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TWAS newsletter

NEWSLETTER OF THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD

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AFTER TWO YEARS OF UNPRECEDENTED – INDEED EXPLOSIVE – GROWTH IN 2002 AND 2003, TWAS HAS SPENT MUCH OF THE PAST 18 MONTHS SOLIDIFYING THE PROGRESS THAT IT HAS RECENTLY MADE IN ADVANCING ITS MANDATE.

2004: Consolidating the Academy's Growth

The Academy's primary objective during this period has been to ensure that the promise afforded by the additional revenues and the expanded base of programmatic activities is transformed into solid and sustainable achievements.

While taking measures to bolster the administrative framework for programmes and activities doesn't elicit the same level of excitement as announcing their launch, these "nuts and bolts" efforts have helped to institutionalize the Academy's new-found strength and impact. As a result, TWAS's profile has reached new heights in the international science arena and, increasingly, in the international economic development community. Here are selected highlights of what has transpired:

- *A panel of eminent scientists has selected the first two winners of the Trieste Science Prize (TSP). Sergio H. Ferreira, professor of pharmacology, faculty of medicine, University of São Paulo, Ribeirão Preto, Brazil, won the TSP in biology for his contributions to the discovery of molecules that combat high blood pressure and for his seminal studies on chemical mediators that curb inflammatory pain. T.V. Ramakrishnan, DAE Homi Bhabha professor of physics, Banaras Hindu University, won the first TSP in physics and astronomy for his fundamental contributions to condensed matter physics and, more specifically, for his theory of liquid-solid transition and the behaviour of electrons in disordered systems. For additional information about the prize winners, see* TWAS Newsletter*, vol. 17, no. 2, 2005.*

- *The newly renamed TWAS International Programme for Higher Education and Research (IPHER) programme has experienced an increase of 250 fellowships over the past two years,*

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c/o ICTP, Strada Costiera 11
34014 Trieste, Italy
tel: +39 040 2240327
fax: +39 040 224559
email: info@twas.org
website: www.twas.org

TWAS EXECUTIVE DIRECTOR
Mohamed H.A. Hassan (Sudan)

EDITOR
Daniel Schaffer

ASSISTANT EDITOR
Peter McGrath

MANAGING EDITOR
Gisela Isten

SUPPORT STAFF
Helen Grant, Sheila Khawaja, Helen Martin, Leena Mungapen, Sandra Ravalico

DESIGN & ART DIRECTION
Sandra Zorzetti, Rado Jagodic
www.studio-link.it

PRINTING
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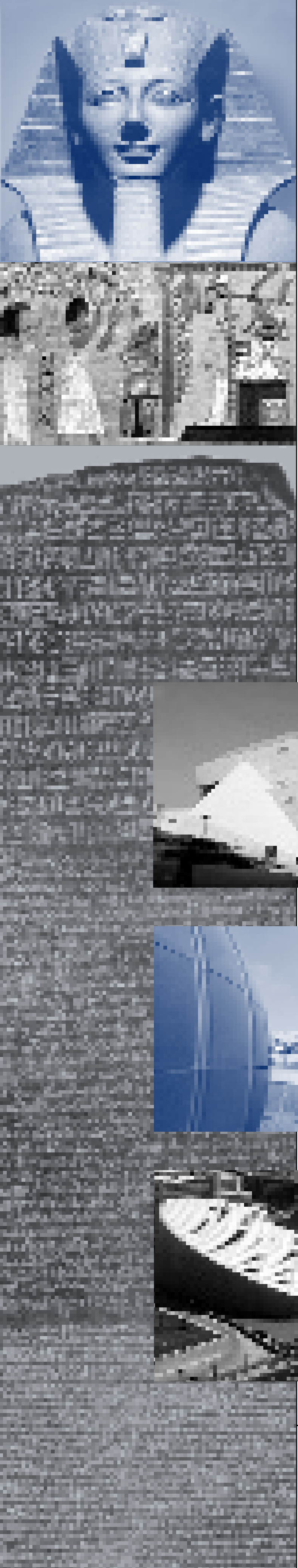


thanks largely to the generosity of the governments of Brazil, China, India and Mexico. Each of these countries has agreed to provide 50 graduate and post-graduate fellowships annually to young researchers from other developing countries to attend universities and research institutions located in the sponsoring nations, enabling the researchers to continue their studies. The programme, which TWAS secretary general Jacob Palis observed has turned the Academy into "mini-university", has generated a new set of administrative challenges. The Academy has sought to address these challenges by devising an effective management system and by adding personnel. In 2004, for example, the broad array of fellowship programmes that the Academy oversees was placed under a single banner and an additional TWAS staff member was assigned to the programme. At the same time, arrangements were made with the Brazilian Academy of Sciences to send three staff members to TWAS for a one-year period to help shoulder some of the responsibilities for the fellowship programme. The three individuals are scheduled to arrive in Trieste in autumn 2005.

- *The Italian government's decision in late 2003 to transform its financial sponsorship of TWAS from a "voluntary" into a "permanent" contribution, sanctioned by parliament, has placed the Academy on a secure financial footing. TWAS, as a result, has been able to create two additional professional posts: one for finance and another for programmes, both under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Academy's administrative agency. The posts, advertised in international print publications and e-journals, elicited more than 250 and 450 applications, respectively. Ernest Jones, formerly a financial officer with the UN's World Food Programme, headquartered in Rome, Italy, has been appointed financial officer. He arrived in Trieste in September 2005. Evaluations of the applicants for programme officer are continuing.*

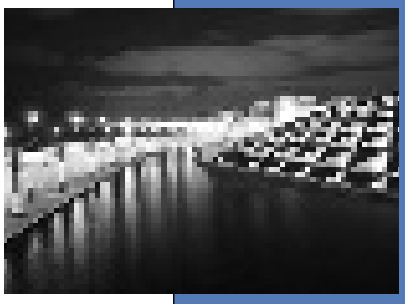
- *The Academy's affiliated organizations also took steps to build on their recent growth and to set the stage for future expansion.*

  - *The Third World Organization for Women in Science (TWOWS), for example, devised plans for its third international conference to be held in Bangalore, India, from 21-25 November 2005. At the meeting, TWOWS members will elect a new president to replace Lydia Makhubu who has led the organization since 1993 (see "Women in Science", p. 34). The organization will also set an agenda for the years ahead seeking to build on the success of the fellowship programme for young women scientists who are seeking graduate and post-graduate degrees. This programme, which enables women scientists, largely from the least developed countries (LDCs), to attend universities in more advanced developing countries for extended periods while earning their degrees in institutions in their home countries, is funded by the Department of Research Cooperation of the Swedish International Development Agency (Sida-SAREC). For additional information about TWOWS, see* www.twows.org.

[CONTINUED PAGE 4]

- *The executive board of the Third World Network of Scientific Organizations (TWNSO) met in South Africa in September 2005 to begin forging a multi-year strategic plan. Efforts will focus on providing more extensive services to member institutions, which include ministries of science and technology, research councils and academies of science, and on pursuing independent and sustainable sources of funding. TWNSO will also seek to promote cooperative projects that will enable member institutions to share their expertise. The organization will continue to partner with the United Nations Development Programme's (UNDP) special unit for South-South Cooperation (SSC) to showcase successful applications of science and technology in addressing critical economic and social needs in the developing world. In addition, it will look for potential external sources of funding to develop a programme focusing on pilot-scale demonstrations of scientific research findings and appropriate technologies. For additional information about TWNSO, see* www.twnso.org.

