supported groups in
physics and mathematics, to participate in a summer school organised by the Department of Physics and Astronomy at Uppsala University and the Department of Physics at Freie Universität Berlin, Germany. The summer school included both seminars and research visits to laboratories and research groups in physics at Uppsala and Stockholm Universities as well as lectures and seminars on gender equality. The goal was to increase the awareness of gender bias that could exist at home institutions and in academy in general.

The participants from ISP supported groups, were chosen considering the applications to the gender equality grant announced and allocated by ISP at the beginning of 2016. Betty Nannyonga from Makerere University was the project grantee, and Priscilla Muheki from Mbarara University came from the other granted group in Uganda. The other participants were Lindah Karea (Institute of Nuclear Science & Technology (INST), University of Nairobi, Kenya), Alix Masoop Dehayem\(^\text{28}\) and Ruth Wabwile at the time both from the Department of Physics, University of Nairobi, Kenya, all coming from the short-listed groups with very good applications to the two previous grants.

\[\text{Figure 1. ISP staff and the five participants from Kenya and Uganda to the Summer School in 2016. From left: Ruth Wabile, Lindah Karea, Therese Rantakokko, Priscilla Muheki, Carla Puglia, Alix Masoop Dehayem and Betty Nannyonga.}\]

ISP hoped that the summer school could also be an opportunity to start a new network that could grow and lay the foundations for common activities and

\(^{28}\) At present Dr Dehayem is a Coordinator at Alan Alda Center's Women In STEM Leadership Program at Stony Brook University, Stony Brook, New York, United States.
joint efforts for colleagues in Africa. ISP has always been aware that there is no unique solution to the gender gap and that each group/network should find its own solutions or pathway to them. The goal of our work in this initial stadium was to give a possibility to develop a strategy and fund activities designed to address the local needs. Spending two weeks together at the summer school in Uppsala, gave the participants the opportunity to get to know each other and start to discuss common experiences and activities.

ISP is very glad to see that what was only a wish became a reality: in fact, we can say that the summer school was the seed from which the network Eastern Africa Network for Women in Basic Sciences (EANWoBAS), that joins mathematicians and physicists from Kenya, Uganda, Rwanda Tanzania and Zambia could grow. EANWoBAS is the first and only ISP supported network working with gender issues.

Figure 2: Award ceremony of the Marie Curie PhD scholarship granted to Ms. Rashida Haque at University of Dhaka by the ISP gender equality grant on 6 August 2017.

The high quality of the many applications we received for the Gender Equality Grants, gave a measure of the importance to support this kind of activities in a more sustainable way and that just two grants per year or sporadic financial support could not be enough. In fact, gender equality promotion is a process that requires a long-time and a continuous effort. For these reasons starting in 2017, it became possible for all ISP supported groups and networks in physics and mathematics to apply in their ISP project application for ear-marked extra funds for gender activities that should run during the three-year grant period. In this way, ISP could support gender projects in a more continuous way, thus assuring the feasibility of the suggested and implemented projects. In 2017, of 13 applications within the physics programme, six groups applied for gender
funds and this number has increased ever since until today when ISP Physics (IPPS) has 22 grantees (out of 28 supported projects) and ISP Mathematics (IPMS) six grantees (out of eight supported projects).

From the yearly activity reports, ISP could learn that these funds are used for different activities: recruitment, mentorship, financial support for registration fees, costs for accommodation or exchange researcher visits and conference attendances for female PhD students. It is worth mentioning that Professor Siddique e-Rabbani, leader of a physics group in Bangladesh, applied for institutionalizing a PhD position for female candidates with the hope that this external funded PhD position would allow the female students to work part-time, giving them the chance to harmonize work and family duties. In Tanzania at the University of Dar es Salaam, Dr Eunice Mureithi and Dr Margaret Samiji every year organise a summer school for female high school students for training in mathematics and physics to improve their final grades and facilitate the female students’ access to the university education programs in science.

Figure 3: Left: First Science Camp at the University of Dar es Salaam, 5–11 July 2016. Right: Third Science Camp, 1–5 October 2018.

Many of our supported groups use the funds for the recruitment of students to the university and many are also visiting primary and high schools to inspire girls to study science and continue their education at the university level. This work is very important especially in Africa, the only continent where the girls are not represented among the most educated people and are even still not attending the primary schools29.

In 2018 Betty Nannyonga and Priscilla Muheki (Uganda), Alix Masoop Dehayem (Kenya), Ruth Wabwile (Kenya), Eunice Mureithi (Tanzania) and many colleagues from Rwanda and Zambia started the East African Network of Women in Basic Science (EANWoBAS)\(^{30}\) (Figure 4), with physicists and mathematicians working together for promoting the girls access to science. The many activities organised by this network are run in different countries and their various network nodes share experiences, efforts and visions. The activities include all the important well-known needed efforts to improve women’s participation in education and research: recruitment, mentorship and networking just to mention some.

The lessons learnt

ISP learns each year from the activity reports about the possible reasons behind the gender gap in education and research.

One of the most common reasons for the low number of female students in physics and mathematics programmes are family duties and childcare, traditionally considered women’s activities. This implies that the few graduate girls who would apply for MSc or PhD studies are generally not supported by their families, who, in conformity to the norms, would rather see them taking care of the house and the children. To continue their studies these graduate girls would need full scholarships, covering both registration fees and monthly allowances.

Another reason, given by our supported groups, is the scarcity of female students choosing these fields at the undergraduate level. It is often also mentioned that in almost all African countries there are even very few female students choosing science subjects in secondary schools. Actually, as already mentioned, there is very low participation of girls in primary school in Africa, and consequently, they cannot attend all the higher levels of education.

EANWoBAS is doing an amazing and thorough job visiting many high schools in remote villages (figure 5) to inspire the girls and at the same time convincing their parents that women can indeed study science and that they should support their daughters. Some groups in Ethiopia and Uganda use the ear-marked funds to sponsor summer schools where good secondary school students, and especially females, are invited to run some research projects at the university. This gives them some direct experience of research activities in physics and mathematics, increasing their self-confidence, and hopefully

changing their minds regarding the myth of scientific subjects as hard and only suitable to male students.

Some group leaders have also mentioned that the few girls applying for university studies often do not pass the admission selection due to the weaker pre-university knowledge they have in comparison with their male colleagues. This issue is addressed in Tanzania by Dr Margaret Samji (IPPS) and Dr Eunice Mureithi (IPMS) by organising every year a summer school called “Science Camp,” which is currently in its sixth edition, where female students learn mathematics and physics, participate in experiments, and improve their knowledge, thus improving their chances of admission to university courses.

Many of the supported groups/institutions have already implemented or suggested positive incentives for the admission of female students or the employment of female scientific and technical personnel. Importantly, this reveals a growing awareness of the gender biases women face in their professional careers and also a positive attitude with many ideas about how to promote a more balanced gender distribution.

However, so far very few institutions have developed a gender policy document, and when asked about it, many researchers refer instead to
governmental documents/laws promoting gender balance at every level in society\textsuperscript{31}.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{EANWoBAS at Bunya High School, Uganda.}
\end{figure}

Outcomes

In the following section, we will review some of the results we have obtained so far from our focused efforts.

\textit{Table 2} compares the proportion (in percent) of female PhD and Master students in the different programmes of ISP (chemistry, mathematics and physics) in 2015 and in 2020. As a result of equal opportunity grants and other efforts, we can clearly see an increase in the number of female PhD and Master students in the physics programme. Later we will look at the yearly progression considering the data accumulated in the physics programme.

\textsuperscript{31} The institutions with a gender equality policy document are (as stated in the activity reports): University of Nairobi, University of Eldoret (Kenya), University of Zambia, Makerere University (Uganda) and University of Dar es Salaam (Tanzania). In Bangladesh, the government established education free of costs for female up to graduate level.
Table 2. Proportion in percent of female PhD and Master students of groups and networks in the different programmes in Africa and Asia in 2015 and 2020.

<table>
<thead>
<tr>
<th>Students and region</th>
<th>Chemistry (% female)</th>
<th>Mathematics (% female)</th>
<th>Physics (% female)</th>
<th>Total ISP (% female)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD students in Africa</td>
<td>25</td>
<td>40</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>PhD students in Asia</td>
<td>82</td>
<td>36</td>
<td>67</td>
<td>70</td>
</tr>
<tr>
<td>All PhD students</td>
<td>30</td>
<td>39</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>Master students in Africa</td>
<td>36</td>
<td>42</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td>Master students in Asia</td>
<td>41</td>
<td>49</td>
<td>0</td>
<td>98</td>
</tr>
<tr>
<td>All Master students</td>
<td>37</td>
<td>44</td>
<td>23</td>
<td>47</td>
</tr>
</tbody>
</table>

In tables 3 and 4 we report the proportion (%) of female leaders and staff members in the research group and scientific networks supported by ISP in chemistry, mathematics and physics, by region. The comparison of these two tables gives an overview of the proportion changes from the start of the more focused gender efforts and discussions with the ISP partners abroad.

Table 3. Proportion in percent of female staff members and female leaders of groups and networks in the different programmes and in the different regions in 2015.

<table>
<thead>
<tr>
<th>Groups/networks per region</th>
<th>Chemistry (% female)</th>
<th>Mathematics (% female)</th>
<th>Physics (% female)</th>
<th>Total ISP (% female)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Staff</td>
<td>Leader</td>
<td>Staff</td>
<td>Leader</td>
</tr>
<tr>
<td>Groups and networks Africa</td>
<td>22</td>
<td>19</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Groups and networks Asia</td>
<td>39</td>
<td>29</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>21</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4. Proportion in percent of female staff members and female leaders of groups and networks in the different programmes and in the different regions in 2020.

<table>
<thead>
<tr>
<th>Groups/networks per region</th>
<th>Chemistry (% female)</th>
<th>Mathematics (% female)</th>
<th>Physics (% female)</th>
<th>Total ISP (% female)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Staff</td>
<td>Leader</td>
<td>Staff</td>
<td>Leader</td>
</tr>
<tr>
<td>Groups/networks Africa</td>
<td>27</td>
<td>22</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Groups/networks Asia</td>
<td>36</td>
<td>56</td>
<td>37</td>
<td>67</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>32</td>
<td>17</td>
<td>33</td>
</tr>
</tbody>
</table>

We can also follow the progress in the physics programme in more details looking at the yearly proportion of the female students, staff members and
leaders in the period 2015–2020: these data confirm that there is a real, gradual increase of women participation even if still far from the ambitious goal of 50% gender balance at the supported groups/networks.

Table 5. Proportion of female students (%) from 2015 to 2020 of all postgraduate students in activities supported by the Physics programme of ISP also considering the different regions.

<table>
<thead>
<tr>
<th>Students and region</th>
<th>Physics (% female)</th>
<th>Physics (% female)</th>
<th>Physics (% female)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD students Africa</td>
<td>12</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>PhD students Asia</td>
<td>18</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>All PhD students</td>
<td>13</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Master students Africa</td>
<td>21</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>Master students Asia</td>
<td>24</td>
<td>21</td>
<td>32</td>
</tr>
<tr>
<td>All Master students IPPS</td>
<td>22</td>
<td>22</td>
<td>29</td>
</tr>
</tbody>
</table>

Table 6. Proportion of female staff members and project leaders (%) from 2015 to 2020 of all postgraduate students in activities supported by the physics programme of ISP also considering the different regions.

<table>
<thead>
<tr>
<th>Region</th>
<th>Physics (% female)</th>
<th>Physics (% female)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015 Staff/leaders</td>
<td>2017 Staff/leaders</td>
</tr>
<tr>
<td>Groups/networks</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Africa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Groups/networks</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>Asia</td>
<td>17</td>
<td>29</td>
</tr>
<tr>
<td>Total Physics</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

By disentangling the data by the different regions, we can clearly see that the increase of women participation in the programme, both as students and staff members/leaders, is a real trend. It is interesting to relate these data to the increased support and effort by ISP and mainly by the local colleagues. This shows that the funds, the organised activities and the discussions nurtured by them are really contributing to locally increase the inclusion of women in science. This representation of the data by regions also shows that the increase
is not apparent and due to the inclusion of new supported group in Asia (more specifically in Myanmar) where almost all the staff and the students in natural sciences are women.

Looking forward

During the last year we, the ISP staff, have also undertaken a training related to gender balance and gender mainstreaming. As a result of this training, ISP will start using the collected statistics in a more active way, analysing in depth what can be learned from the existing indicators and measurements, and which of them are most suitable to use for ISP purposes. We want to learn what the causes are behind the values obtained by the indicators, and get viable information to guide us in our work.

We have noted, as also the data confirm, that many of the leaders of the ISP supported activities are by now well aware about the gender gap and willing to actively work for bridging the disparity. It is well known that gender equality and equal opportunities are only reached by joined efforts involving both women and men, as well as all the leaders and team members. Only in this way our work combined with the work of our colleagues can result in a sustainable change allowing girls, women, and other minorities to participate in education and research activities on the same grounds. The time has finally come to take care of all the talents who can contribute to making this world a better place to live for all of humanity.

We are committed to continue supporting our groups and local networks in this important effort, because gender is never separated by its social and cultural contexts. This was exactly the reason why we organised a two-day meeting on the occasion of the 60th anniversary of ISP “Gender, diversities and unconscious bias: how to master the playground rules in Academia” where we could listen to and interact with experts and colleagues in Europe, Asia and Africa but all working with activities that tackle the gender equality. It was a unique occasion that gathered us together to constructively interact. ISP intends to make this as a recurrent yearly or biannual meeting with the aims to keep alive the collaboration and the enthusiasm, and to get inspired by each other’s experiences for a better understanding of the actual and soon, we hope, hinder-free playground for women in science.
ISP Gender Workshop on 9–10 September 2021

Dr Barbara Brena

*Deputy Director of the International Programme in the Physical Sciences, ISP, Uppsala University, Uppsala, Sweden*

On September 9–10, 2021, ISP organised a lunch-to-lunch workshop with the title “Gender, diversities and unconscious bias: how to master the playground rules in Academia” as one of the events to celebrate the ISP 60th anniversary. The motivation behind this workshop was the need for the ISP staff to increase their expertise in working with gender issues in different cultural and social contexts. We wanted to discuss some questions: how can ISP efficiently work towards gender equality in a different culture, meaning a society organised on different principles, traditions, and values, with respect to those we are used to? How can ISP contribute to lifting gender awareness in research and even introduce measures to help women undertake an academic career? And how do we implement this work in our disciplines in a successful way, considering the global general underrepresentation of women in Science, Technology, Engineering and Mathematics (STEM)?

At the workshop we invited experts in gender studies to increase our knowledge about crucial issues that can affect women’s research careers as well as colleagues from several ISP supported groups, to learn more about their work with gender issues to finally develop our strategies together.

Among the speakers at the event, Dr Katerina Berndt Rasmussen, from the Institute for Futures Studies and Stockholm University, Sweden, explained the *Implicit Association Test* (IAT) and showed the connection between implicit bias and different kinds of discrimination. Dr Minna Salminen Karlsson, from the Centre of Gender Research, Uppsala University, Sweden, discussed the visible and invisible obstacles that female researchers can experience throughout their academic career and she highlighted, in particular, the importance of mentors, sponsors, and networking. Professor Gabriele Griffin, also from the Centre of Gender Research, Uppsala University, Sweden, and Swedish supervisor within the Sida bilateral research cooperation programme in Mozambique, described her project on gender and

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32 According to the UNESCO Institute for Statistics (UIS) data, less than 30% of the world’s researchers are women (http://uis.unesco.org/en/topic/women-science).
gender mainstreaming in Mozambique, including an analysis of the gender situation in that country.

We had also the opportunity to listen to many voices from researchers from ISP supported groups from countries in Asia and Africa who have been successfully engaged in activities to promote gender equality. Dr Betty Nannyonga, from Makerere University, Uganda, and leader of the ISP network Eastern African Network of Women in Basic Science (EANWoBAS), spoke about Implicit gender-career bias in academic institutions. She elucidated how a gender bias, often deeply rooted in society and based on prejudice and stereotypes, is at the origin of the big underrepresentation of women in science. An example is the view that women do not possess the innate talent that is required in STEM fields. Gender bias has a large impact on women’s professional life: it influences their choice of studies and it negatively affects all stages of their careers, with repercussions on their work-life balance, and mental health.

Dr Alix Dehayem from the Alan Alda Centre for Communicating Science, Stony Brook University, New York, USA, shared her own story as one of the very few female students of nuclear physics at the University of Nairobi, Kenya, and how she became a successful researcher. She explained the importance of empowering female students and researchers, via mentoring programmes and platforms like workshops and networks to increase their visibility and networking possibilities.