- *The InterAcademy Panel on International Issues (IAP), which received secure financial support from the Italian government in 2004 under the same parliamentary law that turned the TWAS budget into a permanent allocation, has expanded the scope of its activities to include assessments of water management, access to scientific information, biosecurity and genetically modified organisms. These programmatic concerns have been added to IAP's long-standing focus on issues related to building the capacity of academies of science, science education, and health issues for women and children. The focal point of IAP will continue to be strengthening the capacity of science academies to become leading voices on science-related issues in their home countries and to emerge as key advisors for their governments, especially in developing countries. For additional information about IAP, see* www.interacademies.net.



- *The InterAcademy Medical Panel (IAMP), which arrived in Trieste in December 2004 as the newest member of the constellation of scientific institutions now operating under the administrative umbrella of TWAS, met in Sicily, Italy, in September 2005 to begin the process of laying out a long-term programmatic agenda. IAMP, which now consists of 52 medical associations or medical divisions within science academies, is expected to raise its profile substantially in 2006 when it holds its second annual general meeting in Beijing, China, and uses the event to officially launch the publication of the second edition of* Disease Control Priorities in Developing Countries. *For additional information about IAMP, see* www.interacademies.net/iamp.

As always, TWAS would like to extend its thanks to its generous sponsors, most notably the Italian government but also the Department of Research Cooperation of the Swedish International Development Agency (Sida-SAREC) and the Kuwait Foundation for Advancement of Sciences (KFAS) for their contributions to core programmes within the Academy, including the research grants programmes and the publication of the TWAS Newsletter, respectively. We would also like to the thank the Global Environment Facility (GEF); Global Change

SysTem for Analysis, Research and Training (START); and the United Nations Development Programme (UNDP) for their past support and we sincerely hope that we can continue to partner with them in the future. Finally, we would like to thank the scientific organizations that have stood by our side during this period of growth and, more recently, consolidation, most notably the International Council for Science (ICSU), the Chinese Academy of Sciences, the US National Academy of Sciences (NAS), the Initiative on Science and Technology for Sustainability (ISTS) at Harvard University's Kennedy School of Government, and the Science Institutes Group (SIG) at the Institute of Advanced Study in Princeton, USA.

The past 18 months may have lacked the glamour and pizzazz of the previous two years. Yet, in many respects, this period has represented a return to the Academy's roots and a deep-seated expression of the Academy at its best: Working tirelessly behind the scenes to ensure the efficient administration of its programmes and activities all as part of a larger strategy to advance the Academy's mandate. That mandate, simply put, is to promote scientific excellence and build scientific capacity for science-based development in the developing world.

Indeed it is periods like the one we have just experienced that make it possible for TWAS to continue to grow in strength and visibility. As every farmer knows, you must till the field to reap the harvest. ■

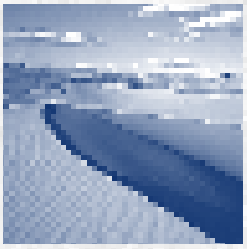
C.N.R. Rao
President
TWAS
Trieste, Italy

TWAS 16TH GENERAL MEETING

TWAS will hold its 16th General Meeting at the Bibliotheca Alexandrina *in Alexandria, Egypt, from 29 November - 3 December 2005. The meeting will include a ceremony officially inducting TWAS's newest members into the Academy as well as lectures by TWAS Prize winners in the basic sciences. The first winners of the Trieste Science Prize – Sergio Ferreira in biology and T.V. Ramakrishnan in physics and astronomy – will also be honoured and present lectures on their research and experience as scientists living and working in the developing world. Other highlights of the meeting will include a session on the state of science education in developing countries; a lecture on the state of science in Egypt by Ismail Serageldin, president of* Bibliotheca Alexandrina*; invited lectures by Peter Raven, president, Sigma XI, and H.K. Gupta, secretary, Department of Ocean Development, government of India; and a series of workshops focusing on the social sciences and biotechnology in the South as well as the World Year of Physics 2005. For additional information about TWAS's 16th General Meeting, see* www.twas.org.

S&T IN THE ARAB WORLD: AN AGENDA FOR ACTION

THE 16TH GENERAL MEETING OF THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD (TWAS) WILL TAKE PLACE AT THE NEW ALEXANDRIA LIBRARY IN ALEXANDRIA, EGYPT. WHAT BETTER PLACE TO LAY OUT A BOLD AGENDA FOR REFORMING THE RELATIONSHIP BETWEEN SCIENCE AND SOCIETY IN THE REGION THAN AT THE SITE OF ONE OF THE ANCIENT WORLD'S GREATEST SEATS OF LEARNING – A PLACE NOW SEEKING TO REGAIN ITS FORMER STATUS AS A CENTRE OF GLOBAL KNOWLEDGE.



At the turn of the first millennium, the influence of the Islamic world – whose principles and prowess were largely centred in the Arab region – stretched from the Iberian peninsula in the west to India in the east, and from the Balkans in the north to Africa and the Arabian peninsula in the south.

Alexandria, Baghdad and Damascus, residing at the crossroads between Europe, Africa and Asia, emerged as thriving hubs of trade and cultural exchange for a startling array of people, goods and ideas. Encounters with other cultures spurred historic progress in science and technology that allowed for unprecedented breakthroughs in astronomy, mathematics and physics.

A millennium later, however, it only takes a brief glance at the area that belongs to the Islamic world to realize that traces of its past glory have largely vanished. In its place is a faded portrait of economic stagnation marked by chronically low rates of annual growth in gross domestic product (GDP).

Out of 56 countries that comprise the Organization of Islamic Conference (OIC), 22 (nearly half the world's total) are classified as least developed countries (LDCs) and 29 as low-income countries. Strikingly, OIC countries are endowed with enormous reservoirs of oil and gas (an estimated 70 percent of the global energy resources are found in OIC countries) that have proven to be both a blessing and curse. Yet, the total GDP of OIC

countries – just US$1.2 billion – is but half that of Germany and one-quarter that of Japan.

Of the 56 OIC countries, 22 are recognized as belonging to 'the Arab world' (see box, page 8). Six of these countries are classified as LDCs, yet many of the challenges faced by these 'poorer' countries are common to 'wealthier' nations within the Arab region.

The region's long-standing economic troubles have not only overshadowed its progressive and productive history but, more importantly, have adversely impacted the region's current state of affairs. For example, Arab countries on average spend less than 0.2 percent of their GDP on research and development, compared to 1.6 percent in east Asia and the Pacific and 2.6 percent in Organization for Economic Cooperation and Development (OECD) countries.

High illiteracy rates, averaging more than 25 percent for males and 50 percent for women in some countries, compound the region's economic and social ills and undermine its hopes for the future. So, too, does the continuous loss of the region's most talented scientists and technologists to countries outside the region. The small number of scientists and engineers working in Arab countries – 124 per million population compared to 2,830 per million population in OECD countries – have caused the Arab world to contribute minimally to the world's scientific research output as measured by publications in peer-reviewed international journals and the awarding of international patents for technological innovations. Gender inequality, which is more entrenched in Arab countries than in most other parts of the world, further saps the potential of the region's human capital.

Arab states must introduce more comprehensive and rigorous courses in science and mathematics.

These persistent troubles call for greater investments and broad ranging reforms in science and technology policies. Key aspects of this effort should include:

- Improving science education at the primary and secondary levels, upgrading universities and research institutions, and launching and reinvigorating merit-based national science academies.
- Harnessing science, technology and innovation for economic development and social benefits.
- Enhancing international scientific collaboration.

Each of these reforms requires specific actions that should also prove instrumental in achieving two broader objectives:

- Raising the status of quality research and education in science, technology and innovation by focusing on human resource development and the development of universities and research institutes of excellence.

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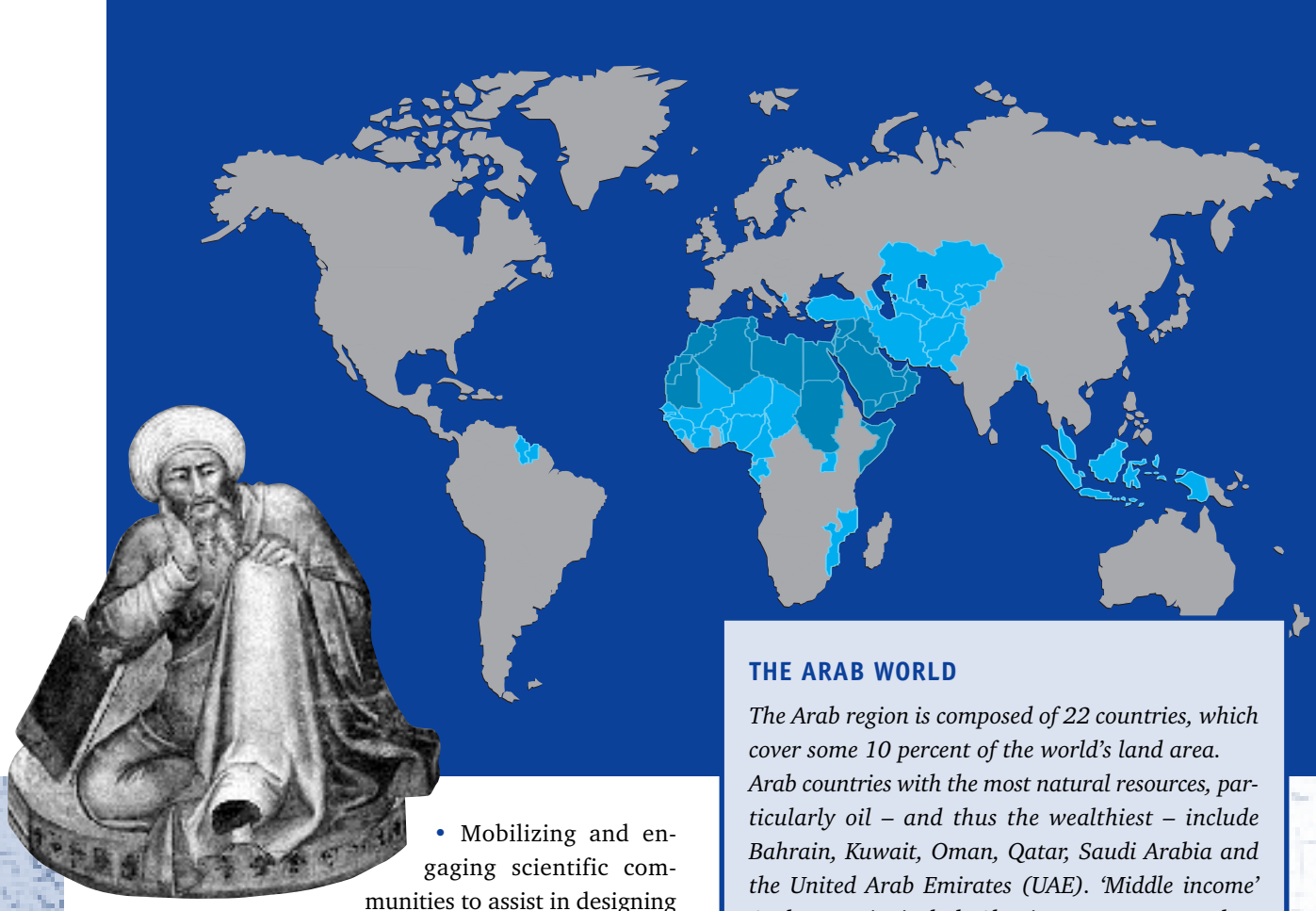


• Mobilizing and engaging scientific communities to assist in designing and implementing solutions to real-life problems and challenges facing Islamic countries.

Primary and secondary education

To strengthen the role of science in development, Arab states must introduce more comprehensive and rigorous courses in science and mathematics both in schools and religious seminaries. Innovative ways of teaching science must help children learn and involve them directly in acquiring new knowledge, especially through new information and communication technologies (ICTs). Special schools for children gifted in science should be established and scientific information, including access to noncredit 'distance learning' courses, which present science in ways that can be easily understood by a non-expert audiences, should be offered to adults both on radio and television.

Higher education and research

To attract talented students from other countries, Arab states should seek to strengthen their universities and research institutes. Such measures have already taken place, but progress to date has been slow and halting. Universities with excellent teaching and research facilities, such as those in Dubai, Oman, Qatar and other Gulf States, should open their doors even wider to students and young researchers from other countries. Recent efforts to partner with renowned universities in the US and Europe should be expanded and well-publicized. In addition, access to high-level science courses and lecture seminars should be facilitated by providing access to such information on the internet. Again, this is taking place but the pace of reform should be accelerated.

Academies of science

As in many other countries around the world, efforts should be made to transform science academies from sombre 'old men's clubs' into dynamic 'boundary' organizations capable of addressing key social problems and advising governments on scientific issues of critical

THE ARAB WORLD

The Arab region is composed of 22 countries, which cover some 10 percent of the world's land area. Arab countries with the most natural resources, particularly oil – and thus the wealthiest – include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE). 'Middle income' Arab countries include Algeria, Egypt, Iraq, Jordan, Lebanon, Libya, Morocco, Palestine, Syria and Tunisia. The poorest Arab countries include six of the world's 50 least developed countries: Comoros, Djibouti, Mauritania, Somalia, Sudan and Yemen.

national and international concern. Scientists working in Arab countries that do not yet have merit-based science academies – the majority – should encourage their governments to launch such organizations. At the same time, the institutional capacities of existing academies should be strengthened through both national and international efforts, including collaborations with the African Academy of Sciences (AAS), the Academy of Science for the Developing World (TWAS) and the Inter-Academy Panel on International Issues (IAP). Such collaborations have already borne fruit, leading, for instance, to the establishment of the Network of Academies of Science in Countries of the Organization of Islamic Conference (NASIC), an association consisting of the OIC region's 16 merit-based science academies. NASIC was launched in 2004 under the auspices of IAP's Capacity Building Programme for Young Academies.

Building scientific capacity is a critical element in the Arab region's overall efforts to promote sustainable economic development.

International collaboration

International collaboration should be encouraged, especially for the purposes of fostering a new generation of talented scientists throughout the Arab world. Such collaboration should take place through fellowship programmes for meritorious undergraduate and graduate students to study at universities and centres of excellence both in the developed and developing world; the creation of quality universities and research centres of excellence to attract students from other developing countries; and the development of national and regional funding programmes that are designed to support and reward the most promising young scientists, especially during the earliest years of their careers. Short- and long-term visits of highly qualified scientists from other countries, including expatriate scientists in Europe and the United States, should be fostered to help boost research and training capacities. 'Twinning arrangements' between universities and research centres in Arab countries and their counterparts in the developed and developing world should be launched to help open corridors of international exchange utilizing and expanding on existing initiatives. And finally, competitive institutional grant programmes should be created to upgrade the infrastructure of existing institutions and lay the groundwork for transforming such institutions into regional and perhaps even international centres of excellence.