Professor Yvonne Bonzi, from the University Joseph Ki-Zerbo, Burkina Faso, shared her work for reducing the gender unbalance and inequalities in academia in her country. She pinpointed how the inequalities arise from social and cultural reasons, for example from the fixed roles men and women are expected to play as family members in some societies. Due to this mentality, many girls are fully excluded from education. It is therefore important to reach out to these female children and arise their interest in scientific disciplines.

Dr Leela Pradhan, from Tribhuvan University, Nepal, described the activities she undertook already before her collaboration with ISP, like establishing mentorship programmes for young female science students and organising mini science boot camps at both urban and rural science schools to raise pupils’ interest in science.

A slightly brighter situation for women in STEM disciplines was shown by Dr Vanseng Chounlamany, from the National University of Laos. A large number of female students enroll in STEM studies, and there is a considerable representation of female teachers and researchers in Laos. Nevertheless, the gender balance is still remote at the decision-makers levels at university.
Professor Siddique e-Rabbani described the situation in Bangladesh, a country where a few women have succeeded in reaching very prominent positions in science. He pointed out the importance of creating infrastructures to support women researchers during pregnancy and maternity.

Through all these very interesting presentations we could recognize some of the more local hinders that prevent women from education and research in low and lower-middle income countries. We also could get a confirmation about how important it is, the work that our colleagues are doing locally to address the local needs and to overcome the local barriers.

Outcomes of the event: a virtual discussion

At the end of the event, we organised a virtual discussion (we had to use zoom since we were still in the middle of the Covid-19 pandemic), in which we asked the public and the speakers to give short answers to a few questions to summarize the most important messages that had emerged from the conference. In this way, we gave word directly to all the participants who could share their thoughts and we got further inspiration about how to continue and improve our work. The full list of the questions and answers is reported at the end of this chapter.

First of all, we wanted to get an overview of what had inspired the participants, in large part females, to choose a STEM discipline for their studies. The answers highlighted in particular the environment, like having a supporting family and teachers, the inspiration, often coming from role models in the media and school-like activities introducing school children to science and mathematics. Finally, also a personal predisposition towards scientific subjects was mentioned.

We successively put the question of what can be the major factors that could prevent a girl from choosing to study a STEM subject in the cultural environment the participants were coming from. The answers varied from issues of lack of self-confidence and self-esteem, which in general affects girls in larger extent than boys, to lack of encouragement from either family or teachers. The traditional division of roles between sexes, attributing girls and women to a specific role in the family and society, as well as poverty and ignorance were also given as strong factors.

We wanted to dig deeper into the obstacles female scientists often experience, so we asked about the main difficulties a woman researcher can encounter along her career path. Here, together with the issues already highlighted by
the previous answers, like tradition, marriage, and female family duties, we also noticed the mentioned difficulty to work on the same terms as male colleagues in male-dominated environments. This means that, for example, women are not given the same opportunities as their male colleagues. This issue includes a reported lack of communication and information encountered by women, who are often excluded or left aside by their male colleagues. Social exclusion is a common experience for women in STEM all over the world. In addition, also the lack of possibilities for women PhD students to combine studies and family, was mentioned.

Our last question was about the possible solutions to these problems connected to the personal experience of the participants. Among the suggestions, including the need for empowering women and giving them support from mentors and sponsors, as well as more stable positions, the need to work against sexual harassment was brought up, using existing rules and educational campaigns, a planned strategy at the institutional level, and the strong need to educate not only scientists and teachers but men in general, into gender issues.

From the workshop, it emerged that the most correct and effective way to tackle the discussed issues, and what particular measures should be taken to make a change, is linked to the various environments/cultures. In this way, tailored solutions/activities/programmes could lead to good outcomes. For these reasons the funds given by ISP to local groups and networks are important and relevant since they can be used for activities to address the different local needs. With this event, we also succeeded in starting a forum where voices from different cultures and countries could share their knowledge, experience and activities. The participants were very engaged and expressed their appreciation for the event, which is very important for us. We will continue working to keep the forum alive, by planning future events. We want in fact to keep listening and learning to develop more and more focused measures to effectively improve the situation of women in STEM in the countries where ISP is active, together with our colleagues in these countries.
Appendix A:

ISP 60th Anniversary Workshop: Gender, diversities, and unconscious bias: how to master the playground rules in Academia, September 9–10, 2021, Final discussion

1. What gave you the inspiration to choose a STEM discipline for your studies/career?

- Good and inspiring teachers
- An internship at a research institute
- Early age seminars about science at the schools
- Interaction with professionals
- Availability of resources, labs, computer
- A good library in high school
- Access to additional facilities that extended one’s view of science and what doing science means
- Scientific experiments
- Good capability in science
- Spontaneous interest towards science
- Curiosity
- Science oriented TV programmes
- Family support

2. Considering your particular environment, what prevents young girls from starting a scientific education?

- Lack of confidence in their capabilities.
- Lack of family support and esteem from family members
- No encouragement from teachers
- Women often think that science is difficult and not suitable for them but only for men.
- Social pressure about how a woman's career should look like and about building a family (besides marriage)
- Marriage
- Women’s responsibility/life in the house: even little girls are limited to playing in and around the house while boys can go out further into more daring environments.
- Stereotypes (negative stereotypes), lack of support, lack of finance, lack of networking
• No proper social environment for studies
• Poverty, as the very first factor, and feminization of poverty
• Poor material support, lack of books and laboratory
• Lack of field visits
• Lack of secure job perspectives
• Lack of information
• Religion

3. Considering your particular environment, what are the main problems that female scientists encounter in their careers?

• Lack of flexibility: lack of possibilities for women to do their studies and combine that with family - we need more flexible scholarships for young women researchers, especially in developing countries
• Family burden and chores, unbalance in the distribution and sharing of duties in the family
• Marriage and unsupportive spouses and family
• Mentality
• Religion
• Discrimination
• Lack of communication and leadership
• Very often women are working in men dominated environments
• Despite the capacity of females, they are undermined by a male-dominated system and are not given the opportunity or responsibility
• Absence of technological tools

4. What solutions would you propose, after listening to the workshop and considering what made you stay in science?

• Role models: media and movies should present female characters with expertise in STEM
• Motivation and empowering of women by experienced professionals
• Support from sponsors and mentor
• Need of friendly study/work environments
• Scholarships for females at Master and PhD levels to give the students a chance to fight
• More stable work positions for young women (and men), eliminating infinite post-doc positions
• Financial facilitation and mentoring
• Creating increased awareness and at the same time empowering females both in the house and in the socio-economic system
• Women more easily undertake career jobs, for example in the manufacturing industry, but they have a hard time continuing in research where it is very difficult to start a real career job
• Working against sexual harassment using existing rules and educational campaigns
• At the institutional level: higher Institutions should have a planned strategy to reduce gender inequality
• Education on gender issues, with male participation.
• Educate the men (especially all those unsupportive spouses) on what they can gain if they have a financially independent wife and not depending on them
• Need of information to increase awareness on challenges and opportunities
• Plan own contributions, struggle
• Hard work with passion and love for science are fundamental ingredients
A Gender Success Story - The Case of Uganda

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Despite an overall improvement in enrolment, female students continue to be disproportionately underrepresented in basic sciences in Uganda. Through the 2007 Science Preference Policy³³, the government directed that science students would receive 75% of the government scholarships to public universities and tertiary institutions. Public universities have made special provisions to encourage women in science through internal quota policies. However, girls are still underrepresented, a problem acknowledged in government documents like in the Gender in Education Policy of 2016.³⁴ In 2017-2018, Uganda implemented its National Science, Technology and Innovation (STI) policy.³⁵ Makerere University Council in August 2019 approved an affirmative action policy ring-fencing 40% of vacancies in all basic sciences disciplines for women.

The Uganda government has continued to develop policies that encourage a higher female intake, and support for science-based courses, by enabling universities to provide for increased enrolment quota for female students in science-based courses. In addition to the support and nurturing by the government of Uganda, other programmes such as Sida through the International Science Programme (ISP), have given financial, social, and all possible support to lift the girls in low income countries, including Uganda.

Many reasons are given to explain the low numbers of girls in science fields of study, such as self-perception and low confidence in girls' capabilities. Some girls (and their parents/guardians) tend to believe that success in basic sciences is a question of natural abilities and that girls do not have the same capability as boys to excel in these fields. The underrepresentation of women in basic sciences is partially rooted in such long-standing gender stereotypes and cultural biases which have created false expectations and misconceptions. In some societies there is even sexism, where social constructions dictate what is regarded as appropriate work (and therefore the course of study) for women.

Domestic and career responsibilities result in conflicts between career and family like inflexible work hours or the extreme amount of time needed to take care of everything. Additionally, the perception of women in these fields as unfeminine, the lack of belief that they will be able to handle the work, and the lack of social encouragement, create further obstacles to pursuing careers in basic sciences.

Even though science can play a crucial role in meeting internationally agreed development goals, it can only facilitate equitable and sustainable development if the aims, concerns, situations, and abilities of women, as well as men, are considered when formulating science policies and executing corresponding initiatives.

In 2009 I joined ISP as a PhD fellow through the East African Universities Mathematics Programme (EAUMPS), a network that was constituted in 2002 by the Departments of Mathematics at Makerere University (Uganda), University of Dar es Salaam (UDSM, Tanzania) and University of Nairobi (UoN, Kenya). By 2011, I had completed and defended both the Licentiate and PhD degrees. In 2013 I won one of the Gender Equality Grants that ISP advertised, and which has led to the formation of local and regional networks to support women in basic sciences. For the last nine years, I have worked with, and been supported by, ISP to hold activities that support and mentor women in basic sciences.

We work specifically in mathematics and physics, through gender equality activities such as gender and science seminars, workshops, mentoring sessions, training, and conferences to support the girl child in sciences, and empower her to succeed alongside the boys. By 2017, all Makerere undergraduate mathematics female students were mentoring one another and were determined to major in mathematics or physics. A “Women in Natural Sciences (WINS)”\textsuperscript{36} network within the University College of Natural Sciences was created and supported all science and gender related challenges and activities. The network partnered with Makerere University School of Women and Gender Studies (SWGS)\textsuperscript{37} to offer more knowledge and understanding of gender construction and science achievement. With this achievement, WINS expanded to all local universities, bringing on board women achievers in mathematics and physics around the country, and the “Uganda Women Mathematicians” (UGAWOM) was formed to carry out mentorship roles and gender training.

\textsuperscript{36}https://cns.mak.ac.ug/blog/bridging-gap-females-basic-sciences, Launching in 2016.
\textsuperscript{37}https://womenstudies.mak.ac.ug.
UGAWOM’s core values were to respect the girl achievers in basic sciences, to enable them to excel, be accountable for their success in science or, in case, for their lack of achievements in sciences, assist them to commit to sciences, stress the importance of teamwork as a mechanism for success, and achieve all this with integrity amidst societal and cultural stereotypes and challenges. UGAWOM came up with a vision, mission, aims, and objectives, upon which gender-smart solutions and capacity development were premised. UGAWOM and SWGS collected data, developed an analysis of factors that affected participation, and documented trends, challenges and opportunities for women and girls’ participation in science careers. With this partnership success, the local network once again expanded to include Eastern African countries under EAUMP, and in July 2018, the Eastern Africa Network for Women in Basic Sciences (EANWoBAS) was born.

Figure 1: UGAWOM Brochure.

EANWoBAS comprises Kenya, Tanzania, Rwanda, Zambia and Uganda, with each country serving as a node run by a coordinator. It mentors to empower girls through volunteerism with integrity and collaboration while promoting creativity (MEVIC). EANWoBAS advocates for "Sciences for all", with the following objectives:

- build the capacity of women in basic sciences by way of training, embracing new technologies and innovations through research and development;
- develop a platform for advisory and advocacy roles to public and private sector organisations on all matters related to basic sciences within the Eastern Africa region;
- initiate, conduct and assist various programmes aimed at promoting basic sciences among women within the Eastern Africa region and beyond, through aligned collaborations, synergies and partnerships;
- mobilise resources, knowledge management, networking and information sharing amongst stakeholders.

In furtherance of the foregoing principal objectives, EANWoBAS has the power to:

- co-operate and affiliate with other corporations or institutions having similar objectives as those of the association;
- publish and distribute various literary works in furtherance of the main objects;
- mobilise resources from voluntary agencies and coordinate its efforts for advancing the development of basic sciences to the society through social action;
- take the mentioned steps by personal or written appeals for grant proposals, sponsorships, donations, subscriptions, or otherwise as may seem expedient to solicit contributions for the association's funds;
- acquire copyrights, patents, rights of production or presentation, licenses and privileges of any sort likely to be conducive to the objects of the company.

The network also involves education and training (at primary and secondary schools), for teachers, school administrators and parents. EANWoBAS recognizes that women's capacity to participate in science, technology and innovation is grossly underdeveloped and underutilised. In addition to having less access to technology and information, they are also underrepresented in education, entrepreneurship, and employment.

The impact of affirmative action in education policy has visibly narrowed gender gaps in education, but this has not yet translated into equal employment opportunities for women. Nonetheless, EANWoBAS is a source of inspiration in science practice. Under the ISP umbrella, EANWoBAS women are debuting and making a mark in science, as stewards of basic sciences, researchers and practitioners and form part of the backbone of the respective national basic sciences ecosystems.

EANWoBAS has generally adopted processes and approaches which benefit women at local, national and regional levels. A range of support activities and
programmes encourage girls to study basic science subjects and female professionals to remain and pursue their careers in basic sciences fields, by integrating gender concerns and taking steps to understand gender patterns of use and access.

EANWoBAS has many gender-focused initiatives that form best practices such as financial support to academically talented but economically challenged graduate women, and a budget for conducting gender-sensitive tailor-made career guidance in secondary schools and teaching practice in rural-poor-science-performing schools. EANWoBAS provides science teaching materials to secondary schools, and engages learners through marathons, science camps, seminars, workshops, and conferences, all aimed to provide equal access and success in science learning environments across the region.

In March 2019 EANWoBAS visited schools in the Mayuge district, Uganda, where mentorship was given to teachers, learners and parents on the importance of mathematics and science in daily life. Support in form of scholastic materials was also distributed. With the breakout of the Covid-19 pandemic, all aspects of life were obstructed and schools were closed for about two years. Nationally, loss of lives, jobs, and disruptions in access to health and social services were reported. In addition, an overwhelming number of teenage pregnancies were reported across the country with Mayuge accounting for over 6,205, with a big fraction of girl-mothers expecting to give birth soon. Most of these girls had been visited by EANWoBAS as students in 2019. The probability for many of the abused adolescent girl-children to go back to school remains dreadfully low due to fears of being laughed at by the peers, being abused by educators, and pressure from parents to indulge in income-generating activities to cater for the babies, a condition that could have forced many school-age children to remain in marriage. In this regard, EANWoBAS organised a "take back the girls child to school" drive in the district, visiting the young mothers, parents, school teachers and local leaders. We partnered with a role model: the successful story of a woman who had previously faced the same dilemma, but went on to beat all odds, completed her education, and is now gainfully employed. In this story, the girls saw themselves, and formed a bond with EANWoBAS: we have seen all our mentored young mothers go back to school in January 2022. EANWoBAS continues to avail itself to communities of Mayuge to improve the education of the girl children during the pandemic.

Each year since 2018, EANWoBAS has supported on average 500 secondary school students with science materials, and about six schools with mathematics and physics textbooks. We have also provided tuition to six
female Master students to enable them to complete their graduate studies and improve their employment potential.

**Figure 2: The mothers of the pregnant girls/young mothers, interacting with EANWoBAS women.**

EANWoBAS is a cornerstone of inclusive growth and gender equality at local and regional levels, supporting gender-focused mentorship, and inclusion into science careers, as well as capacity building for gender equality. With more guidance and support, EANWoBAS expects to promote further development for women in science by building their knowledge through policies and actions promoting equal access to basic sciences education and training, and equal opportunity in the management and implementation of research. Broad science education preference policies do not seem to have helped girls and women much. The initiators of these policies have to understand and appreciate the need for affirmative action if women are to benefit more.