Science, technology and innovation

Building scientific capacity in the Arab states is a critical element in the region's overall efforts to promote sustainable economic development. To advance this goal, Arab countries must identify leading research institutions in the region that focus on science, technology and innovation. In this regard, the Third World Network of Science Organizations (TWNSO) and TWAS have published detailed profiles of institutions of excellence throughout the developing world, periodically updating the list. Listed institutions that share common goals, such as the provision of safe drinking water or a desire to improve land management policies, should seek to form networks designed to address common problems and to learn from each other's experiences. In addition, high-level roundtables should be organized to bring together leaders in the scientific, development and policy communities, including ministers of finance, planning and science, for the purposes of developing joint programmes that address the challenges of science-based development from an integrated perspective that promotes new ideas and builds consensus.

The agenda outlined above is an ambitious one but the scope of these broad initiatives is no less compelling than the scope of the problems that Arab nations face (see "Facts and Figures", page 10). The good news is that there is increasing recognition that the economic development challenges confronting the region can no longer be ignored and that science, technology and innovation can no longer be dismissed as non-essential factors better left to wealthier regions of the world to pursue. The next step in this process is to transform awareness into action. ■

ARAB SCIENCE: NUMBERS COUNT

HOW DOES EDUCATION AND SCIENCE IN THE ARAB REGION COMPARE WITH THE REST OF THE WORLD? HERE'S A SNAPSHOT.

Historically, Arab culture has contributed a great deal to the world's scientific development. Today, however, the region lags behind in many critical science and technology indicators.

Population

The 22 countries of the Arab region (see box, page 8) are home to 4.5 percent of the world's population. The current population of 295 million is expected to reach 315 million by 2015.

Literacy

Illiteracy affects some 68 million people in the region, including 38 percent of the adult population, higher than the average 27 percent illiteracy rate in all developing countries. In industrialized countries, the illiteracy rate is a mere 1.1 percent.

Publishing

Over the past 1,000 years, about 100,000 books in total have been translated into Arabic. That is equivalent to the number of books translated by Spain into Spanish each year. North American writers publish more than 100,000 books each year; Arab writers publish only some 6,500 books.

Support level

In 2002, the Arab region spent US$6 per capita on research and development compared with US$953 in the USA, US$465 in the European Union, US$42 in Latin America and US$40 in China.

Output

Switzerland produces 80 frequently cited papers per million inhabitants each year, the USA 43, Israel 38, but Kuwait just 0.53, Saudi Arabia 0.07, and Egypt 0.02. Taken together, the number of scientific publications originating in the Arab region account for only 1.1 percent of the world total.

Personnel

The Arab region employs 124 research scientists and engineers per million people, surpassing only the African region and lower

than the 313 average for all developing countries. Indeed, the number of Arab researchers per million inhabitants is just 0.5 percent of the number in the Russian Federation, which has about the same number of people. Of the 20,000 research scientists and engineers employed in the Arab region, more than half are located in Egypt.

Projects

Over the past 30 years, the Arab world has spent more than US$1,000 billion on turnkey projects – *i.e.,* 'off-the-shelf' technology, often for military purposes. Indeed, the amount spent each year on military needs imported from abroad is more than the combined investment in health, education, research and development.

Strategy

Some 44 percent of Arab researchers work in the water and agriculture sectors, suggesting that the region has not yet 'leap-frogged' into the intellect-intensive knowledge economy. Just 6.2 percent of the region's science budget is allocated to fundamental research.

Public/Private

In the member states of the Organization for Economic Cooperation and Development (OECD), 70 percent of all research and development is performed by private enterprise, 17 percent by universities and 10 percent by government. In contrast, private enterprise in the Arab region accounts for just 1 percent of research and development, universities 30 percent and government 69 percent.

Connected

There are fewer than 25 computers per 1,000 people in the Arab region compared to the global average of 78.3. Similarly, in 2000, 1.6 percent of the Arab population was using the internet, compared with 30 percent in the USA. However, such Arab countries as the UAE (30 percent) and Bahrain (19 percent) do have a significant number of internet users.

Education

Average government expenditure per student is just US$2,400, compared to US$14,200 in Spain. However, student enrolment in the Arab region is estimated to be 25 percent of the population, much higher than many other developing countries. The enrolment of women is also high in some countries, including Saudi Arabia and the Gulf states. In Qatar, for example, 46.2 percent of eligible women enroll in tertiary education, but only 13.7 percent of eligible men. Currently, some 200 universities employ 140,000 faculty to teach 3.6 million students. Despite these encouraging figures, the region's growing population means that enrollment is expected to rise to 5.6 million by 2015, which will require an extra 110,000 faculty. ■

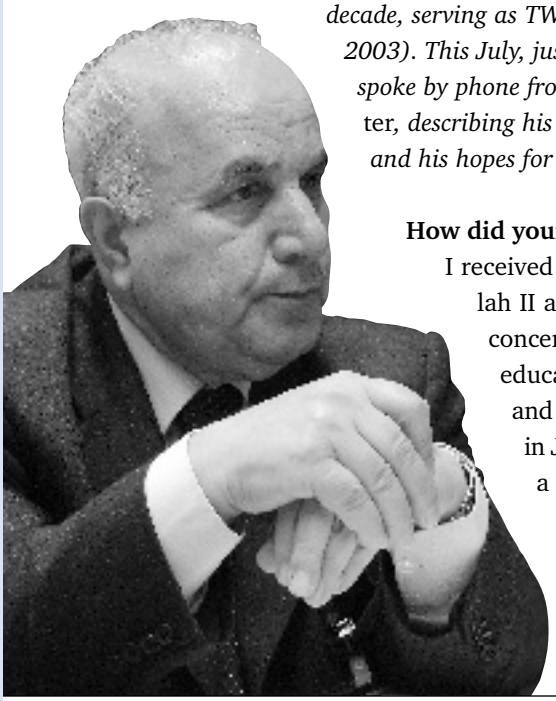
Sources

- *Arab Fund for Economic and Social Development*
- *United Nations Economic and Social Commission for Western Asia (ESCWA)*
- *United Nations Development Programme (UNDP)*
- *United Nations Educational, Scientific and Cultural Organization (UNESCO)*
- *World Bank*

THIS SPRING, KING ABDULLAH II APPOINTED FORMER TWAS SECRETARY GENERAL AND VICE-PRESIDENT ADNAN BADRAN PRIME MINISTER OF JORDAN. IN AN EXCLUSIVE INTERVIEW WITH THE EDITOR OF THE *TWAS NEWSLETTER*, PRIME MINISTER BADRAN SPEAKS ABOUT HIS FIRST DAYS AS THE POLITICAL LEADER OF HIS COUNTRY AND HIS AMBITIOUS PLANS TO HELP PLACE JORDAN ON A PATH TOWARDS SUSTAINABLE DEVELOPMENT THAT BENEFITS ALL JORDANIANS.

PRIME MINISTER BADRAN

Adnan Badran (TWAS Fellow 1991) was named Prime Minister of Jordan by King Abdullah II this past April. Badran, who is a plant biologist by training, had been serving as president of Philadelphia University in Amman and was recently elected head of the Arab Academy of Sciences in Beirut. During the late 1980s and early 1990s, Badran held a number of government posts in Jordan, including minister of education and of agriculture, and secretary general of the Higher Council for Science and Technology. On the international stage, he has long been actively involved in high-level discussions devoted to global educational and science and technology policy issues. He was, for example, deputy director-general (1993-1998) and assistant director-general for natural sciences (1990-1996) at the United Nations Educational, Scientific and Cultural Organization (UNESCO), headquartered in Paris. Badran has been an active member of TWAS for more than a decade, serving as TWAS secretary general (1992-1998) and vice-president (1999-2003). This July, just three months after his appointment, Prime Minister Badran spoke by phone from his home in Amman with the editor of the TWAS Newsletter, *describing his experience to date as the leading public official in his country and his hopes for the future of Jordan. Excerpts follow.*



How did your appointment as Prime Minister of Jordan come about?

I received an unexpected phone call one afternoon from King Abdullah II asking if I would be interested in speaking with His Majesty concerning my views on a broad range of reform issues related to education, human resources development and the use of science and technology for the promotion of sustained economic growth in Jordan. As president of Philadelphia University in Amman and a participant in the World Economic Forum held annually in Davos, Switzerland, I had seen King Abdullah on several occasions but it was always in an official capacity and in settings with tens, if not hundreds, of other people, where we would often exchange brief pleasantries but little else. To

say the least, the phone call was a surprise. The next day, the King and I continued our conversation in person at his royal residence where we spoke for an hour and a half, largely focusing on what needed to be done to lay a strong foundation for sustained economic progress in Jordan in the 21st century. A day later, I received a second phone call from His Majesty asking me to form a government.

What is a typical day like? What are the major challenges you routinely face?

My daily schedule is very hectic and the range of challenges and constituencies that I must deal with is much broader, as you can imagine, than the range of challenges and constituencies that I had to address as an administrator of an institution of higher education, where I dealt primarily with faculty and students. Now I am involved in all facets of society, most notably issues related to poverty, unemployment, economic equity, education, human skills development and environmental protection that are of paramount importance to the people of Jordan. And I must often address these complicated issues within a tight timeframe that places a premium on quick decisions usually taken with incomplete information. While my previous experience – largely outside of government – makes me an outsider of sorts, I do think it provides me with some advantages as well. I have spent a good deal of time not only within the university system in Jordan but also in the United States (as a student) and in Europe (as deputy director general of UNESCO). This experience allows me, to some extent, to see things differently and to propose solutions that may be different – and, hopefully, more effective – than solutions proposed in the past by public officials who have spent their entire careers in government. Since King Abdullah II has asked me to lay out and implement a broad-ranging agenda for reform, an outsider's perspective may come in handy – at least I hope so. The future will tell whether my 'not-business-as-usual' approach is an asset or a liability.

Could you give us an example of how your background has an impact on policy?

Take the issue of unemployment. There are an estimated 220,000 unemployed people in Jordan today – people who can work and want to work but who do not have jobs. That's roughly 13.5 percent of the population between the ages of 15 and 64. At the same time, the nation employs more than 500,000 migrant workers – people, largely from other countries in the region, who often have job skills that Jordanian workers do not. Put another way, Jordan has twice as many migrant workers as it does unemployed native citizens. Instead of viewing unemployment largely as a social welfare issue (which it undoubtedly is), during the first months of my tenure as Prime Minister, I have also defined it as a 'skills-gap' problem that can be overcome by additional training. As a result, the government has opened 10 human resource centres since April that are devoted to teaching unemployed workers skills that they can apply in the workplace – for example, improving their ability to communicate; to work in group settings and as part of a team; and to acquire basic knowledge about computers and new information technologies. Perhaps more importantly, the government has decided to cover one-third of the worker's salary for the first six months of employment in private firms and government agencies that create job opportunities for jobless workers. The goal is to give Jordanian workers the skills, training and experience that they need to secure jobs that already exist but are currently held by non-Jordanians. We hope to train some 25,000 to 30,000 workers a year and to cut the number of migrant work-

[CONTINUED PAGE 14]

ers in half over the next five years. We also believe that a smaller labour pool will ultimately help to raise salaries, providing an added equity benefit that would be more difficult to achieve under other economic development scenarios.

What other initiatives do you plan to implement?

Extreme poverty is another critical issue facing Jordan, adversely affecting nearly 7.5 percent of the population who live on US$2 a day. We hope to tackle this problem on several fronts. For example, in the near-term, we plan to launch a micro-credit programme that will make small loans available to individuals, especially women, who would like to pursue and profit from such traditional industries as weaving and pottery. At the same time, we hope to reduce the nation's rate of population growth from 2.6 percent, its current level, to 2.1 percent over the next five years, largely through a vigorous set of educational and healthcare initiatives. We believe that such efforts will help improve the lot of women and that, in turn, will have a tremendous positive impact on the nation's economy and social well-being. We also hope to analyse the comparative advantages – the niche markets, if you will – that Jordan's small- and medium-sized companies may be able to exploit in the international market place and then devise policies, including a programme of government subsidies, that will help these firms to ultimately compete on their own. In addition, we plan to encourage universities to adopt entrepreneurial strategies, including lending a hand in the development of incubators and research parks, that will serve to promote nationwide efforts for research, development and innovation by tapping the country's best brains. Finally, we plan to encourage financiers, including banks, to provide venture capital for the development of science-based products and services that may help boost the nation's exports, especially if these products and services are protected by international patents, which developing countries sorely need to obtain in order to protect their intellectual property. These latter goals, involving universities and banks, are clearly long-term initiatives that will require changing the attitudes of two of Jordan's most powerful and most conservative institutions. But if we can successfully instil a culture of innovation as part of their mindset, both universities and banks can serve critical roles in the nation's efforts to build a successful strategy for sustainable growth.

Where does science and technology fit in your overall strategy for long-term growth?

As a scientist who has devoted his life to the promotion of science and technology in the developing world, I fully appreciate the critical role that science and technology play in sustained economic growth. As Abdus Salam said decades ago, no other factor separates the North from South more than the developed world's mastery of science and technology. If anything, the role of science and technology has grown even more significant in our increasingly knowledge-based, technology-driven global society. That's why my government has decided to invest in higher education – a policy that precedes my appointment as Prime Minister and one that I plan to continue with equal enthusiasm. But I would be remiss if I didn't also note that my government's science and technology policies have been based on the notion that the nation's knowledge workers – and particularly its scientists and technologists – must be encouraged and given ample opportunities to put their knowledge to work to address critical social and economic issues. Knowledge for the sake of knowledge, however appealing, is not enough. The government – and, more importantly, the people of Jordan (and I might add other countries, particularly in the developing world) – expect a return on their investment. And, while I respect the enormous contributions that uni-

versity professors and researchers make to a nation's economic and social well-being, I think it's important to remember that there are other pressing priorities that must be addressed, including educational reforms at the primary and secondary school levels, poverty alleviation, unemployment and a broad range of environmental issues that, in Jordan's case, include access to adequate supplies of safe drinking water. Therefore, I don't foresee an increase in expenditures for higher education in Jordan in the years ahead. Instead, Jordanian universities must make more efficient use of the resources that they now have; they must forge closer partnerships with their colleagues in other universities both in Jordan and in other countries; and they must take greater advantage of external sources of funding, especially from international aid agencies and private foundations seeking to promote joint research initiatives, fellowships and exchange programmes. I believe that a strong and consistent flow of knowledge is the key to progress and that a broad range of institutional channels – both nationally and internationally – are already in place to facilitate this process. Jordanian scientists and technologists, in short, need to take better advantage of what is already available.

How will you measure the success of your initiatives in the months and years ahead?