**Figure 3: Girls holding bags with scholastic material donated by EANWoBAS with the support of ISP.**
Specifically, EANWoBAS continues to advocate for:

a) effective policies to increase access to quality basic sciences education; teaching strategies and learning environments; assessment procedures and monitoring tools; approaches to reach more girls, build basic sciences literacy and skills, and address gender divides; gender roles and expectations on girls' participation, progression and learning achievement; increase the awareness of family, peers and teachers about gender stereotypes in schools, in the communities, and in the broader society, and to improve the educational resources to influence girls’ aspirations, confidence and self-confidence in basic sciences studies;

b) mentorship opportunities to interest girls in science fields, and retain their interest in basic sciences studies and engagement;

c) more role modelling and extracurricular activities to attain genuine and equitable development;

d) empowerment, leadership and confidence as common drivers, which have to be imparted through existing and potential partnerships to help advance gender-responsive basic science education and career advancement of women in basic sciences;

e) encouragement and support of girls and women to realise their full science potential;

f) well-funded support programmes for girls and women in basic sciences such as secondary school science awareness, mentoring programmes and scholarships for young women, particularly from less advantaged backgrounds;

g) more cooperation in secondary schools, universities, the private sector and the state in developing a whole programme that not only increases access for women into those fields, but supports them along their career path.

EANWoBAS believes that science must support women's development and livelihood activities, through solutions that achieve the overall objectives of interventions while closing relevant gender gaps in the process. It is imperative to support education, training, ensure women's equal access to opportunities, resources, education, and services to support their science and gender-related activities. This can be achieved through understanding outdated but prevailing cultural norms and institutional inertia that create hard roadblocks, particularly when it comes to gender.

EANWoBAS has also recognized that most of the girls visited sought to gain money from relationships with men, due to impoverished homesteads and lack of income-generating activities. Since the visit to Mayuge, the women have trained in home basic income-generating activities such as baking, soap
making, home gardening, and making various snacks. During the subsequent visit to Mayuge, we shall train the girls, their mothers and guardians to engage in such small-scale economic activities instead of selling out their daughters for food and other home necessities.

Starting out as a single-woman-led activity at Makerere University in 2013, ISP made EANWoBAS grow to over 80 women in five countries. Activities that run in one university in 2013, are now held in more than seven across the network, with more than 62 schools visited in the course of two years, and about 10,000 school students visited each year. This has led to better outcomes, including better grades and improved indicators of student achievement.

EANWoBAS is continuously committed to promoting gender equality and empowerment of women in basic sciences and the commonly recognized process for achieving this is gender mainstreaming. Our gender mandate requires that we complete an assessment of the network's capacity to provide gender equality and women's empowerment. Within three years, we shall have completed the assessment, and the resulting gender capacity development plan will contribute to improving the region's capacity to advance gender equality. Our goal is to develop feasible action-oriented plans that address the challenges and gaps identified during the assessments and support the development of women's capacities.

This plan responds to our objectives to develop feasible action-oriented gender capacity building plans addressing the capacity challenges and gaps delineated by the assessment process, and to support women’s needs for the capacity development. We shall build capacity in the following areas:

- Knowledge and understanding of gender-related concepts;
- Knowledge and implementation of gender mainstreaming policies;
- Gender learning and application;
- Support for gender mainstreaming;
- Accountability (institutional gender accountability);
- Budget allocation;
- Operationalization – challenges and limitations in mainstreaming gender into operational work due to aspects of institutional mandates. The collection of gender information is often limited to sex-disaggregated data and there is a need to provide the women with the capacity to develop new recruitment strategies to attract female candidates to science courses.
- Partnership with respective schools of gender and mainstreaming in our universities and development of viable plans to integrate gender and science into the already existing - or new - programmes.
This will be the plan for the next six years. By the end of the nine years, we shall have a network process on knowledge and understanding, skills and competencies, and access to learning and support. Challenges envisioned here will be for example how data on online gender self-assessment will be collected, whether it will be possible to have physical interviews with women in the network, and the difficulties to convince policy makers that science and gender can be strategically integrated within their frameworks. We also expect challenges to inhibit our ability to mainstream gender effectively in our areas of work and might lack support and partnerships to actively suggest ways to achieve these objectives.

We have had an impact, and proven relevance since inception. The network has promoted basic sciences in Eastern Africa for three consecutive years including outreaches, school visits, math camps, marathons, science days, and workshops and seminars.

Over five women in the network are completing their PhDs, three hold Master’s degrees, and six are supported by the network to complete their Masters. We have mobilised resources locally in the nodes to finance activities on a broader level, brought women mathematicians on board and they have interacted with our girls and given them hope on how to link mathematics and physics to industry. We have carried out numerous research and published manuscripts within the network, improved our collaboration and increased the number to six active nodes, with a pending seventh. This year we have attained four PhDs from Uganda, and expect four more in the next couple of years. We expect six Master’s degrees completed within 2023, increased basic sciences majors from the network, and girls enrolling and remaining in basic sciences at university.

Collaboration and activities held in the network have increased, we have numerous ongoing industry-based research, and have formed research groups in basic sciences; although some were derailed by the Covid-19 breakout, we plan to improve on using e-opportunities. We have had new publications from the network, including a self-help book, and improved cooperation and capacity training.

We have also had challenges especially brought about by the Covid-19 pandemic, such as not being able under the circumstances to perform research training, and hold workshops. Since the lifting of the lockdown, we expect to work on these challenges and have already organised our math run this year planning it in different locations to avoid mixing and further possible transmission of Covid-19 during the run.
ISP has made us fulfil our dreams by supporting our academic achievements, and it continues to ease our work as role models by giving us the possibility to give back to several communities. ISP has provided the girls in Mayuge with a chance to meet and compare challenges and mitigation measures with women facing similar difficulties. It is likely that these girls would otherwise not have been empowered to return to school as mothers. In addition, some parents would not have supported their return to school, and would have considered them failures and disappointments.

Thanks to ISP dedication to nurture and support, we have been able to have impactful success stories, and for that we are forever indebted.

Figure 4: In pink and black, EANWoBAS women in Mayuge, preparing to talk to the pregnant girls/young mothers, to advise them to return to school.
Experiences on Gender Approach Integration by a Female Scientist in Burkina Faso

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A University trainer is an educator, and when that concerns a woman, she may also socially be a wife and a mother. As a female scientist, she wants the best for her sons as for her daughters and all girls. Professionally, a scientist aims to advance knowledge for achieving solutions to development challenges, with involvement in national and international cooperation.

In Burkina Faso society, as generally in developing countries, roles, responsibilities and tasks for women and men are given according to what is considered to be adequate for each gender. So, girls are more affected by housework during their studies. Early marriage of female students and pregnancies of young women scholars are common in the country, and one girl in ten marries before her 15th birthday. The problems are multiple for girls and women due to many prejudices and they are deemed to have no ambition, no curiosity, and no capacity for long-term studies.

Facing the above-cited facts, it is hard for a southern scientist to remain unmoved by situations on gender inequity in education and also in science, observed during years working at university.

Facts observable

A national gender policy has been in place in Burkina Faso since 2009 followed by a National Gender Strategy (NGS) and its operational action plan (2020-2022). Inequalities between boys and girls seem to have been partially resolved in primary and secondary schools with 154,775 candidates at the baccalaureate exam in 2021 with 44.7% being female.

However, by examining statistics at the university level, high disparities were observed. In 2018–2019, only 35.3% of university students in Burkina Faso were female, while 26.8% of students at Master level and 26.5% at PhD level were females in public universities. The representation of females in natural sciences is less than 28%. At University Joseph Ki-Zerbo (formerly known as

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University of Ouagadougou) female professors are only 14.5% of the teaching staff in science and technology. In our Department of Chemistry, only two women were full professors in 2020, and since 2000, only two ladies have defended their PhD theses, one in 2013 and the second one in 2022, supported by the International Science Programme (ISP) grant to our research group working on biopesticides.

Through research grants, workshops and mentoring, also the International Foundation of Science (IFS) helps young developing countries scientists to establish their careers. IFS eligibility criteria such as age limits promote women's participation. For Burkina Faso, from 2010 to 2020, however, only 22.2% of grantees are women. The main reason for the low proportion of female candidates from Burkina Faso is the lack of female students in general in higher education in the country.

As chemists, involved in the biopesticide research group with ISP support since 2008, our interest in the development of botanical pesticidal compounds, has given us the opportunity to be in contact with farmers working in garden market cultures in different villages with associations as the Koala (Association ADESK), Gomponson (Association Kombi-Naam), Koubri (Watinoma), and at Somgandé in a peri-urban area (Association la Saisonnière). In all of these sites we meet many women active in garden market production. Within associations, women are active and communicate well around their specific tasks accepted according to the social division of labor. When an exchange meeting is organised in gender-mixed mode relative to joint activities such as market gardening, women do not speak much. They settle in a separate group one place back. Even if they have the right to express their opinion, they must be asked with insistence to communicate their opinion during meetings.

In observing women in both contexts, either students or farmers, we found that the apparent lack of ambition was due to a lack of communication capability. So, an effort was done on reinforcing skills in communication. When women are educated, they gain a voice and a place in society, which gives them more economic opportunities, as said by Amartya Sen, Nobel Laureate in Economics 1998.

We believe that female communication is insufficient in Sahelian countries and must be promoted in gender approach, and we choose to give a voice or a tribune of expression to girls and women beside men within various activities.
Personal experiences: Acceptation to be a complete female role model by learning

During sensibilization activities involving female role models, it is important to show pictures of happy female scientists as “Women Stars” to motivate students. As a public star, you must first be excellent in your scientific expertise and able to communicate science with ease and love. A female scientist needs to develop skills in communication and gender approach, which are not exact sciences. Therefore, a female researcher must be aware of gender equity and accept a stressful process of learning by doing in order to acquire those communication skills that will be necessary for her as a role model.

My participation in scientific communication activities started in 1995 within the West African Society of Chemistry established in August 1994. My own potential as a trainer increased by 2000 with my contributions during scientific proposal writing seminars organised with the integration of gender equity, by Dr Cecilia Öman with IFS support in Burkina Faso and in Benin.

Numerous platforms, associations, and networks aim to reach gender equality through awareness for access and retention of female scientists at different levels: institutional, national, regional and international. We learn through all these activities by for example contributing with seminars in scientific camps for girls and conferences on scientific themes.

Some active contributions were done in synergy with institutions, such as IRD (Institut de Recherche pour le Développement), and scientific days for females PhD students were arranged which included communication, posters and panels with role models. I was a mentor in an award programme in 2019, within a network with focus on high level students in agriculture to increase their leadership. Panels on gender approach on mathematics were organised through the national academy organisation.

Organisation of activities at any levels

At each level of education, responsibility strategies can be applied to activities relative to gender promotion. We were involved in different categories of actions in and out of the university. As Director of research at the university from 2008-2013, I organised scientific days with scientific competitions (oral communications or posters), with separate prizes for female and male PhD students.
As coordinator of the ISP supported biopesticide research group, I am organising a yearly competition for the best scientific communication by a female researcher. Many seminars on chemistry, and in particular on water, were given at different institutions. Holiday scientific trainings were organised with students in chemistry, where the themes of Sustainable Development Goals (SDGs) were in the focus of competitions held in the years 2020 and 2021 at the university and at a school. As General Director of Science Institute (IDS), an institute located at Ouagadougou in charge of training secondary school teachers, in the years 2018 and 2019 I organised competitions in mathematics, on water themes, and in 2019, the 150th anniversary of the Mendeleev table, on the periodic table. Also, I organised an experimental exhibition on the theme of agriculture, with the IDS students and invited PhD female students. Furthermore, a group of female scholars from a secondary school (Belemtissé) that were already trained in ludic chemistry manipulation were invited for experimental exhibition for the benefit of the IDS students.
My deep involvement in the coaching of candidates during the international competition “My thesis in 180 seconds” (MT180s), in scientific communication, helped Dr Zabré Généviève, representing Burkina Faso, to win the first prize in September 2018.

As Laureate of the Kwamé Nkrumah Price of the African Union 2013 in fundamental sciences and technologies, I have given many presentations. One can also note that ISP support has contributed to increasing my potential in scientific publications required as one eligibility condition for the prize.

In meetings celebrating the International Day of Women (8 March), we took the opportunity to speak about the importance of education for girls by presenting famous African female scientists as models.

As a researcher, during mobility in Togo (Kara University) and Ethiopia (Mikelle University), side events were organised to meet female students for discussions. In connection to the themes of the visit, messages could be prepared and used in presentations. Core values of the host institution can be exploited to communicate about leadership, participation, innovation and anticorruption. The values of institutions are shown to be the same values that can be applied in sciences and research.

Any discipline like chemistry, physics, mathematics, biology, literature, sociology, etc. can be linked to one or many SDGs, and each person can see this as a part of an interconnected platform of global development. Letters were prepared for scholars in one pilot village on themes such as communication and the SDGs. Water issue is easy to use as an example to show that tiny drops, as compared to an ocean, could solve population’s water demand. In 2022, the opportunity will be taken in the theme of activities to speak about the importance of basic sciences for development.

Implication of women farmers during workshop with local language interpretation

The national workshops on biopesticides held in 2013 and 2015, with ISP financial support, were moments of strategic reflection in the field of biopesticides and their extension with actors from farmer’s associations, networks of scientific journalists, NGOs, and technical structures of ministries, training and research institutes. It was important to organise the visits of female participants to the university. It was their first time to enter a university campus and to participate with high-level educated experts. If time is reserved for these women to speak in their traditional language, if you are careful in group photo to give them visibility, this increases their honor and
active participation. They will give their opinion on the topic and get a great consideration compared when meetings were organised in village.

Conclusion

My commitment is due to my determination to share knowledge. The result is that my own skills have increased by building my personal capacities, and it is a pleasure to take actions in awareness-raising activities.

Evaluation of impact of my gender approach activities in terms of statistics is difficult, but I am satisfied in terms of individual change. Some changing behaviour that induces female student metamorphosis encountered during only one-week workshops, motivation of female farmers and leadership, and successes in studies, were observed. The actions take time, energy and cost money. With the annual support of ISP in gender approach activities within the framework of the research group, the gender activities extend from Ouagadougou to other towns: Bobo-Dioulasso and Koudougou. This women capacity building in communication and science fits with the ISP’s strategic plan, which aims to impact both institutions and education for scientific knowledge and human resources development.

However, new challenges arise in Burkina Faso due to insecurity. The territory counts about a million and a half of intern refugees, and more than 3,000 closed schools. But we cannot tire or give up, as Wangari Muta Maathai said who received the Nobel Peace Prize on 8 October 2004, and was the first African woman to receive this distinction.

Figure 3: Lecture on the theme "Research in chemistry, what contribution to development?" given by Professor Bonzi after receiving the AU price to pupils on 4 April 2014.
Our Experiences as Women in STEM in Kenya

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Science, technology, engineering and mathematics (STEM) play a critical role in the development of national economies. STEM is the cornerstone of national development, without which no nation can excel scientifically and technologically. As a result, nations that aspire to develop in these areas should give great attention to the teaching of STEM subjects at all levels of education. In spite of this, only a small population of the girl child has been actively involved in STEM programmes, and their drop-out rate as they move up the echelons of learning is alarmingly higher than boys. In this chapter, we highlight some of the challenges experienced by women in STEM in Kenya, our success stories and our vision for the future.

Challenges faced by women in STEM

Generally, women account for a minority of the world’s researchers. According to UNESCO Institute of Statistics, less than 30% of world researchers are women (UIS, 2019). Some of the drivers and barriers which lead to the low participation of women include lack of role models, cultural expectations and family responsibilities, gender-based harassment and sexual violence at the workplace or in higher learning institutions, unjust working conditions, religious doctrines, societal stereotypes, and stalled careers which cause them to leave their jobs.

In the African culture, male and female counterparts are not at par when it comes to child-bearing responsibilities, hence for married couples, women shoulder the responsibilities of nurturing the family. Many studies have shown that commitment to family duty has hindered their involvement and advancement in research, further studies and accepting high positions or jobs that take them away from their families; yet attainment of PhDs and professorship at the university is through research and writing, which is time-consuming in STEM areas. Studies have shown that women in science-related

fields publish less, are paid less for their research, and do not progress as far as men in their careers (UIS, 2019). While women who pursue postgraduate studies after raising their families are often cut-off by age when they apply for scholarships and research grants, those who pursue their postgraduate studies first also fear they would not get married. Besides this, women have to work extra hard to prove their capability. For these reasons, the research work culture is lowest among women in most African universities, and this creates a situation where STEM women are underrepresented in the top positions.

Research has shown that most females have less confidence in their science and mathematics abilities compared to their male counterparts and they begin to lose interest in STEM-related careers from early adolescence while in primary and secondary school levels. This has been attributed to family socialization structures as in some cases, parents encourage boys to be more physically active, strong, hardy, and persevering when faced with their own challenges while girls are brought up to be tender, caring and obedient. As they grow up, boys tend to be self-confident and independent while girls are seen to be emotional and more affectionate. This kind of grooming makes it harder for girls than boys to adapt to the important learning tools in science and mathematics, which include discussion, problem solving, and laboratory exercises; and ultimately challenges their participation and pursuit of STEM related careers.