I am very much impressed by the enormous success of Singapore, a small, once impoverished country that I think could serve as an inspiration and model for Jordan. Largely by nurturing its human resources and building its scientific and technological capacities, Singapore has transformed itself into a modern, wealthy nation in a relatively brief period. The issues that Jordan must address are relatively clear. We need to reduce poverty, increase employment, improve education and close the gap between the nation's wealthiest and poorest citizens. Aggregate statistics of economic progress in Jordan indicate that progress is being made. These same statistics, however, also indicate that the benefits of economic growth have been uneven and that the breach between the nation's 'haves' and 'have-nots' may be widening not shrinking. The good news is that the strategies we must pursue to ensure that all people benefit from economic growth are also relatively clear. For example, we must develop programmes that enable people to acquire the education and skills that they need to successfully participate in a dynamic, knowledge-based economy. We must build the infrastructure, particularly in information technologies, that allows people to develop these skills. And we must ensure that there are adequate job opportunities for our people to apply the knowledge and skills that they acquire. Education is the key to all aspects of this strategy, and science and technology are fundamental elements of the educational curriculum that we must develop. Finally, we must move beyond rhetorical support for these goals and set concrete targets that can help us determine whether we are forging ahead or falling behind: for example, targets for reducing unemployment, for increasing income, and for curbing the percentage of Jordanians living in extreme poverty. If there is one goal above all others that I would like to achieve as Prime Minister, it is to double Jordan's annual personal income from US$2,000 a year, where it stands now, to US$4,000. As a scientist, I fully understand the value of precision and accountability in everything I do, and I plan to apply these same standards to my work as Prime Minister. On the other hand, as a nascent politician, I fully understand the potential impact derived from empowering people, and that is what I hope to do in the months ahead. ■

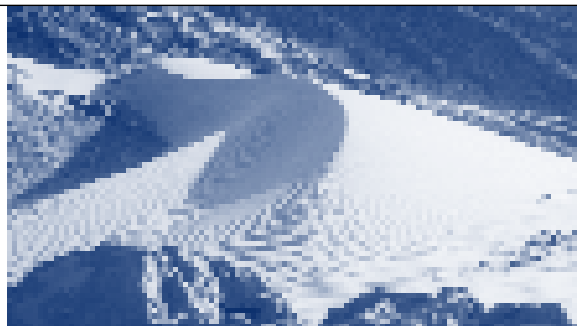
TOWARD ENVIRONMENTAL SUSTAINABILITY IN THE ARAB REGION

THE ARAB REGION, WHICH AT ONE TIME LED THE WORLD IN SCIENCE, NOW FACES A HOST OF DEEP-SEATED ECONOMIC DEVELOPMENT AND ENVIRONMENTAL PROBLEMS. MOHAMED T. EL-ASHRY (TWAS FELLOW 1990), FORMER CHAIRMAN AND CHIEF EXECUTIVE OF THE GLOBAL ENVIRONMENT FACILITY (GEF), DESCRIBES WHAT HAS GONE WRONG AND OUTLINES THE MEASURES THAT NEED TO BE TAKEN TO REVERSE THE REGION'S LONG-STANDING ENVIRONMENTAL DECLINE.

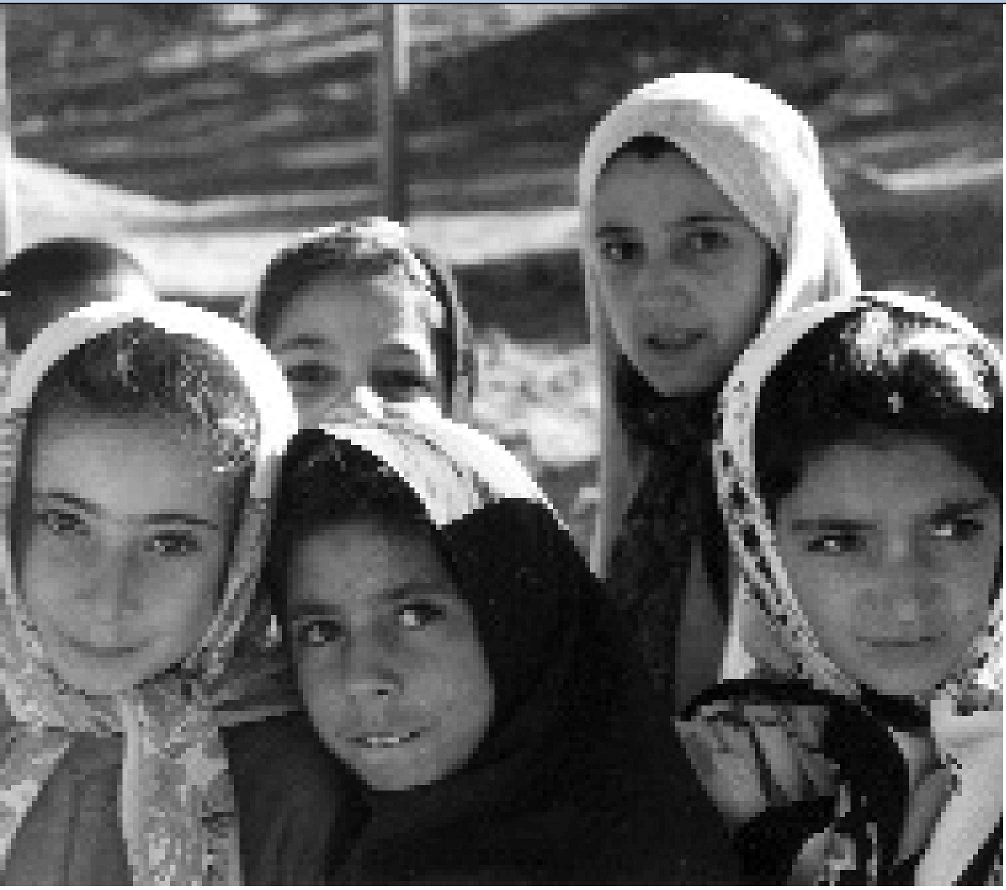
Future generations in the Arab region will continue to face serious environmental challenges unless significant attention is given – and adequate investments are made – to reverse the current state of environmental degradation, particularly for issues related to water scarcity, water and air pollution and public health. Progress on these fronts will be stymied unless dramatic steps are taken to strengthen the region's chronically weak environmental institutions and legal frameworks.

Environmental and natural resource problems in the Arab region have been dictated by the region's geography and its arid and semi-arid climate. Uneven distribution of water resources and arable land has led to a concentration of about 250 million people in the coastal zones and river valleys. This demographic phenomenon, which has spurred a corresponding concentration of industry, agriculture and transport activities, has led to unique and complex environmental management problems. The growing pressure on the region's fragile resource base has been exacerbated by high population growth rates – currently averaging 2.1 percent a year – and the continued migration of people from rural areas to crowded urban centres.

A passing glance at the region's state of development reveals that its economy and infrastructure often exceed the standards of other developing regions. However, this broad profile masks the Arab region's lagging performance in education, job growth, public health and environmental quality.



Indeed differences in employment opportunities and environmental conditions within and between Arab countries are striking. Some countries – for example, along the Persian Gulf – have major oil



and natural gas resources and attract labour from other parts of the region; others – for example, several of those in North Africa – have large and growing populations and/or limited natural resources. As a result, they are labour exporters.

A common challenge faced by countries throughout the region, however, is the need to strengthen institutions, particularly institutions that are responsible for integrating environmental protection and natural resource management issues into the development process. Stronger institutions are imperative if successful transitions to sustainable development are to be achieved.

In one way or another, the major environmental issues facing the region revolve around limited quantities of water for human consumption and acute water quality issues emerging from scarce supplies, inadequate municipal wastewater treatment, high pesticide-laden agricultural run-off, and uncontrolled effluents from industry.

Average per capita water availability in the region is about 1,200 cubic metres per year (the world average, in contrast, is about 7,000). According to the World Bank, annual water resources per capita in Arab countries are expected to fall to 740 cubic metres per year by 2015. Despite growing urban populations, almost 90 percent of the region's water resources are allocated to the agricultural sector, with only 7 percent going toward domestic consumption.