There is a societal stereotyped mindset that sciences and STEM related jobs are not meant for ladies. Some professions such as engineering are still regarded in some quarters as a ‘no go zone’ for females while nursing and catering professions are seen as exclusive for women. Many science subjects have been given a masculine outlook by educationists, such that a girl in science, mathematics and technology education attracts attention. The societal influence of gender stereotypes and bias against women in science has consequently affected the girl child’s aptitude. Many girls have bought into this kind of stereotyped mindset that sciences are hard and not meant for them, thus affecting their confidence and performance in STEM subjects. A lot of effort must therefore be put in by teachers and lecturers at all levels of education to evoke their enthusiasm and courage to pursue sciences that can lead to meaningful national development.

Stereotypes by parents about girls and STEM careers affect girls' perception of STEM subjects and related careers. For instance, if a mother has mathematical anxiety, this will have a direct impact on the comfort level of
their daughters toward mathematics, and also towards a mathematics career\(^{39}\) (Mandina et al., 2013). Apart from the parents, some teachers at the primary and secondary levels of education often tell the girls that mathematics and sciences are very difficult and not meant for them. Consequently, these negative attitudes and expectations contribute to the low participation of girls in STEM as they feel less confident in themselves.

Strong female role models are critical to helping young women discover their passion for science, mathematics and technology, thus boosting their confidence in their academic abilities. However, there is a lack of exposure to role models that can positively impact young women's science and mathematics performance, thus helping in dispelling the negative stereotypes. Besides this, most of our institutions are under-equipped with instruments for experiments and analysis. At the undergraduate level, the student-to-equipment ratio is so high such that students don't get enough ‘hands-on’ experience with the equipment. This affects their competence and negatively impacts their confidence levels, especially the girl child who is trying to beat many odds to pursue a STEM-related career.

Most women have experienced gender-based harassment and sexual violence in higher education institutions or at the workplace and many have had their careers stalled. The harassment may include derogatory comments, unsolicited sexual advances and physical violence, among others. Although many African universities have gender policies and policies against sexual harassment, sexual manipulation of women is reported to be widespread. This is majorly attributed to financial needs, the imperative to get good grades to open doors in a scarce labour market, graduate unemployment, and peer pressure (Dranzoa, 2018). Besides sexual harassment, women in some religious communities are denied equal opportunities to compete with boys on equal terms.

Our success stories

Professor Lydia Njenga, leader of an ISP supported chemistry research group at University of Nairobi, is one success story who has beaten all the odds to reach her current position. Her interest in STEM started in primary school where she was the best in mathematics. While in primary 6, she was requested to attempt the Kenya Primary Education (KPE) mathematic paper, which was done that year and she scored 65%. After her KPE in primary 7, she joined a

girls’ high school where her love for science was nurtured and she opted to join the science stream and passed her Kenya Certificate of Education (KCE) with Division 1, scoring either point 1 or 2 in all the science subjects. She pursued sciences in the then A-levels where she passed the Kenya Advanced Certificate of Education (KACE), and in 1976, she joined the University of Nairobi to pursue Bachelor of Science (BSc) with a chemistry major. Despite many challenges experienced by her fellow male counterparts, she graduated with first-class honors and was a top student in the class of 1979 in the Faculty of Science and joined postgraduate studies the same year. She believed that if both male and female students can be given the same exams, it also means what a male student can do, a female student can also do; and this became her motto.

Professor Njenga began as a Demonstrator (a position equivalent to Graduate Assistant) in 1982 and became a Tutorial Fellow in the Department of Chemistry in 1983. During this period, there was no Kenyan female academic staff in the department. She faced a lot of resistance from the male staff, and she had to fight for her space and prove her capability. In 1985, she was awarded a sandwich training programme through the collaboration with ISP, to carry out her PhD research in Analytical chemistry and was based at Uppsala University, Sweden. While there, she was mentored by the female PhD students who were ahead of her, and also after observing the role of the female students in the department and the respect they received from their male counterparts, she purposed to become a role model to other female chemistry students back in Kenya. During her postgraduate studies, she experienced a lot of challenges from male colleagues who felt she deserved to undertake social sciences and not chemistry. Due to her resilience and hard work, she saw an upward mobility in her career and in 2006, she became the first female to be promoted to the position of Associate Professor of Chemistry at the University of Nairobi. She has been involved in teaching, research and supervision of both Master and PhD students; and has published widely in her areas of expertise.

She became the first female Dean in the School of Physical Sciences (SPS) in 2011, where she was elected twice unopposed for her two terms as the Dean. This came as a major breakthrough because even the other STEM related programmes such as engineering, architecture, agriculture, etc., had never had a female Dean since the inception of the University of Nairobi in 1970. During her Deanships from 2011-2014, she mobilised the Women in Chemistry (WIC) group to visit primary and high schools (girls only and mixed schools) in Nairobi, Kiambu, Murang’a and Kajiado counties as role models in STEM-related fields for the girls, to encourage them to change their mentality towards mathematics and sciences, and also talk to them about STEM courses in the university and available career opportunities.
This initiative was important because primary and high schools are the feeder pools to higher education: increasing their enrolment at the basic level of mathematics and sciences automatically leads to increased participation at higher institutions of learning. The teams also presented the schools with Kiswahili Periodic tables as part of the celebration of the International Year of Chemistry (IYC) in 2011. Most of the students in the schools visited by the WIC group passed their exams, and more female students joined the university, and undertook science related courses such as engineering, medicine, computer sciences, pharmacy and basic sciences.

Through her office, she organised mentorship talks with the female university students. The mentorship sessions would focus on year 1 and 2 undergraduates before they choose course units to study in year 3 and 4. The focus was on the career opportunities available. This led to an increase in females excelling in their academic performance and many of them applied to do postgraduate courses in sciences. The mentorship for postgraduate females would begin before they undertake their research work. This served both to guide them in their path of studying, and offer the necessary support when they meet obstacles or get stuck. As a result, their studies could be completed more quickly. She was able to identify areas of opportunities where women could apply for promotion or employment. Some of these would include offering scholarships to postgraduate students, and especially to girls to enable them surmount the economic challenges and complete their studies on time. She also managed to regularly buy sanitary towels to the economically challenged female students.
After the Deanship, she was promoted to become the Director of the Board of Postgraduate Studies (BPS) from 2015 to 2016. When BPS was transitioned to Graduate School (GS) in 2017, she became the first Director (a position equivalent to Principal level) from 2017 to 2021. Through her office, she identified areas where there was shortage of women in STEM and offered scholarships to the needy female students. This enabled most of these ladies to complete their Masters and PhD studies on time, and some of them have been absorbed in their areas of discipline. During this period, she was also a member of the University Executive Board.

Having Professor Njenga as a female role model in the Department of Chemistry served to attract more female students to pursue graduate courses. One of her success stories is Dr Ruth Odhiambo, a lecturer in the same department. The mentorship journey began in 2008 when she joined the University of Nairobi as a Senior Administrator of the Pan Africa Chemistry Network (PACN) project in the Department of Chemistry. After registering for her PhD studies in Inorganic Chemistry, she got absorbed in the department as a Tutorial Fellow in 2012. Shortly after that, she joined the Women in chemistry (WIC) group, visited schools together with other female staff and students and consistently held mentorship talks with Professor Njenga. She became part of the Inorganic Chemistry Research Group which was sponsored by ISP from 2011 to 2020. Professor Njenga was the deputy group leader from 2011 to 2014, and thereafter, in 2015, took over as the group leader with Dr Odhiambo as the deputy group leader from 2017. Through the ISP sponsorship, Dr Odhiambo undertook her research work at the Centre for Analysis and Synthesis (CAS) in the Department of Chemistry, Lund University, Sweden, on a sandwich training programme between 2012 and 2015,

Figure 2: National Workshop on Trends in Teaching and Research in Inorganic Chemistry and its Applications in Kenya”, held at the Department of Chemistry, University of Nairobi May 2016.
and became the first beneficiary in the research group to graduate in December 2015. Shortly after the graduation, she got promoted to the position of a lecturer in 2016.

Through their leadership in the Inorganic Chemistry Research Group, other students joined the ISP sponsored sandwich programmes on flexible periods of time and to date, three PhD (two female and one male) and two MSc (one female and one male) students have trained to completion of their studies. Other research students not sponsored through the ISP grant have also benefitted indirectly since we are a source of inspiration to them, encouraging and walking with them through the difficult paths we have also experienced. To increase the research capacity of the department, the Research Group also purchased a number of pieces of equipment through the ISP research grant. These include a Fourier Transform Infrared (FTIR) instrumentation, Fumehood, Glovebox, Gas chromatography mass spectrometry (GC/MS) instrumentation, Luminescence spectrophotometer, Potentiostat, Solid Phase Extractor, Schlenkline & its accessories and UV-Vis spectrophotometer.

Under our leadership the research group, has conducted a series of instrumentation workshops for both academic and technical staff to improve their confidence levels in handling instruments. Part of our team has also participated in training departmental staff in other equipment such as NMR, HPLC and LC-MS. We have organised two international inorganic chemistry conferences for dissemination of research findings, a national inorganic chemistry workshop to discuss the trends in teaching and research in inorganic chemistry and its applications in Kenya and other workshops such as “Research Management” where Dr Cecilia Öman from ISP was the main facilitator.

Through the research group activities, we have established North – South and South – South collaborations with other scientists in related fields of research. We have a Memorandum of Understanding (MoU) with Professor Ola Wendt (Lund University, Sweden) who hosted two of our female PhD students, and Professor Martin Onani (University of Western Cape, South Africa) where one of our PhD and two MSc students went on sandwich programmes for laboratory research work. For mentorship and supervision, Professor Njenga and Dr Odhiambo visited the students in their respective laboratories to discuss their progress and pursue further areas of collaboration with the host institutions.

40 Nuclear magnetic resonance (NMR), High-performance liquid chromatography (HPLC), Liquid chromatography-mass spectrometry (LC-MS).
Through ISP support, members of the inorganic chemistry research group have presented their research findings in international conferences and also published their work in high impact journals. From the ISP grant, we have seven publications in highly credible peer reviewed journals and three manuscripts currently under review. The ISP grant gave us an experience for successful proposal writing and through collaboration, we established a strong research foundation on inorganic synthetic chemistry. Consequently, we have been able to submit proposals to other funding agencies to further our research work, and so far, TWAS (The World Academy of Sciences) and NRF (National Research Foundation, South Africa) have approved our proposals and funded our work. The credit goes to Dr Peter Sundin who initiated this relationship when he visited the Department of Chemistry in 2010, he has supported us quite immensely to date.

Both Professor Njenga and Dr Odhiambo continue to work together in promoting gender equity, holding mentorship talks with young girls, being role models to the upcoming female researchers and seeking for research funding through writing proposals among other activities. This is to ensure continuity in the success stories of the female gender in our department and society at large. So far, we have witnessed many more females pursuing postgraduate studies compared to previous years. In some of our STEM related departments where there are no female role models, the number of female graduate students continues to dwindle. Some of the students who have dared to break the glass ceiling either take too long to graduate, drop out
altogether or move abroad to complete their studies when they get scholarships. This scenario has however changed in our department.

The situation of women in our discipline at the University of Nairobi and other Kenyan universities

In the Department of Chemistry, most of the female students have been carrying out research in natural products and environmental chemistry, and a few others in physical chemistry. Many ladies have been shying off from inorganic chemistry, especially on synthetic work, due to lack of infrastructure, lack of grants, expensive chemicals and the time-consuming nature of the research. Lack of research grants may be attributed to the fact that most donor agencies have been funding natural products and environmental chemistry. This explains why we are most grateful to ISP for supporting our project on the design and synthesis of inorganic complexes with potential application in catalysis, environmental sensors and anticancer drug agents. The scenario in our department is replicated in the entire nation of Kenya for similar reasons. The low participation of females is also replicated in other STEM areas which have difficult subjects, e.g. engineering, physics and mathematics.

Impact of the activities of the inorganic chemistry research group

Since the ISP support started, our two female group members who graduated with PhD in 2015 and 2020 have been promoted to lecturer and tutorial fellow positions respectively. The other male PhD student who graduated in 2020 has been absorbed in Kisii University in Kenya. All of them are teaching and conducting research in synthetic Inorganic chemistry with potential application in environmental sensing, catalysis and medicinal fields. They continue to mentor undergraduate as well as postgraduate students in similar or related fields. Our MSc graduates are currently seeking for funding to pursue their research at PhD level in the same area. More students are pursuing to completion their postgraduate studies in STEM, and many more are joining.

Through the MoU and collaborations, our postgraduate students have been able to do their research work through fellowships financed by the ISP grant. Some of our group members have visited our collaborators’ laboratories, and currently we are able to send samples for analysis, especially when equipment not locally available is needed. We have gained enough experience to enable us train others, our students have also completed their research work on record time, and their publications have been accepted in high impact journals, with
increased citations. We have been able to attract other research grants from international organisations such as TWAS and NRF. This is due to the impact of the research findings and their potential application in addressing environmental and health related challenges.

Through the purchase of equipment for research, we have established a ‘synthesis unit’ for inorganic chemistry, where we are currently training more postgraduate students. Consequently, research on the design and synthesis of inorganic complexes with potential application in catalysis, environmental sensors and anticancer drug agents has been established at the University of Nairobi. Students from other universities are able to tap into the available resources and carry out their research in inorganic chemistry locally. The group members have also benefitted through the leadership and management trainings. One of group members was appointed the chairman of the Department of Chemistry; his capacity has been built through the ISP activities, giving him an edge above others while Ruth (coauthor of the present chapter) was appointed a scientific advisor to the International Foundation for Science (IFS).

Our vision for the future

Although we have made a number of steps ahead, we are still far from reaching the goal of gender equity, and a lot more needs to be done. We hope to see mainstreaming of gender analysis in STEM for high-quality research and supporting institutional transformation to advance gender equality and women leadership. This is because gender diversity is critical to high-quality science, discovery, and innovation for development. ISP would be of great help by giving us financial support to carry out gender mainstreaming data analysis in Kenyan universities, technical colleges and STEM based research institutions.

As a parting shot to the young girls, there are no limits to what a female scientist can do. The abilities in science, mathematics and technology are not fixed and therefore can be improved upon through consistent effort and hard work. The girls should deal with any negative attitude and build their confidence through hard work and resilience. This is because, they always do standard exams together with their male counterparts and compete favorably well, which implies they are capable. They should not play the gender card, but instead work doubly hard to prove their competence; they should overcome perfectionism and try every opportunity that comes in their way without giving up. They should identify the right models in STEM to guide and mentor them, and rather than work in isolation, they should build sisterhood/networks and a strong support system in order to surmount the challenges along their career path of growth.
There is no force equal to that of a determined woman, therefore be determined in pursuing your vision.

Acknowledgements

We wish to thank ISP and IPICS for the financial support that enabled the Inorganic Chemistry Research Group to undertake the activities reported in this paper. We are most grateful to Associate Professor Peter Sundin for his unrelenting support, Dr Cecilia Oman, Hossein Aminaey, the entire IPICS secretariat and our collaborators. We also thank the University of Nairobi for administering the grant.

References


A Research Journey with Biochemical Ecotoxicology in Zimbabwe

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The biochemical ecotoxicology (IPICS ZIM:02) research cluster was formed at the National University of Science and Technology (NUST) in 1999 with the objective of becoming a proficient group in this field in Zimbabwe, providing information on the health status of both aquatic and terrestrial ecosystems. It was led by Dr Yogeshkumar S. Naik, who got his first grant from the International Programme in the Chemical Sciences (IPICS), at ISP, Uppsala University, that year.

The research activities of the group focused on establishing the effects of anthropogenic pollutants on aquatic and terrestrial ecosystems and on identifying ways to reduce ecological risks to protect the environment. The research group commenced its activities with three members, the mentioned Dr Yogeshkumar Naik, Mr Andrew Siwela and I, all working in the Department of Applied Biology and Biochemistry at NUST. In 2000, I had enrolled for MPhil studies in the department, as an IPICS ZIM:02 student. To be a postgraduate student during that time was challenging because most of the laboratories at the university were under-equipped. In fact, the departmental biochemistry laboratory had only very basic equipment, which was not even adequate for teaching. When Dr Naik got his first research group grant from ISP, he approached the university management, and NUST allocated him laboratory space. That new ecotoxicology research laboratory was equipped from scratch with funds from ISP. Continued and constant support from ISP turned the ecotoxicology laboratory into one of the most well-equipped research laboratories at NUST. Research activities in the group (IPICS ZIM:02) started only at the end of 2000. Setting up the laboratory took longer than expected as most of the equipment and consumables were imported, and the buying process at NUST was slow. Also, the process of acquiring duty-free certificates was slow. Duty-free certificates are required for bringing in all goods bought outside the country using donor funds.

Once the equipment and chemicals were in place it took hard work to ensure the set objectives were met. Working full time and carrying out studies was
very taxing, I must admit. Being married and a mother of two girls aged one and five did not help. During weekdays, I remember working from 8 am to 4.30 pm carrying out my regular work duties in the department. After working hours, I would work on my research project, carry out exposure studies, analyse samples with analytical equipment, perform statistical analysis of results, and write reports. Internet for literature searches was also a challenge then, and I could only access it at the university, so it meant long hours at work. I appreciated the fact that my husband was very supportive of my studies. Even when the load became unbearable, he was there beside me, encouraging me to soldier on. For the duration of my studies, he took care of our daughters when I worked late in the laboratory since knocking off after 10 pm was common practice for me. I converted my MPhil studies to PhD studies in 2003. During that period, I also studied and completed a Master’s degree in Applied Science (toxicology) in 2005. I completed my PhD in 2007 thanks to the support from ISP.

In 2008, I became the deputy leader of the research group. Dr Naik continued to lead the group up to 2013, and during that period, the research was concentrated on identifying pollutants, particularly agriculturally based chemicals, and assessing their effects in aquatic ecosystems. Up to 2006, the research group centred its activities on pesticides (organophosphates, carbamates, pyrethroids, neonicotinoids, fungicides and herbicides), because at that time these were the main anthropogenic pollutants of concern (because in those years Zimbabwe’s economy depended on agriculture). In 2006, the country’s economy collapsed and the anthropogenic activities in the country significantly shifted from being mainly agricultural to mostly mining, when small scale and illegal gold panning activities mushroomed in all parts of the country. The shift to mining activities was without doubt a survival response adopted by people to counteract the harsh economic conditions that prevailed during that time. This is because the benefits from gold panning activities are immediate, while rewards from farming activities take time to be received and also depend on other factors like the rain. Gold panning activities in the country exploit mercury in the extraction processes and unfortunately, the mercury is carelessly discarded in water bodies or by river banks. From 2006 and onwards, mercury and other toxic elements such as lead and cadmium became the primary pollutants in the country. Our research group responded to this shift in anthropogenic activities in the country by incorporating research on mercury and other toxic elements.

In 2014, I took over the leadership of the research group, and introduced research on terrestrial environments. Pollutants, including industrial chemicals in textiles, and pharmaceutical effluents and domestic chemicals such as pharmaceutical and beauty care products, have been investigated in the ecotoxicology laboratory. These chemicals enter water bodies and
terrestrial environments through aerial drifts, runoffs, soil erosion, leaching and improper disposal. Once in the aquatic and terrestrial ecosystems, the various chemical pollutants, which vary in toxicity, affect aquatic and terrestrial biota.\textsuperscript{41}

The research group has exploited both active and passive biomonitoring methods in its activities. Active biomonitoring involves carrying caged organisms to polluted sites and exposing them to contaminated sites for specified periods before analysing them for specific parameters within the organisms.

Alternatively, water and soil could be sampled from contaminated sites and the samples used for exposure studies using laboratory-bred organisms. Passive biomonitoring involves sampling aquatic and terrestrial biota from their natural habitats and analysing them for specific compounds. The indicator species utilised in the research laboratory include snails (both terrestrial and aquatic), fish, frogs, earthworms and plants. The various projects carried out in the research group have investigated biochemical, endocrine disruptive and genotoxic effects of different anthropogenic chemical pollutants. Surveys are carried out to gather information about chemicals used by people in various communities, and studies are then designed with the data from the surveys in mind.

With the financial support from ISP, the research group carries out sampling in selected water bodies in the Matabeleland regions of Zimbabwe, particularly in the major dams which supply drinking water to the city of Bulawayo, the second largest city in Zimbabwe. The dams include Mzingwane, Nsiza, Mtshabezi, Mguza, and Upper and Lower Ncema. Samples collected from the freshwater bodies include water, fish, snails and plants. Pollution on land is investigated in targeted areas associated with anthropogenic activities like mining and farming. Besides soil samples, non-target species exploited for studies on land pollution are plants, land snails and earthworms.

Dissemination of research findings has always been an important part of the activities of the group. Results from the various projects are shared in reports, at seminars, conferences, workshops and as publications in refereed journals. Funds received from ISP have enabled members of the group to carry out various activities which include attendance at conferences and workshops, and hosting of research seminars including stakeholders’ workshops. The group members have contributed to conferences such as: African Network for

\textsuperscript{41} Terrestrial biota comprises all living organisms (bacteria, fungi, plants, animals) that inhabit a given area on land.
Analysis of Pesticides (ANCAP), Society of Environmental Toxicology and Chemistry (SETAC) Europe, Southern and Eastern African Network of Analytical Chemists (SEANAC), Southern African Nordic Centre Conference (SANORD), China Africa Water Resources meetings and SETAC Africa. Participation in conferences and workshops has enabled the members of the research group to interact and link with other researchers from different countries. We have established contacts in both Africa and Europe. The members have collaborated with partners in South Africa in areas including exchange visits for scientists and students, workshops, external examination of students’ theses and co-supervision of students. Locally the research group has participated in collaborative research projects with researchers at NUST and the country’s environmental regulator, the Environmental Management Agency, to remediate polluted water bodies such as Mguza dam.

The research group holds regular seminars for members to report their findings to other researchers within the university. Members of the group have also been asked to present their work at seminars held outside the university. The research group hosts annual stakeholder’s seminars where it engages with various partners with the aim of finding ways of reducing contaminants in aquatic and terrestrial environments. It collaborates with government officials, city councils, regulators from the National Water Authority and from the Environmental Management Agency, industrialists and community members. The research group shares its results on ‘Pollution levels in aquatic and terrestrial ecosystems in Matabeleland regions of Zimbabwe’ and discusses with its partners ways to safeguard terrestrial and freshwater habitats. It also provides consultancy services to individuals, institutions and industries by carrying out analyses of various pollutants in environmental samples which include soil and water.

ISP has contributed immensely to the education of many Zimbabweans. Financial support from ISP has enabled several postgraduate students in the research group to complete their studies and more students are expected to graduate in 2022. The research group continues to look for postgraduate candidates, and for the 2022 academic year two potential PhD candidates have submitted proposals for consideration. I must, however, add, that getting students, and in particular female students, for postgraduate studies by research has been a challenge for the group and the Department of Applied Biology and Biochemistry as a whole. Most students shy away from postgraduate studies because of economic challenges. Those who indeed choose postgraduate studies prefer to do MSc studies, which take one to one
and a half years to complete, rather than postgraduate studies by research, MPhil studies, which take a longer time (two to three years) to finish.

Generally, in the undergraduate classes, the number of male and female students is almost equal, however, a significant difference is noted in postgraduate classes, with more males than females in most cases. It has been observed at the university that by the time the females complete their first degrees they are planning for family life and the responsibilities of such commitment usually hinder postgraduate studies. The reason why most females tend to shun postgraduate studies, and especially studies involving research, is because they consider them difficult and more demanding.

The research group has organised and hosted gender seminars where female role models speak to female students to encourage them to take up postgraduate studies. The gender seminars have been carried out targeting female students at different levels of education. Seminars have been carried out for secondary school form 2 students with the intention of encouraging them to take up Science, Technology, Engineering and Mathematics (STEM) subjects at ordinary ‘O’ level. Attendances at career guidance sessions at schools by research group members have revealed that students drop STEM subjects at ‘O’ level because they perceive them to be difficult. The students only realise the importance of some of the dropped subjects when they try to enroll for STEM-related courses/degrees at the university. Seminars have also been organised for high school students (forms 4 and 6) to spread awareness of STEM-related courses/degrees at the university and STEM-related career paths. At the university level, the group has targeted graduating females and has arranged meetings to encourage them to enroll for postgraduate studies.

In the last two years, the need for internet at the university has heightened significantly because of the Covid-19 pandemic, which has transformed many academic activities into online-based. The need for reliable, stable internet services also increased for the research group as it adapted to lockdown restrictions. The university provides internet for both staff and students, but the internet connectivity is slow and it is difficult to remain connected, especially during online meetings. The research group is grateful for the financial support from ISP, which has ensured accessibility of good, stable internet with constant connectivity from a private source. This has enabled the research group members to carry out literature searches effectively and carry out zoom meetings to discuss various issues pertaining to research in the group. In 2020 and 2021, group members managed to participate and present papers virtually at international conferences.

42 Unlike most other Masters qualifications, the MPhil is a research degree. An MPhil is based entirely on the completion of an independent thesis.
In 2018, the group jointly with ISP hosted a research management workshop for researchers and academics at NUST. The facilitator at that workshop was the ISP Chemistry (IPICS) deputy programme director, Dr Cecilia Öman. Participants were introduced to the “Real-time Outcome Planning & Evaluation” (ROPE) tool and the “Strategy for Change” (SfC) template.

Participants learnt how the ROPE and SfC tools involve, setting ambitions, outcome challenges, activities to overcome the challenges, milestones, outputs and outcomes to increase efficiency in research activities. The ROPE system utilises progress markers and other indicators to assess the success and shortcomings of the project at hand. From that workshop, monthly meetings/workshops for the research group with Dr Cecilia Öman commenced in January 2021, and have been going on well. In these meetings/workshops, research group members discuss various research activities they are working on and share ideas on how to adopt the ROPE management and SfC tools for their individual research projects in order to increase efficiency in research processes. Topics like “Scientific writing, publishing and predatory journals” are tackled in these workshops with the goal of equipping group members with knowledge that ensures positive research outcomes such as increased numbers of completed research projects, published manuscripts and approved grant applications.

The research group has also contributed to the body of knowledge in the field of biochemical ecotoxicology through the publication of papers in journals...
such as *Environmental Science and Pollution Research, Chemosphere, African Journal of Aquatic Science*, and *Bulletin of Environmental Contamination and Toxicology*.

I do not have enough words to express my gratitude to ISP with special thanks to Associate Professor Peter Sundin, Associate Professor Cecilia Öman and all the ISP team at Uppsala University for everything they have done to facilitate the smooth running of activities for IPICS ZIM:02 as well as for partnering with the research group in its journey as it strides towards becoming a Centre of Excellence in the field of Biochemical Ecotoxicology.
The Role of a Mathematics Network in Addressing Gender Balance in STEM in the East Africa

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The Eastern Africa Universities Mathematics Programme (EAUMP) started in 2002 through the support of the International Science Programme (ISP) and in collaboration with the Departments of Mathematics at the University of Dar es Salaam (UDSM), Tanzania, University of Nairobi (UoN), Kenya and Makerere University (MAK), Uganda. Later in 2008 and 2009, the universities of Rwanda (UR) and Zambia (UNZA), respectively, also became members.

Apart from the objectives to build research capacity in mathematics, EAUMP also has the ambition to attain a 50/50 gender balance in mathematics within the network.

By 2002 when EAUMP started, the number of PhD holders was 33.43 Out of these, there was only one woman, Professor Masanja at the University of Dar es Salaam. Today the situation has changed for the better: from three percent female PhD holders in 2002 to a little less than 12% in 2021.

Table 1: The number of academic staff with PhD in the five nodes of EAUMP in 2021.

<table>
<thead>
<tr>
<th>University</th>
<th>UDSM</th>
<th>MAK</th>
<th>UoN</th>
<th>UR</th>
<th>UNZA</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>M</td>
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<td>18</td>
<td>33</td>
<td>16</td>
<td>11</td>
<td>97</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>20</td>
<td>38</td>
<td>17</td>
<td>13</td>
<td>110</td>
</tr>
</tbody>
</table>

The increase of female PhD holders has been made possible through PhD training in the sandwich model44 between the regional and Swedish universities. In every funding cycle of three years, three PhD students from each node have been awarded and trained on EAUMP scholarships in the said mode of training. With the capacity so far built in mathematics, we plan to gradually shift from the sandwich model of training. The cost of local training

43 UDSM had nine PhD holders, UoN seventeen and MAK seven in 2002.
44 Invented by ISP, in the sandwich model PhD students are allowed to spend some periods at a host university when the home university is not yet certified to issue PhD degrees. Read more at: https://www.isp.uu.se/about-isp/history/sandwich-model/
is much lower than sandwich training. Furthermore, women with younger families prefer to study locally to be closer to their children.

Through the sandwich model many research collaborations with international mathematicians have been achieved, new areas of mathematics have been introduced in the region, joint publications have been realised, improved teaching at departments have been realised to a great extent, and academic networking of regional students placed in the same alma mater in Sweden has been possible. In short, the sandwich model has built a cadre of local researchers that can supervise PhD research training in their home universities. In Rwanda, Tanzania and Uganda the said shift of PhD training to the local model is also strongly motivated by the presence of solid and internationally recognized PhD curricula developed under the Sida bilateral research support in these countries.

From 2002 to 2021, EAUMP has fully supported 25 graduated PhD students. It is sad to note that only 16% of the EAUMP PhD graduates are female, clearly showing extreme gender imbalance.

EAUMP has also been supporting MSc training on a local model. Over 100 MSc graduates have been supported by EAUMP and ISP since its commencement in 2002. The EAUMP MSc scholarships are allocated on a gender-sensitive basis and approximately 35% of the EAUMP supported students are female. This is because female students joining MSc are mostly fewer in number, compared to male students. Female participation has increased significantly but remains lower in number in comparison to male students.

The role of EAUMP in gender balance in STEM

EAUMP has been setting aside funds every year for gender activities to help improve the number of women in science:

- EAUMP supports **postdoctoral fellowships**. The fellowships enable staff members to go for a 4-6 months research visit abroad, mostly to Sweden. The postdoc opportunity is one of the major ways the network has tried to build research capacity and competence in the region. To date, EAUMP has fully supported seven regional staff for postdoctoral fellowships. Since only one of these is a female (Dr Betty Nannyonga from Makerere University), the effort was not enough.

- EAUMP organises **summer schools**. The summer schools are mainly organised for regional postgraduate students and young staff with the
main motive to acquire skills/knowledge in areas where the region is most disadvantaged, e.g. in Algebra, Geometry, and Analysis. The schools are jointly organised by the member departments in collaboration with ISP and International Centre for Theoretical Physics (ICTP) and take place annually at a particular node but on a rotational basis. Thus, the schools aim at introducing participants to current trends in some areas of pure mathematics. They also offer participating students to get ideas or topics for research and give the opportunity to initiate collaborations. The schools are mainly supported by EAUMP and ICTP (International Centre for Theoretical Physics). In some cases research collaborations with international mathematicians have resulted into the joint supervision of postgraduate students. The female participation in the summer schools varies year by year, and is approximately 35% on average. EAUMP gives special priority to female students who show willingness to participate.

- EAUMP organises network research group meetings at least once per year (starting in 2017 with support from Sida). The participants of the research group meetings include PhD students, supervisors and various experts from the five nodes of EAUMP and also from other networks that are supported by ISP. Seven female experts have participated. The main aim of research group meetings is to build collaborative research in the region and with other ISP supported mathematics networks such as PDE, Modelling and Control Theory in West Africa. Usually the female participation in the meetings is approximately 20%. This network meetings are also a chance for women mathematicians to meet and share experience.

- The group organises the EAUMP regional conference. The hosting of the EAUMP conferences rotates–among the five nodes. The conferences attract participants regionally and also internationally. EAUMP has given special support to female participants to attend these conferences, e.g. to the one held in Nairobi in 2019 with the theme: Harnessing Women and Girls’ Potential in STEM for Sustainable Development. Female attendees in the conferences are 30% on average. Through these conferences staff, postgraduate students and other regional and international mathematicians present their results and share knowledge on emerging trends, areas and methods.

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45 The first EAUMP conference took place in 2003 and was hosted by the University of Nairobi.
As a response to the haltered activities due to the Covid-19 pandemic, EAUMP started the **African Mathematics Seminar (AfMS)** series in May 2020, with Dr Jared Ongaro of University of Nairobi, as the coordinator and host. It has become an instant success, with many regional and international mathematicians showing interest in taking part in AfMS weekly seminars. The main goal of AfMS is building mathematical networks across Africa and showcasing African mathematical talents. The participation has exceeded all expectations with a total of 1,400 participants in 2020 and 2,310 in 2021. The majority of the presenters are international, and the seminars have attracted even Field medalists. Out of the African speakers, about 25% are female.

EAUMP has also been supporting various gender activities, jointly with the network for female researchers in mathematics and physics in Kenya, Rwanda, Tanzania, Uganda and Zambia, Eastern African Network for Women in Basic Sciences (EANWoBAS)\(^{46}\).