While water availability remains relatively constant, demand is increasing sharply as a result of population growth and the ongoing expansion of irrigation systems. To meet this rising demand, groundwater, the main source of water in many Arab countries, is being extracted beyond its renewal rates. Such unsustainable extraction practices carry serious consequences both now and for the future. In coastal North Africa, for example, excessive pumping of groundwater has resulted in the contamination of many aquifers with sea water.

Degraded water quality reduces the availability of fresh water for both domestic and agricultural use and raises the cost of water treatment and reuse. Less than 15 percent of the total volume of wastewater generated in the region is adequately treated. Other sources of water pollution include agricultural run-off containing high levels of pesticides and fertilizers and industrial discharges laced with heavy metals and other toxic substances.

Despite progress, of the nearly 300 million people who reside in the region, 45 million people still live without access to safe water and 85 million people live without access to proper sanitation.

The region is also suffering from the loss of arable land and increased coastal degradation. Permanent cropland, currently less than 6 percent of the total area, is shrinking largely due to land degradation and development pressures.

[CONTINUED PAGE 18]

The financial impact of land degradation is estimated to stand at US$1.15 billion per year in lost agricultural production alone. In addition, lack of integrated coastal zone management has fuelled competition over land and marine resources. The World Bank estimates that the region is losing about US$1.2 billion a year in tourism revenues due to coastal zone degradation and wastewater discharges into the sea.

Pollution-related health problems, particularly in urban and industrial centres, represent another major environmental challenge. Sources include open municipal waste dumps, the burning of municipal waste, an aging and poorly maintained vehicle fleet, inefficient use of fossil fuels for power generation and manufacturing, and industrial emissions of oxides of sulphur.

The concentration of industry around major urban centres accounts for a large part of the region's urban air pollution. Cairo and Alexandria, for example, account for about 90 percent of Egypt's industrial pollution. Similar percentages apply for major cities in Algeria, Morocco and Tunisia.

Environmental problems in the region are not abstract issues that, as some once argued, only the rich can afford to address. These long-lasting environmental problems have significant impacts both on the economy and human health. National environmental action plans across the region estimate that the annual cost of environmental damage ranges from 4 to nearly 10 percent of gross domestic product (GDP) – for example, in Algeria, it is 9.6 percent; in Morocco 8 percent; in Syria 7 percent; and in Lebanon 6 percent.

These costs are higher than those for eastern Europe, where the average is 5 percent, and substantially higher than the rich countries of the Organization for Economic Cooperation and Development (OECD), where the average is between 2 and 3 percent. Overall, it is estimated that the environmental health burden is responsible for about 15 percent of the total health burden in the region.

Slow progress in improving environmental quality and pursing sustainable development in the Arab region is rooted in policy and institutional failures. These failures, in turn, are related to lack of public knowledge and awareness. In many countries, environmental information is difficult to come by. The public, moreover, often does not have the educational background to fully understand the limited information that is available.

Development strategies can only be sustained when countries integrate environmental issues and actions into their overall economic development plans and policies. Arab countries, for example, need to remove the perverse incentives embedded in subsidies and price interventions, which tend to exacerbate economic and ecological losses, particularly in the region's energy and agricultural sectors. Water subsidies, especially in irrigation, continue to be a major stumbling block for many countries seeking to improve the efficiency of water use. Similarly, energy subsidies stand in the way of more effective energy policies.

The liberalization of investment could provide substantial environmental benefits by promoting competition, specialization and improving access to environmentally benign technologies. This is particularly relevant for the Arab region because so much of the region's industry is publicly owned and powered by out-

Mohamed T. El-Ashry

moded, inefficient and highly polluting technologies. Tunisia's problems with phosphates in water supplies, Algeria's problems with mercury pollution, and Egypt's problems with cement dust are all associated with long-standing and entrenched patterns of state ownership marked by an unwillingness or inability to

maintain and update the nation's industrial base.

Increased competition and investment in environmentally benign technologies could lead to significant reductions in industrial air and water pollution problems throughout the region. In many cases, such policy initiatives must be complemented by measures designed to overcome the existing conflict between economic development and environmental degradation. Taxes and government regulations that are both transparent and enforceable should be directed at specific resource-users in order to force a full accounting of the environmental costs of their behaviour.

Central to achieving environmentally sound and sustainable development is the creation of institutional and technical know-how capable of analysing, selecting, adapting and applying suitable technologies for energy, transport and industrial and agricultural production.

Creating centres of excellence and networks of research and training should also be a high priority. Such institutions should concentrate on developing strong in-country capacities for science and technology. Improvements in natural resource management should also be a priority and steps should be taken to transfer such knowledge to others in the region. As an added bonus, centres and networks of excellence would enable countries to participate more effectively in international discussions and negotiations on the global environment ranging from climate change to the conservation of biodiversity.

Scientific knowledge and technical know-how must serve as the foundation of the region's overall strategies for attaining its sustainable development goals. To ensure that such knowledge is used effectively, scientific assessments of current situations must be taken at both national and regional levels. These assessments, including the benchmarks that they establish, should be used to devise effective sustainable development action plans that emphasize efficient resource and energy use in agriculture, industry and transportation. Over the long term, they should also focus on the development of renewable energy sources, especially the region's limitless supply of solar energy.

Responding to these complex and interconnected challenges will require increased regional cooperation. Cooperation among countries tends to reduce tensions, thereby enabling countries to redirect resources towards development. Indeed some infrastructure and environmental projects, which promise to contribute to economic well-being, can only be implemented in a regional context. These projects could include, for example, regional water and agricultural development schemes and electric power grids.

The beginning of the 21st century is an opportune time to establish an 'Arab agenda on sustainable development' that sets the stage for fostering broad-based economic growth without compromising the region's fragile environment. The success of such an initiative will require a pact that not only nurtures regional cooperation but also pools regional human and financial resources in ways that promote the long-term stability, prosperity and security of the Arab region. ■

Mohamed T. El-Ashry
TWAS Fellow 1990

Senior Fellow, UN Foundation
Former Chief Executive Officer
and Chairman,
Global Environment Facility (GEF)
Washington, DC, USA

email: mohamed@el-ashry.com

STRONG FOUNDATION FOR SCIENCE IN KUWAIT

THE KUWAIT FOUNDATION FOR THE ADVANCEMENT OF SCIENCE (KFAS), NOW NEARING ITS 30TH ANNIVERSARY, OFFERS A UNIQUE, YET POTENTIALLY APPEALING, MODEL THAT OTHER NATIONS IN THE ARAB REGION MIGHT CHOOSE TO EMULATE FOR THE PROMOTION OF SCIENCE AND CULTURE.

The Kuwait Foundation for the Advancement of Science (KFAS), which was launched by His Highness the Amir of the state of Kuwait in the mid-1970s and now operates as a private funding organization, will celebrate its 30th anniversary next year. The foundation is headquartered in Kuwait City.

"While foundations, especially private foundations, are not commonplace in the Arab region," says, Ali A. Al-Shamlan (TWAS Fellow 1987), the foundation's director general, "KFAS has succeeded through an unusual funding scheme that has provided it with the financial resources that it requires to develop a wide range of programmatic activities in Kuwait, the Arab region, and, increasingly, institutions outside the region as well. Nearly 500 private shareholding companies – including banking, investment, real estate, marine, food and construction firms – now donate 1 percent of their net annual profits to KFAS."

Although KFAS has focused its efforts largely on the promotion of scientific excellence in the Arab region, the organization's mandate also includes efforts to promote education and, more generally, public appreciation for the contributions that the Arab region has made to science and culture throughout the world.