At each EAUMP node, there are Women Associations with the common agenda of trying to bridge the gender gap, through various gender activities. The supported activities include:

- Science camps for High School girls. These are organised annually since 2016, by the Department of Physics and Mathematics at the University of Dar es Salaam.
- Visits to secondary and primary schools to sensitize girls on the importance of taking mathematics and science subjects.
- Support of women in mathematics associations in the region, namely Tanzanian Women in Mathematics (TWM), Uganda Women in Mathematics (UGAWOM), ad Kenyan Women in Mathematical Sciences Association (KWIMSA)
- Support through ISP of workshops, e.g. the one organised by TWM in 2020. The theme was *Promoting Visibility and Participation of Tanzanian Women in Mathematics*. The workshop participants included 62 female mathematics lecturers, statisticians, actuariaal scientists, secondary school mathematics teachers, female mathematics postgraduate students, school inspectors and other invited professionals with interest in mathematics education.

\(^{46}\) EANWoBaS is presented in this book in the Chapter: “A Gender Success Story - The Case of Uganda”.

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Challenges to overcome

There has been a significant increase in women in mathematics in East Africa, but in some areas, such as pure mathematics, women remain highly under-represented.

The main challenges that still remain are:

   (i) The pool of girls doing mathematics and/or natural sciences starts dropping immediately after secondary school. Most girls opt to study humanities and social sciences courses. Therefore there is a shortage of women at the postgraduate level and hence few future female researchers.

   (ii) At the same time women are in their early academic career, they are starting their families. This is usually the most productive stage for an academician. Thus, women, who in East Africa traditionally are responsible for taking care of children and house-keeping, will tend to lag behind their counterparts, in terms of progression in their careers.

More needs to be done in order to achieve gender balance in mathematics and STEM in the region. EAUMP will, with support from ISP, continue its efforts with all possible means to address the gender bias.
The Role of ISP in the Development of Sciences and Gender Empowerment in Laos

Dr Vanseng Chounlamay

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Background

The National University of Laos (NUOL) was established in 1996 as the first state university of the Lao People’s Democratic Republic. It currently has thirteen faculties, two institutes, a library and a hospital. NUOL’s main roles are providing higher education in areas required for the socio-economic development of the country; performing research in a broad range of disciplines, including natural, applied and social sciences; supporting to preserve the culture and values of the nation, and contributing to the socio-economic development of the country. Over 25,000 students pursue undergraduate studies and selected programmes at master and doctoral levels. As the most comprehensive university in the country, NUOL collaborates with many universities in Vietnam, Thailand, Japan, Korea, Europe and in other countries.

ISP collaboration with Laos

The collaboration between ISP and Laos started in 2004 under the former ISP chemistry programme director, Dr Malin Åkerblom, after she first visited the Department of Chemistry at NUOL. This visit was the catalyst for an extraordinarily successful collaboration that has been in place for two decades. NUOL was at its formative stages when the visit took place, and it was looking for international assistance to develop into a modern university. The Department of Physics (Geophysics group) and the Department of Mathematics and Statistics also started a collaboration with ISP. In 2006, Dr Peter Sundin took over as chemistry programme director of ISP and he continued to support the Department of Chemistry.

The support from ISP to NUOL has maintained a good gender balance from the beginning as gender equity is an essential issue in human resource development. As a result, both male and female staff of NUOL have received opportunities to develop their careers and serve as role models.
From 2006, ISP supported two research groups at the Department of Chemistry, researching pesticides residue analysis and water quality, respectively. In 2011, the two groups were combined into one research group focused on Environmental Chemistry. The focus on Environmental Chemistry supported by ISP led to the developing a new Master programme in the area. More than twenty staff and students from the Chemistry Department have attended training courses on analytical instrumentation and pesticide residues analysis in Sweden, Bangladesh, Cambodia and Thailand. Several Master scholarships were also arranged within the awarded grants. The results from the research group have been published in national and international journals and orally presented at national and regional scientific conferences.

ISP support played a key role in capacity building in chemistry. In particular, the ISP support was crucial in developing skills and knowledge of our staff and students in conducting research in Environmental chemistry, especially in the analysis of chemical contaminants (pesticide residues and heavy metals) and water quality. These are critical areas to Laos because industrialization, mining and the use of chemicals in agriculture are increasing in various parts of the country due to economic development. Laos has vast water resources, and growing urbanization and industrialization significantly affect these resources. The study of water quality is beneficial to children’s and women's health as they rely a lot on the Mekong River and its tributaries.

Two female staff members of NUOL led the ISP collaboration with the Chemistry Department - Dr Vanseng Chounlamany (2007-2010) and Dr Kesiny Phomkeona (2010 to present). Their cooperation with ISP contributed to developing leadership skills in both staff members. Dr Chounlamany served as Head of the Department from 2017-2019, and currently serves as the Vice Dean for Research and International Collaboration of the Faculty of Natural Sciences at NUOL. Her specialty is water quality and food safety. Dr Kesiny is presently the Head of the Chemistry Department. The department was able to transfer knowledge and share expertise with governmental agencies, contribute to national guidelines and policies, analyse samples, and provide related consultations. The ISP supported projects improved the ability of the Department to monitor the level of contamination in the environment and develop strategies for prevention and remediation. Furthermore, the projects supported tuition fees and fellowship training for Master and undergraduate students and motivated them to participate in research.

The support of ISP was critical in developing the chemistry teaching and research laboratories at NUOL. ISP provided means to acquire various important pieces of equipment in the chemistry labs to develop capacity in Environmental chemistry (Table 1). This equipment provided the foundation for teaching and research in the Department of Chemistry and shaped the
minds of thousands of young students and staff. ISP also sent technical staff to NUOL to train local staff to use the acquired equipment. The development of graduate programmes in chemistry and the participation of undergraduates in research would not be possible without the crucial research infrastructure support of ISP, together with its cooperation partners at Stockholm University and Umeå University in Sweden.

Table 1. Equipment Provided by ISP and partners for the Chemistry Laboratory Development.

<table>
<thead>
<tr>
<th>Equipment type, model, and name of the manufacturer</th>
<th>Year acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Absorption Spectroscopy</td>
<td>2011</td>
</tr>
<tr>
<td>GC/MS (Agilent 5890 series II plus) with a mass selective detector and an auto liquid sampler</td>
<td>2011</td>
</tr>
<tr>
<td>Spectrophotometers (HITACHI U-2000)</td>
<td>2013</td>
</tr>
<tr>
<td>High-Performance Liquid Chromatography (HPLC) with UV-visible detector (HP)</td>
<td>2016</td>
</tr>
<tr>
<td>Gas chromatograph Agilent 6890A with Mass selected detector</td>
<td>2016</td>
</tr>
<tr>
<td>LC/MSMS, Quattro Premier XE UPLC/MSM</td>
<td>2017</td>
</tr>
<tr>
<td>High-Performance Liquid Chromatography (HPLC) with UV-visible detector</td>
<td>2017</td>
</tr>
<tr>
<td>Spectrophotometers (YOKE K-8001S)</td>
<td>2021</td>
</tr>
</tbody>
</table>

ISP support also helped the Geophysics group at the Department of Physics at the Faculty of Natural Sciences to enhance its scientific capacity and contribute to education and research. Similar to the support extended to the Department of Chemistry, several Geophysics staff received Master and PhD scholarships (one PhD completed in Thailand and another has PhD training in progress in Vietnam) to strengthen their qualifications and develop research capacity. Furthermore, funding was provided to acquire critical geophysical teaching and research equipment. Another significant contribution of ISP is the donation of software, computers and related IT support for the Geophysics Group. ISP also supported curriculum development and several research projects covering groundwater investigation, rock magnetism, potash mining, etc.

The Department of Mathematics and Statistics at NUOL has been another beneficiary of ISP support. Five staff members of mathematics (three males and two females) were provided scholarships to pursue PhD studies in Thailand and Europe. This support has strengthened the profile of the department and teaching and research activities.
Gender empowerment – A self-reflection

The status of gender equity in Laos can be understood by looking at the key data. The country has a population that is equally split between males and females, but the literacy rate of men is higher than women (78% vs 63%). However, the literacy rate of the 18-25 yrs. age group is over 90%, and it will positively impact raising the literacy rate amongst women in the future.

The Gender Gap Index measures gender equality based on economic opportunity, education, health and survival and political empowerment. The Gender Gap Index is 0.748 for Laos higher than the global average and the highest for Indochina and South/Southeast Asia. The country is also ranked first for economic participation and opportunity for women in the gender gap ranking. The Lao society has high respect for women due to religious and cultural values. Strong laws against gender-based discrimination in employment, education, and other key areas exist, and the Lao constitution guarantees women's equal position and rights. Another important fact is that the majority of the labour force are women but engaged in low-income jobs, mostly in agriculture, manufacturing and commerce.

Although science is taught in secondary schools across the country, there is a critical shortage of qualified teachers in rural areas, because most teachers prefer to live in urban centres. There are also issues in the laboratories to support STEM education and qualified staff to maintain the laboratory infrastructure. A critical concern in STEM education is that 40% of youth in the age range 15-17 yrs. do not complete secondary education. Most of these youth enter the labor force at an early age and remain in low-income jobs with little opportunity to develop a career. It is crucial to reverse this trend and attract youth to complete secondary education. Another strategy is to strengthen vocational training paths for those not qualifying for universities and encourage youth to pursue careers in trade and technology.

At a personal level, the author was born in a remote village in the Northern part of Laos and brought up in a traditional village society focused on agriculture. After completing high school, she entered NUOL to pursue an undergraduate degree in chemistry. She was the first to enter a university in her immediate family. The author was absorbed into the university's academic staff and received a Swedish government scholarship to pursue a Master degree in Chemistry at the Khon Kaen University, Thailand. She was later awarded a Japanese government scholarship to pursue her PhD at the University of Philippines. The author believes that NUOL supports attracting qualified females to pursue careers in STEM and providing them with leadership opportunities. For example, the author served as the coordinator of
ISP for chemistry at NUOL and later was appointed as Head of the Chemistry Department. She was mentored by senior management to develop her leadership skills and currently serves as a Vice Dean. NUOL has promoted the participation of women in STEM and has made substantial progress. For example, over 40% of the Faculty of Natural Sciences students are females, and 38% of academic staff are women. However, the participation of women in engineering has room to improve (23% female students and 32% female teachers). Also, at the postgraduate level, the participation of women is weak, especially in the PhD programmes, where only 13% are females. There is an equal split between male and female students at the university level and a similar split for academic staff. Like many other universities around the world, the participation of women in senior management is low (13%). The senior management of NUOL has taken a proactive approach to support gender empowerment and has established the following goals for 2021-2025:

- Females representation to be 30% in decision-making and other committees.
- Females to represent a minimum of 30% in training and study programmes (domestic and international).
- All research projects to have at least 25% of female participation.
- Female students in STEM to be at least 40%.
- Support the government plan to increase the number of university students in STEM to 20,000.

With the above goals, NUOL is positioned to become a success story in the region for the participation of women in STEM. The author believes that international agencies can support the above goals by partnering with NUOL. In this regard, the author has identified several strategies to complement the goals of NUOL and develop an outreach programme to attract more girls to STEM education and women to STEM-based careers. These strategies are:

- To double the number of STEM-related teachers and provide incentives for STEM teachers to work outside the urban areas.
- To develop labs and other facilities for STEM education in schools, especially in rural areas.
- To provide gender-based scholarships to increase highly qualified women in STEM to take leadership roles and increase role models.
- To provide leadership training to women in STEM and international exposure to study best practices.
- To develop school-level programmes such as science fairs and exhibitions to attract children to STEM disciplines.
- To support women in STEM to pursue business opportunities in STEM and increase the female labour force in STEM-related businesses/factories, etc.
To encourage international agencies and the private sector to support STEM-based networks and promotional activities to have more girls from rural areas complete secondary education.

Conclusions

ISP has had a significant role in the development of sciences at NUOL. The successes of the Chemistry, Physics and Mathematics and Statistic departments over the past two decades in teaching and research is partly due to the active support provided by ISP. This support contributed to capacity building by training staff and developing the laboratory infrastructure. ISP paid attention to supporting women and offered several opportunities to further their careers. The long-term advice and mentoring of Dr Peter Sundin in shaping the ISP programme at NUOL deserves special recognition.

Laos has supported women and ensured their position in society. However, as a developing country, there are challenges that women face, and their empowerment through education and entrepreneurship is critical to the success of women. As the leading university of Laos, NUOL has a pro-active plan to support women in higher education and support and mentor future leaders of the education field. The author has been a beneficiary of the initiatives of NUOL and is pleased to note the increasing number of female students in sciences and female academic staff in STEM disciplines. International agencies and programmes like ISP can play a role in further developing STEM in NUOL and Laos by promoting outreach activities directed to girls in secondary schools. Support for female academic staff leadership development is another priority.
Grooming Research Culture in Nepal and Strengthening Female Scholars with Support of ISP

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Introduction

According to a report by UNESCO\textsuperscript{47}, the literacy rate of Nepal in 2018 was about 67\% of the total population, which is an increase by about 8\% from 2011. The male literacy rate was about 79\% and that of females was about 60\%. The adult literacy rate between ages 15-24 was about 92\% (females 90.88\% and males 94.03\%).

In the same report, it appears that 12\% of the population enroll in tertiary education among which about 12\% of the females and 13\% of the males. However, women receive only about 16\% of the undergraduate degrees, and 11\% and higher degrees of science including engineering, mathematics, and physical sciences.

Comparative plots of girl versus boy enrollment in rural and urban areas (Table 1) show the dominance of boys at the higher level education in Nepal's

\textit{Table 1: Student enrollment at various levels of STEM at different parts of Nepal.}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{student_enrollment.png}
\caption{Student enrollment at various levels of STEM at different parts of Nepal.}
\end{figure}

urban and metropolitan areas.\textsuperscript{48} Due to the remoteness of the hilly and mountainous region, schools are very sparsely located, leading to very limited access to education. These data also show a drastic decrease at higher levels following the universal trend.

The low percentage (11\%) of women’s involvement in higher levels of STEM reveals the need for the empowerment of women and girls in science in Nepal. One of the major reasons for the very low enrollment of females in higher education is Nepal's patriarchal and conservative social culture. Women are often overlooked, regarded only as mothers or wives, while men are the breadwinners. Therefore, many women lack the knowledge and encouragement to seek work outside their homes, especially in STEM fields. Women mostly do not have their own role models, or mentors, to look up to for guidance.

The women’s participation in science and technology can be increased by providing moral support, good counseling from senior personalities both men and women, government policies that prioritise equal access to resources, job opportunities, and good incentives for researchers.

A brief history of ISP support to Nepal

ISP’s support to Nepali researchers has quite a long history, dating back to 1989 when Kedar Nath Baral, from Tribhuvan University, Amrit Campus, visited Uppsala University, Sweden, as a research scholar for his PhD. Dr Baral pursued his research activities at the Division of High Voltage at Uppsala University as a guest researcher, being invited and hosted by ISP. Later, in 1998, Rakesh Shrestha, also from Amrit Campus, received sandwich support from ISP to study at the Department of Physics at Colombo University, Sri Lanka. However, Mr Shrestha could not continue his research activity and could not complete his PhD. Another round of support was provided to Shriram Sharma (the current Principal Investigator of the Atmospheric and Materials Science research group), starting in 2003 as a sandwich programme between Uppsala University and Colombo University. Dr Sharma defended his thesis and got his PhD degree in 2007 at Colombo University, Sri Lanka.

The idea of enhancing research in lightning and atmospheric physics in Nepal originated during Dr Sharma’s postdoctoral research visit to Uppsala.

\textsuperscript{48} Record from Arghakanchi District Educational office, Nepal.
University in 2014, under the framework of Erasmus Mundus, when meeting with the then ISP Physics Programme Director Ernst van Groningen and the then Deputy Director Carla Puglia. At that point, Pitri Bhakta Adhikari had already registered for his PhD, under Professor Baral and Dr Sharma, but was not able to perform research activities for which he would have needed a digital storage oscilloscope which was not available. Realising the problem, ISP instantly ordered an oscilloscope for Nepal, with the help of which Mr Adhikari carried out his research and accomplished his degree.

Having learned about the zeal of the researchers in Nepal and realising their need for support, Dr van Groningen, and Professor Puglia visited Nepal in January 2020, to seek funding options for starting a research centre which got materialized from the beginning of 2021.

During the directors’ visit, we had extensive discussions on various ways to support the researchers in Nepal. After visiting the existing laboratories and interacting with authorities, faculties, and students, it was realised that despite a growth in the culture of research at the university, research activities took place in the margins. This was mainly due to the lack of facilities such as infrastructure and state-of-the-art equipment. The research activities in the field of experimental physics had not been adequately developed owing to the lack of quality instruments, laboratory space, and infrastructure. Even though Nepal had amassed several accomplished experimentalists, who graduated from world-class universities, they were not able to move forward.

Following the completion of my own PhD and postdoctoral research at Kent State University, Ohio, USA, I returned home to apply my newly acquired skills at my home institution. With support from national donor agencies such as the University Grants Commission (UGC), Ministry of Education Science and Technology (MoEST) and Nepal Academy of Science and Technology (NAST), I initialized experimental research on the synthesis of nanomaterials and characterisation and fabrication of devices such as gas sensors and dye-sensitized solar cells at the department in 2013. Since the research laboratory was in its infancy, we were seeking international support and collaborators to take further our work. This has been an arduous yet rewarding journey.

Similarly, Professor Rajendra Parajuli, an experimentalist, returned home after his PhD from the University of Innsbruck, Austria, in 2002, but switched to computational physics because of the difficulty in continuing his experiments in Nepal.

We are ecstatic to share that our activities are gaining momentum after we were awarded the ISP grant. We are deeply grateful for the opportunity
provided by ISP to advance our research work as well as expand and strengthen our research networks and connections.

About the Atmospheric and Materials Science Research Group (AMSRC)

Atmospheric and Materials Science Research Centre (AMSRC) at the Department of Physics, Amrit campus, Tribhuvan University (TU), Nepal was established in 2020, with the objective of burgeoning research culture and grooming young researchers at their home university. This noble concept resulted from ISP’s support for Nepal and its scientists. Although there is a long history of ISP’s support to Nepali researchers, this is the first direct support to nurture a research group.

The research group was established with the leadership of Dr Shriram Sharma and Professor Rajendra Parajuli as deputy principal investigator at the Department of Physics led by me, and coordinated by Mr Pitamber Shrestha. The group is currently conducting research activities in the field of atmospheric physics with a special focus on lightning and materials science. At present, five students are working towards their PhD degrees under the supervision of the group members. Apart from the PhD scholars, there are several Master level students who are pursuing their dissertations.

![Figure 1: ISP directors’ visit to Nepal and AMSRC group members.](image)

In addition, the group has been extensively conducting various programmes on gender balance in STEM, led by me. With financial support from ISP, the newly established AMSRC group began to organise several numbers of activities to cultivate more female scholars in STEM. Realising that science at the higher levels is unattractive, without a strong foundation at the primary and secondary school levels, we decided to focus our efforts on motivating young girls early on in their educational upbringing. We held workshops...
where we discussed the major challenges faced by female students during their science careers including social barriers to entering STEM education for rural girls, lack of self-confidence, patriarchal attitudes, lack of mentors, early marriage, and lack of well-paying jobs in science fields.

**Beginning of the journey with ISP**

Regarding gender issues, I recall my first meeting with Professor Carla Puglia, now programme director of ISP physics (IPPS), when she visited Nepal in 2020. She is a spectacular physicist who has devoted her life to fostering science education and research. She is also a magnificent leader fighting for reducing gender bias in STEM. After hearing her strong speech about the importance of equal opportunities in science and education, at an event organised by the AMSRC in 2021, I became personally motivated to educate myself on the gender disparity in the scientific fields in Nepal. Despite having to face these disparities head-on every day as a female Chair of a department, wherein there are only two female faculty members in a group of more than 50 male members, to me they had become a normal yet ignored nuisance. Professor Carla’s visit galvanized my interest in this topic and made me realise that without targeted, concerted efforts toward ending these disparities, they would remain a hindrance even for the next generation of women scientists.

I would like to emphasize the high need of creating research posts like research fellowships and research assistantships to further scientific research. Women researchers should be provided additional facilities such as hygienic and separate bathrooms, nearby day-care space, flexible maternity leave including pre-delivery of children, security, and encouragement to take on leadership roles. There needs to be a change in our society's mindset to promote self-motivation and confidence in women. As one of the few senior Nepali physicists working as a researcher, I have never experienced any of the privileges usually reserved for women in more developed countries during my long career at my home university. As we continue to work towards parity, I hope that my posterity will be able to access more of these privileges. Despite these unfortunate conditions, I, alongside my fellow female physics researchers as well as the group members of AMSRC have continued to promote science and technology in our communities by organising various workshops, training, and seminars with national and international friends.

Professor Rajendra Parajuli, a deputy PI of the AMSRC group, states that his meeting with ISP directors energized him to foster his research activities on the theoretical part of materials science. Today, he is very satisfied with having purchased a license of the VASP software, which will give him access
to computational work in materials science.⁴⁹ We have also purchased a
workstation for the computational work with the support of ISP, which he
believes will be extremely significant. Mr Pitamber Shrestha, a coordinator of
AMSRC, also expresses his feeling that the department is energized due to
ISP support. The research activities have become vibrant and interactions,
sharing the research outcomes, and presentations have become a routine.

As written before, Dr Shriram Sharma started his research journey when he
completed his PhD degree in a sandwich programme between Colombo
University and Uppsala University in early 2007. Working under the
mentorship of Professor Vernon Cooray, a world’s leading scientist, at
Uppsala University, was the most important part of his journey. He says that
ISP’s support (both financial and moral) had always been the source of energy
to pursue research and accomplish the best results. He frequently visited ISP
for any problem and felt like being at home sharing his feelings with his
parents. Dr Lennart Hasselgren, a former director of the physics programme
of ISP, had been a fantastic person to encourage not only him but everyone
associated with ISP. Today, Dr Sharma feels eager to continue with his
research activities in Nepal with the support that ISP has started to give. This
is, indeed, a great opportunity for faculty members and students to foster their
careers. All the group members, faculties, campus management and students
are now sharing a feeling of growth in the research culture at the department.
In fact, all the members of AMSRC would like to take this opportunity to
express our sincere gratitude to Ernst van Groningen and Carla Puglia for
understanding the needs of our group.

⁴⁹ Vienna Ab initio Simulation Package (VASP), G. Kresse and J. Hafner, Phys. Rev.
B 47, 558 (1993); ibid. 49, 14 251 (1994); G. Kresse and J. Furthmüller, Comput. Mat.
Science for a Sustainable Future
ISP, Science and the Sustainable Development Goals

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The Sustainable Development Goals (SDGs) were formulated by the United Nations in 2015 within the Agenda 2030, as a global framework “to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity.” 50 The SDGs are inspired by the Declaration of Human Rights and address the dignity and well-being of all the people of the world as well as the preservation of the environment and the ecosystems. The SDGs are actually a *call for action* that establishes real guidelines to solve the most pressing problems affecting all of humanity. The underlying principle is that no one will be left behind, and the SDGs turn directly to all countries of the world.

The goals focus on sustainable development, where *sustainability* has several components that have to be taken into consideration together, i.e. for each goal its social, economic, and environmental aspects need to be achieved together in what is the holistic approach of the SDGs. To fulfil this important requirement, it is also necessary to analyse how the goals interact with each other, and in what cases they can conflict, i.e. when some achievements can be positive for some aspect but problematic for some other.

The 17 goals are: (1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (10) Reduced Inequality, (11) Sustainable Cities and Communities, (12) Responsible Consumption and Production, (13) Climate Action, (14) Life Below Water, (15) Life On Land, (16) Peace, Justice, and Strong Institutions, (17) Partnerships for the Goals, see *Figure 1*. They focus on several thematic issues, that extend from human needs like nutrition, well-being, health, education, gender equality, and inequality in general, to more scientific-technological themes like energy,

50 https://www.undp.org/sustainable-development-goals
consumption and production, to environmental issues like climate action and life below water and on land. Clearly, these are all crucial topics that need to be urgently faced to provide all human beings the best possible existence.

![UN’s Sustainable Development Goals (SDGs)](image)

**Figure 1: UN’s Sustainable Development Goals (SDGs)**

To practically render the SDGs a guideline for action, specific targets are associated with each goal, for a total of 169 targets. The targets are themselves linked to proper indicators.

Due to the holistic standpoint, several actors need to interplay for the achievements of the goals, and science and technology, together with politics, play leading roles.

Science makes a major contribution in shaping sustainable development, since it generally already works alongside the topics in the SDGs pathways. Due to this, ISP is directly interested in how the research of the ISP supported groups is connected to various SDGs.

Each SDG covers numerous research fields. Let’s look at one example of relevance for many groups supported by ISP: in the last few decades, scientific research has been thoroughly investigating the possibility of exploiting solar energy, and it is rapidly progressing by discovering novel materials and novel possible devices. This kind of research intrinsically involves several disciplines like physics, chemistry, mathematics, engineering, and is often led
in multidisciplinary teams with scientists with different backgrounds working together.

An important reflection is that the goals and their targets are, by their nature, deeply interlinked, and they can possibly lead to results that are positive for one target but challenging for another. It is, therefore, crucial to study and work alongside proper trade-offs and synergies between targets, see for example *A guide to SDG interactions: from science to implementation*, from the International Council for Science.\(^{51}\) For example SDG 7 Affordable and Clean Energy, is a field where several groups supported by ISP perform their research.

The targets to SDG 7 are: ensuring energy access (7.1), increasing the share of renewables (7.2), and speeding up the rate of energy efficiency improvement (7.3). To analyse how SDG 7 is linked with SDG 2, zero hunger, we can observe the following. As a renewable energy source (7.1), bioenergy can become an important fuel for the future. However, a side effect is that there can be a competition between the land cultivated for crops to become fuel and the land cultivated for food. This can lead to higher food prices with an especially hard backlash for the poorest populations. In parallel, if the cultivation of biofuels is prioritised, more resources like energy and water will be spent for this purpose, again at the disadvantage of the poor and of other activities.

To monitor the results obtained in the wake of the 2030 agenda, every four years a report should be written, and the last one was the *Global Sustainable Development Report (GSDR) 2019*\(^{52}\) which can be consulted online. The subtitle is “The Future is now, Science for Achieving Sustainable Development”, which stresses the role that science plays in this agenda. It is argued in the GSDR 2019 that science, including social sciences, engineering, etc., should indeed work in parallel with the 2030 agenda. Obviously, science does not happen in a void, and, on the contrary, it is fully embedded in the society in which it is conducted, and that in various ways influences its objectives and motivations. Still maintaining its objectiveness, which is the pillar science is based on, it is encouraged to seek closer collaboration with policymakers, society and business. In this sense, and since the 2030 agenda aims to find real solutions to the problems highlighted by the 17 SDGs, science

\(^{51}\) https://sdgs.un.org/2030agenda
\(^{52}\) https://www.un-ilibrary.org/content/books/9789210045919/read
can work according to three main lines. *Referring to the 2030 agenda* means that research investigates and understands specific issues evidenced by the 2030 agenda, like the human impact on specific problems. *Guided by the 2030 agenda*, when the goals are taken as starting points for the research, and the solutions, i.e. the fulfilment of the SDGs are also in the focus of the research. *Research designed and conducted in accordance with the 2030 Agenda*, for difficult cases including disagreement of sociopolitical or socioecological types, and that require evidence-based solutions.

After this was written, the Covid-19 pandemic stroke the whole world, and a full overview of the delays, together with all the problems the pandemic brought, and of how this has affected the 2030 agenda is still to be understood, and will hopefully be clearer in the coming GSDR 2023.

Presented below are some of the research findings of the ISP supported groups and network, and their relation to the SDGs.\(^53\)

**Bolivia.** The concentration of alkaloids in tobacco plants increased almost threefold in response to vibrational signals produced by a generalist caterpillar that naturally feeds on the plant. Alkaloids are part of the plants’ chemical defence against herbivores. (IPICS BOL:01)

**Burkina Faso.** An ISP supported chemistry network laboratory at University Joseph Ki-Zerbo was requested by the government to elaborate on the national strategic nutrition plan for the country. (IPICS RABiotec)

\(^{53}\) After each research finding the ISP program as well as the acronym of the group/network are given in brackets. For research groups the acronym refers to the country. More information can be found at www.isp.uu.se.

- IPICS: ISP Chemistry
- IPMS: ISP Mathematics
- IPPS: ISP Physics

In chapter Fact and Figures all former and present research groups and networks are listed.
Kenya. A study of the impacts of pesticides on human health and environment in the river Nyando Catchment, Kenya, was carried out by researchers part of the ANCAP network. Fourteen pesticides were identified as commonly used on crops by farmers, out of which four are toxic to bees and five to birds. The farmers identified declines in the number of pollinating insects, and wild birds’ fatalities. The general knowledge among farmers about chemicals risks, safety, and chronic illnesses was low. (IPICS ANCAP)

In collaboration with World Agroforestry Centre (ICRAF), a research group at the Institute of Nuclear Science and Technology, University of Nairobi, developed prediction models for soil characteristics in Mount Kenya forest. This contributes to improved knowledge on soil fertility and consequently enhances the capacity to estimate the ability to address “hidden hunger” and level of food production quantity from small scale subsistence to commercial farming. (IPPS KEN:01/2)

A mathematics network used a probabilistic weather forecasting model based on quantile random forest and Epanechnikov kernel function (QRF-E) to forecast weather variable that affects the yield of a selected crop. (IPMS EAUMP)

Mali. By using agronomic and climatic data, a physics group developed predictive models providing estimates of millet, sorghum and maize crop yields in the Sikasso, Ségou and Mopti departments in Mali. These models will contribute to the improvement of agricultural yield forecasting tools in the country. (IPPS MAL:01)

Sri Lanka. The Centre for Instrument Development at the University of Colombo evaluated coir, the natural fiber extracted from the husk of the coconut, for reducing damage to tomatoes by vibrations during road transport. Coir was found to be an excellent vibration absorber which is easily manageable, environmentally friendly and reusable without getting structurally deformed. (IPPS SRI:01/3)
Africa. Different mathematical models have been used as a basis for improved disease control: for jigger infections (Uganda), Schistosomiasis/bilharzia (Kenya), pneumonia control (Tanzania), meningitis (Guinea), type-2-diabetes (Rwanda), soil-transmitted helminths infections (Kenya), the spread of malaria (Burkina Faso), and for HIV and Zika infections (Uganda). (IPMS APREA, IPMS BURK:01, IPMS EAUMP)

Bangladesh. A physics group has studied how to remove heavy metals from waste water by using novel magnetite nanoparticles. In connection with the outbreak of the Covid-19 pandemics, another physics group developed a type of transparent canopy to position over a hospital bed to clean the air from the virus. The cleaned air can then be recirculated back safely. Four units of this type have been installed at a premier Medical University. (IPPS BAN:02/2)

A member of a supported chemistry group at Dhaka University, was assigned for four years to the Bangladesh Food Safety Authority (BFSA), and another member is part of a BFSA committee. They contributed to the government’s efforts to establish a modern food safety system in Bangladesh. (IPICS BAN:04)

The Department of Biomedical Physics and Technology at the University of Dhaka, in collaboration with a local NGO, has started disseminating Telemedicine using diagnostic hardware and software developed by the department. The Focused Impedance Method for measuring respiration rate of babies, which grew out of the innovative research of the group, has already been integrated into this application. (IPICS BAN:04)

Bolivia. To control the Chagas disease vector, Triatoma infestants, by using synthetic pesticides has become increasingly inefficient due to the development of resistance in the insects. A chemistry group demonstrated that
the traditional burning of pepper plants, used by the guaraní populations, repels the Chagas disease vectors. (IPICS BOL:01)

**Ghana.** An “African Multi-Spectral Imaging Workshop” was hosted by a supported research group at University of Cape Coast, in Ghana. The method of multispectral imaging can be done at a relatively low cost and could be used in several important applications, e.g., tracing malaria parasites in blood, and diagnostics of cancer. At the workshop, seven state-of-the-art LED imaging microscopes were built. These are now all functional at the home institutes of the participants. (IPPS GHA:01)

**Ethiopia.** A model for the transmission dynamics of cystic echinococciosis in the dog, sheep, and human populations was developed and analysed. A sensitivity analysis of the key parameters was given and strategies that are helpful to control the transmission of cystic echinococciosis were provided. (IPMS ETH:01)

**Laos.** Analysis of organochlorine pesticide residues in fruits and vegetables was done with a new method developed together with a Japanese internship student from Toyohashi University of Technology. The target pesticides were DDT and its metabolites (DDD and DDE). (IPICS LAO:02)

**Myanmar.** A physics group studied the water quality (surface and ground water), so that the suitability of the drinking water could be determined. (IPPS MYA:01)

**Rwanda.** A new mathematical model of human cardio-vascular-respiratory system responses to exercise developed in Rwanda that can be used by medical practitioners, e.g. to regulate the intensity and type of physical exercise recommendable to patients/sportsmen. The model may become an important tool to improve the understanding of the physiology of exercising. (IPMS EAUMP)

**Sri Lanka.** A database with glycemic indices values of foods has been established by members of the supported research group in biochemistry at University of Srijayewardenepura and was in 2009 made available to the doctors practicing at the Family Practice Centre at University of Sri Jayewardenepura, to use in the advising of diet plans of patients. The data was distributed also via TV and at a national exhibition. (IPICS SRI:07)
**Uganda.** The results of infectious disease modelling of malaria, HIV, hepatitis E, and sleeping sickness carried out by the supported Department of Mathematics at Makerere University, have been utilised by the Ugandan Medical Research Council to advice on the best investment strategy to fight infectious diseases. (IPMS EAUMP)

**Zimbabwe.** At the African Institute of Biomedical Science and Technology (AiBST), the synthesis of analogues of the anti-malaria drug amodiaquine was carried out with the intention to overcome the toxicity of the parent compound. In collaboration with the University of Cape Town, analogues thought to be safer were designed and synthesized. Some of them retained good anti-malarial activity. (IPICS AiBST)

Also, effects of the drug efavirenz, used along with other medications to treat HIV infection, were reanalysed by AiBST in perspective of studies of human genetic variations that affect drug pharmacokinetics. This has resulted in more specific dosing guidelines. Partly due to the work the group WHO has recommended use of a lower dose of the drug Efavirenz to reduce incidences of Adverse Drug Reactions. Zimbabwe was one of the first countries to adopt the revised dose. (IPICS AiBST)

**General.** An important part of ISP’s overall goal is to strengthen higher education at partner institutions. Target 4B in SDG 4 – Quality Education, calls for an expansion of the enrolment in higher education and scientific programmes through fellowships, which is one of ISP’s main activities through supported groups and networks.

**Ethiopia.** A PhD programme in Pharmacognosy at Addis Ababa University was approved in 2018, meaning that local PhD students in Pharmacognosy can start to be produced in the coming years. (IPICS ETH:02)
**Ghana.** The supported research centre in mathematics in Ghana, Institute for Mathematical Sciences, has been involved in promoting mathematics (and physics) in schools and society. In 2008 they have organised, among other things, a talent search for pre-university students, and the participation of students under the age of 18 years from Ghana in the International Physics Science Olympiad held in Vietnam. (IPMS IMS)

**Kenya.** The physics group at the Institute of Nuclear Science and Technology, University of Nairobi, was involved in a three-month training of twenty-seven students from disadvantaged families in the Kasarani Constituency, Nairobi, on renewable energy up to certificate level. This was an initiative driven by the member of Parliament of that area. The group has been active in training medical support personnel from the Ministry of Health Hospitals that completed a Diploma course in Nuclear Science. (IPPS KEN:01/2)

**General.** ISP envisions that women and men in supported research groups and networks should have equal opportunities to achieve their full potential in scientific research. ISP is working hard to create awareness of gender biases and to increase women's participation in scientific research to the same level as men. For example, ISP has introduced earmarked extra funds for activities promoting increased gender equality and balance in mathematics and physics at the supported institutions. Another example is the support of the Eastern Africa Network for Women in Basic Sciences (EANWoBAS). The network consists of students and staff members in mathematics and physics from universities in Kenya, Rwanda, Tanzania, Uganda and Zambia, and is the first ISP supported network of this kind. The network strives to create gender balance representation in the basic sciences, on all levels from primary to tertiary education, in East Africa.
Mali. The first female PhD student in physics in Mali graduated from an ISP supported physics group at the University of Sciences, Techniques and Technologies of Bamako. (IPPS MAL:01)

Kenya. “The Women in Physical Science in Kenya” was initiated by an ISP supported physics group at the University of Nairobi, Kenya. (IPPS KEN:01/2)

Burkina Faso. On the request of the Ministry for Health in Burkina Faso, the centre CRSBAN at University Joseph Ki-Zerbo, part of the ISP supported West African Biotechnology Network (RABiotech) has certified new filter equipment devoted to purifying drinking water for human consumption. In the process of approval of the new filter, the Minister of Health has selected CRSBAN as a Centre of Excellence to conduct the experiments which will furnish the scientific results by testing the presence or not of bacteria in water treated by this filter. (IPICS RABiotech)

A chemistry group had interactions with the local population in the northern part of Burkina Faso regarding the issue of arsenic contaminated groundwater. The group installed a pilot station for arsenic treatment on the site. They also had discussions with the local community to explain the whole process. (IPICS BUF:01)

Laos. A chemistry group at the National University of Laos provided consultation and assistance to the Lao Department of Hygiene and Health Promotion, and analysed arsenic in samples of ground water from the disaster area of Sanamxay District that was damaged from the dam collapse in 2018. The group also developed contacts with the Water Resources and Environment Agency and the Ministry of Industry and Trade in Laos. The group contributed to Environment Impact Assessments for several projects in Lao PDR: regarding dam construction, mining exploitation, monitoring of
urban wastewater. They have also given provincial training in water quality, classification of wastewater, and environmental issues. (IPICS LAO:01)

**Uganda.** Group members of an ISP supported research group at Makerere University were invited by the government to assess the environmental conditions of the wetland on the edge of Lake Victoria. The reports will be the basis of government policy streamlining the management of Ugandan beaches. (IPICS UGA:01)

**Zimbabwe.** A farmer from Shangani approached one of the supported chemistry group at University of Harare, because fish was dying in his dam. The group analysed water and sediment samples and found high levels of cyanide and mercury residues. As a result, the farmer moved the fish to an unpolluted location while working on a remediation plan. (IPICS ZIM:01)

**Kenya.** Meetings between the Energy Regulatory Commission and a supported physics group at the University of Nairobi have influenced the legislation in the PV and solar thermal subsector. Home owners are now encouraged to feed into the national electricity grid from solar home systems and to install solar water heaters to reduce their dependence on heating on the national grid. (IPPS KEN:02)

**Tanzania.** Physics researchers in Tanzania have studied different ways to improve the efficiency of solar cells by chemical bath deposition (CBD). Also, a physics group has developed solar cooking devices to reduce the use of firewood and charcoal. These cookers could be used by rural and suburban communities for clean cooking. 42 selected households, in majority women, in Isimani village have been provided with solar cookers and trained on how best to use them. A long-term evaluation of the performance of the cookers will be conducted by the group. (IPPS TAN:01/2, IPPS MSSEESA)
Zambia. The National Science and Technology Council in Zambia has produced a prototype of the polymer solar cells developed by a physics research group at the University of Zambia. Also, the physics research group at the University of Zambia developed a sustainable business model for the operations of the Solar Mini-grids in the area. (IPPS ZAM:01)

Kenya. A mathematics group studied aggregate loss distribution for modelling reserves in insurance and banking sectors in Kenya. (IPMS EAUMP)

Rwanda. A mathematics network studied morphometric characteristics of four important fish species from the Rwandan side of Lake Kivu. In Rwanda, about two million people directly depend on capture fisheries from Lake Kivu. Sustainable fisheries management requires monitoring of population dynamics that help to devise effective intervention strategies. (IPMS EAUMP)

Further, there is a connection to SDG 9 – Industry, Innovation and Infrastructure through the many activities aiming to enhance scientific research and increasing the number of researchers by organising scientific conferences, conducting quality innovative research, engaging in national committees, and collaborating with industry.
Bangladesh. A physics group in Bangladesh studied polycrystalline materials for electronic devices. Another group in Bangladesh performed a study aiming to develop a biodegradable material (cellulose-based papers) for food packaging. (IPPS BAN:02/1)

Myanmar. A physics group used glass technology to be utilised for applications in e.g. batteries and electromagnetic shielding. (IPPS MYA:01)

Tanzania. A mathematics group developed a mathematical model, using Computational Fluid Dynamics (CFD), on leakage in sewage pipes laid in a porous ground. (IPMS EAUMP)

Kenya. A physics group studied the indoor and outdoor air quality (especially PM2.5 concentrations) in urban and rural settlements. The findings showed how low-income households are affected by emissions from different fuels (like wood and kerosene) and concluded that there is a strong need to enhance the sensitization of the effects of air pollution on health in relation to the various types of household fuels, cooking stoves and house designs. The group has also been engaged by the Ministry of Nairobi Metropolitan Development for assessing air quality in the Nairobi Metropolitan area. (IPPS KEN:01/2)

Bangladesh. Results from studies at the Department of Chemistry at Dhaka University, of DDT and its metabolites in soil and water at the “Chittagong Chemical Complex” was submitted to the Bangladesh Chemical Industrial Corporation (Government Authority) for declaring the Godown area as a contaminated zone and to evacuate people. (IPICS BAN:04)

Nepal. Studies of lightning activities in the country were carried out from the perspective of the threats to public life. It was found out that lightning occurrences and fatalities are most frequent in districts along the southern border and least in the northern high-elevation districts, and are concentrated
in the pre-monsoon and monsoon months. However, the districts with the largest stroke densities often do not coincide with those with the highest fatality rates per million people. Moreover, the fatality rate of the middle hilly region is twice that of the southern plains region, despite the plains region having both a considerably higher population density and lightning stroke density. (IPPS NEP:01)

**Ethiopia.** A draft seismic hazard map of Ethiopia and the region at large has been produced by researchers at the Geophysical Observatory, University of Addis Ababa. This map has been submitted to the Ministry of Urban Development and Construction and will be used as a major input for the new building code in the country. (IPPS ETH:02)

**Burkina Faso.** The network “PDE, Modelling and Control” participated in outreach activities with policymakers on the vulnerability of African cities to climate change. An indicative emergency master plan on measures to be taken to cope with natural disasters, especially related to flood risk, was developed with a contribution from the network. This has a strong impact on local and national government regarding climate risks. (IPMS BURK:01)

Finally, there is a general alignment of ISPs work with *SDG 17 – Partnerships to achieve the SDGs*, more specifically Target 17.9 aiming to “enhance international support for implementing effective and targeted capacity-
building in developing countries to support national plans to implement all the sustainable development goals, including through North-South, South-South and triangular cooperation". 
Concluding Remarks

Dr Bengt Ove Turesson

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The International Science Programme is one of the oldest - if not the oldest - organisations working with research cooperation in the least developed countries. To be old is not always an asset, but it means that ISP has accumulated vast experience in research cooperation as well as a large network of scientists and other stakeholders in the countries that we have collaborated or are still collaborating with. The network also includes contacts among a large group of researchers in the North as well as among organisations with a similar mission as ISP.

ISP today supports 43 research groups in 14 countries and 20 scientific networks that involve even more countries in Africa, Asia and Latin America. The support provided by ISP is truly multi-faceted, and it includes everything that is associated with research and postgraduate education. For instance, ISP supports PhD students (both sandwich students and students enrolled in local PhD programmes), postdoctoral fellows, dissemination of research results through participation in conferences, and arrangement of conferences and scientific workshops. ISP also supports the procurement of scientific equipment to its groups and networks and, not least important, the maintenance of such equipment.

During the last twenty years, ISP has worked hard to fight the gender gap in science so that women have equal chances and opportunities to study, to do research and participate in scientific activities. ISP has also worked to create awareness of the gender biases that often exclude women among researchers and stakeholders.

Another feature of ISP’s operations is the focus on developing awareness of publication strategies and fund-raising skills as well as the ability to handle the problems that normally occur in a research project. One example of this approach is the Research Management component in the ISP chemistry programme (IPICS), where the entire research process is addressed in a structured and systematic way with measurable outputs and outcomes.
ISP always strives to make efficient and effective use of the available resources and explore synergies whenever possible, for instance through regional collaboration or through coordination with activities in the bilateral programmes.

ISP’s vision is that development challenges are efficiently addressed in partner countries through increasing scientific knowledge.

ISP’s mission is to strengthen the scientific knowledge, research capacity and postgraduate education in the basic sciences chemistry, mathematics and physics in countries where such capacity is non-existing or weak.

These core values guide ISP in all its endeavours and permeate all activities.

Not very surprisingly, the core values of ISP coincide with the core values and principles of Sida as summarized in Sida’s Handbook for Bilateral Research Cooperation from 2002:
Ownership, sustainability, high scientific quality, academic freedom, flexible and context specific support, and long-term commitment.

2021 was the year of the 60th anniversary of ISP. We are most grateful for the last twenty years of success and development with our valuable partners around the world. Let us stay strong and committed for another 60 years!
Facts and Figures

ISP supported research groups (past and present)

*Table 1. Table of former and present groups supported by ISP. IPPS=physics, IPICS=chemistry, IPMS=mathematics. The ISP acronyms came in to use in 1992.*

<table>
<thead>
<tr>
<th>Country</th>
<th>ISP Program</th>
<th>ISP Acronym</th>
<th>Institute/University</th>
<th>Start</th>
<th>End</th>
<th>Research topics</th>
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<td>Bangladesh</td>
<td>IPICS</td>
<td>BAN:01/1</td>
<td>University of Dhaka</td>
<td>1977</td>
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<td>Chemical and biological studies of medicinal plants</td>
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<td>2018</td>
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ISP supported scientific networks (past and present)

Table 1. Table of former and present networks supported by ISP. IPPS=physics, IPICS=chemistry, IPMS=mathematics.

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# Abbreviations

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<td>Comprehensive Test Ban Treaty Organisation</td>
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<td>High income countries</td>
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<tr>
<td>HPCL</td>
<td>High Performance Liquid Chromatograph</td>
</tr>
<tr>
<td>Ictp</td>
<td>The International Centre for Theoretical Physics</td>
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<tr>
<td>IFS</td>
<td>International Foundation of Science</td>
</tr>
<tr>
<td>IMU-CDC</td>
<td>International Mathematical Union/Commission for Developing Countries</td>
</tr>
<tr>
<td>IUCEA</td>
<td>Inter-University Council for East Africa</td>
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<tr>
<td>IPICS</td>
<td>ISP Chemistry</td>
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<tr>
<td>IPMS</td>
<td>ISP Mathematics</td>
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<td>IPPS</td>
<td>ISP Physics</td>
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</table>
LANFOOD  Latin American Network for Food Research
LMIC  Low and middle income country
LMS/AMMSI  London Mathematical Society/African Mathematics

Millennium Science Initiative

MA  Master of Arts
MAK  Makerere University, Uganda
MER  Main Ethiopian Rift
MPhil  Master of Philosophy
MSc  Master of Science
MSD  Materials Science Division at the Atomic Energy Centre

Dhaka (AECD)

MSSEESA  Materials Science and Solar Energy Network for Eastern and Southern Africa

NIH  National Institutes of Health, USA
NMR  Nuclear magnetic resonance
Norad  Norwegian Agency for Development Cooperation
NRF  National Research Foundation, South Africa
OSW  Organisation for Women in Science for the developing World.

OSWD is part of TWAS (The World Academy of Sciences)
PDE  Partial Differential Equations
PhD  Doctoral degree

RSIF-PASET  Regional Scholarship and Innovation Fund-Partnership for Skills in Applied Sciences, Engineering and Technology

SANORD  Southern African Nordic Centre Conference
SAREC  The Swedish Agency for Research Cooperation with Developing Countries. SAREC was incorporated with Sida in July 1995 as the Department for Research Cooperation

SEAMaN  South-East Asia Mathematical Network
SEANAC  Europe, Southern and Eastern African Network of Analytical Chemists

SETAC  Society of Environmental Toxicology and Chemistry
Sida  Swedish International Development Cooperation Agency
SLU  Swedish University of Agricultural Sciences
STEM  Science, Technology, Engineering and Mathematics
TWAS  The World Academy of Sciences

UDSM  University of Dar es Salaam, Tanzania
UGAWOM  Uganda Women Mathematicians
UNZA  University of Zambia, Zambia
UoN  University of Nairobi, Kenya
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Name</th>
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<tbody>
<tr>
<td>UoN</td>
<td>University of Nairobi, Kenya</td>
</tr>
<tr>
<td>UR</td>
<td>University of Rwanda, Rwanda</td>
</tr>
<tr>
<td>WWSSN</td>
<td>World-Wide Standardized Seismographic Network</td>
</tr>
</tbody>
</table>


88. Regional and Interregional Cooperation to Strengthen Basic Sciences in Developing Countries. Editor: CHRISTER KISELMAN. 2011.


Bengt Meyerson: Linnaeus’ Course to Achievements in Medicine and Pharmaceutics. 2015.


Ing-Marie Munktell: Reflections on University Museums. UMAC – University Museums and Collections in My Mind. 2022.