"The foundation," continues Al-Shamlan, "has sponsored research in both the natural and social sciences in fields ranging from astrophysics to behavioural sociology. And while it doesn't shy away from projects designed primarily for the purposes of enhancing knowledge, it is particularly keen to invest in science- and technology-based initiatives that address immediate

Ali Al Shamlan

social and economic problems in Kuwait and the surrounding region."

Al-Shamlan notes that KFAS, over the past 30 years, has spent some US$60 million on nearly 550 "problem-solving" projects that have addressed a broad range of issues in science, technology, engineering, medicine and the humanities. Funding levels for such efforts are expected to increase significantly in the years ahead.

For example, KFAS served as the major sponsor for a US$16 million project that supplied both computers and computer training to thousands of students in Kuwait's 170 middle-level schools. Thanks in part KFAS, Kuwait is now well-connected to the internet, and its youthful population – more than 25 percent of the population is under 15 years of age – is internet-savvy. The foundation also provided much of the financial support for "outfitting" the nation's Science Club – nearly US$1 million in all – with a planetarium and an observatory, both of which receive extensive use by people, especially young people, from across the country.

KFAS: THE PUBLISHER

KFAS funds a wide-range of publications and media projects designed to enhance Arab-language communication in scientific and other intellectual arenas. To date it has financed the publication of some 250 books on science and technology as well as the biographies of prominent scientists from the region – all in Arabic. It has also financed the production of audio recordings and documentary films on Arabic science and culture designed to reach a large audience. Since 1986, KFAS has been publishing Majallat Al-Oloom*, the Arabic edition of* Scientific American*. KFAS is also the primary sponsor of the* TWAS Newsletter.

KFAS sponsors research in natural and social sciences in fields ranging from astrophysics to behavioural sociology.

KFAS seeks to achieve its overall goals for capacity building in science and other intellectual pursuits largely through two overarching strategies.

First, it awards an extensive array of grants, prizes and honours to enhance and reward the overall intellectual capabilities of the citizens of Kuwait and other Arab countries (see box, KFAS: The Prizes). Second, it provides funding for fellowships and scientific exchange programmes often closely associated with conferences, symposia and training workshops, all designed to help forge strong international partnerships between Arab scientists and intellectuals and their counterparts in other parts of the world (see box, "KFAS and Research", p. 23).

[CONTINUED PAGE 22]

"KFAS's efforts to work with others outside the region are a significant part of our mandate," says Al-Shamlan. "Through these efforts, we hope to spur a broad range of cultural and scientific initiatives both in Kuwait and throughout the Arab region by tapping the ideas and insights of scientists and scholars from elsewhere while simultaneously introducing others to the research and writings of Arab scientists and scholars."

In 2001, KFAS launched a programme with Harvard University's Kennedy School of Government, in Cambridge, Massachusetts, USA, designed to expand research and teaching activities on critical issues facing Kuwait and the Persian Gulf wider region.

Specifically, the Kuwait Program at Harvard, which operates on an annual budget of about US$800,000, provides both post-doctoral research and teaching opportunities at Harvard for scientists and scholars and executive training for mid- and high-level administrators not only from Kuwait but from other Persian Gulf countries such as Bahrain, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE), which are members of the programme's cooperation council. At a more general level, the initiative, in the words of H.E. Sheikh Mohammed Al-Sabah Al-Salem Al-Sabah, Kuwait's Minister of Foreign Affairs, "is helping to build a bridge of understanding between the Arab region and the United States."

Just this past May, KFAS and the Massachusetts Institute of Technology (MIT), also in Cambridge, Massachusetts, announced the creation of the Kuwait-MIT Center for Natural Resources and the Environment, which will focus its attention on research and policy issues related to petroleum, water and, more broadly,

KFAS: THE PRIZES

KFAS sponsors the Kuwait Prize, an annual award that recognizes outstanding achievement in science by individuals of Arab extraction. The prize, with an annual allocation of US$1 million divided among 10 winners, is the oldest and most prestigious prize in the region. Other prizes sponsored by KFAS include the Scientific Achievements Prize, Best Research Paper Prize, Arab Book Fair Prize, Islamic Organization of Medical Sciences Prize, and the Arabian Gulf and Arab Peninsula Research Prize. The annual combined value of these prizes is US$2 million.

the environment. The Center, for example, will examine ways to access groundwater resources using technologically innovative and environmentally sustainable methods, and analyse techniques for gauging the risks that earthquakes pose when extracting large amounts of water and oil from underground sources. KFAS has agreed to contribute US$11 million to the centre over the next decade.

But KFAS's signature achievement doesn't lie thousands of kilometres from its headquarters. In fact, it resides next door to the foundation's headquarters.

It is the 20,000 square metre Kuwait Scientific Centre (see *www.tsck.org.kw*), which opened in the spring 2000 and has since welcomed more than 2.5 million visitors. The centre features simulated habitats, including a world-class aquarium with 60 marine species; interactive exhibits, displayed in the 'Discovery Place', highlighted by an 'image-altering' science funhouse for kids and computerized programmes for older children and adults that illustrate and explain the violent behaviour of the earthquake-prone tectonic plates; and a series of educational films, showcased in an IMAX giant screen theatre that is the first of its kind in the Middle East.

All of these state-of-the-art educational materials are intended to create a unique and memorable experience for its visitors. And while the exhibits focus largely on science and technology, space is also devoted to Kuwait's unique maritime-desert cultural environment that predates the discovery of petroleum and that, in many ways, continues to define the region's desert culture.

In addition, KFAS will also soon celebrate the inauguration of the Centre for the Research and Treatment of Diabetes (CRTD), which will be funded by KFAS and jointly administered by medical research centres and hospitals in Kuwait.

The full range of activities that KFAS sponsors has enabled the foundation to touch the lives of virtually every citizen in Kuwait.

As Al-Shamlan notes: "The full range of activities that KFAS sponsors – from the grants for university-based scientific and scholarly research to the lively educational environment nurtured in the Scientific Centre – has enabled the foundation to touch the lives of virtually every citizen in Kuwait and, more recently, to play a central role in Kuwait's growing desire to participate in the international science arena. It's a full agenda that we think is making a difference for both science and society in our country." ■

For additional information about the Kuwait Foundation for the Advancement of Science, see ⋯⁘ *www.kfas.com.*

KFAS AND RESEARCH

KFAS's research directorate promotes the development of scientific, cultural and technical skills within Kuwait's scientific and cultural communities, largely by funding exchange programmes. The focus has been on preserving the nation's heritage, fostering in-country and international cooperation and exchange, and sponsoring the development of scientific databases.

TIME TO SHARE

A RECENT WORKSHOP, ORGANIZED BY TWNSO AND SPONSORED BY UNDP-SSC, DISCUSSED VARIOUS MECHANISMS BY WHICH KNOWLEDGE AND INFORMATION CAN BE SHARED TO PROMOTE LOCAL DEVELOPMENT IN THE SOUTH.

Imagine a library – a great repository of knowledge – that remains locked and inaccessible. It would fail in its mission of providing information. In other words, information has little value unless it is shared and disseminated. Even small bits of information that are shared can help build a greater understanding of a problem and lead to practical solutions. At a workshop held in Trieste, Italy, on 4-6 July 2005, organized by the Third World Network of Scientific Organizations (TWNSO) and TWAS, and sponsored by the United Nations Development Programme's Special Unit for South-South Cooperation (UNDP-SSC), representatives from 15 developing countries met to exchange ideas and analyse best practices on knowledge sharing for local development in the South.

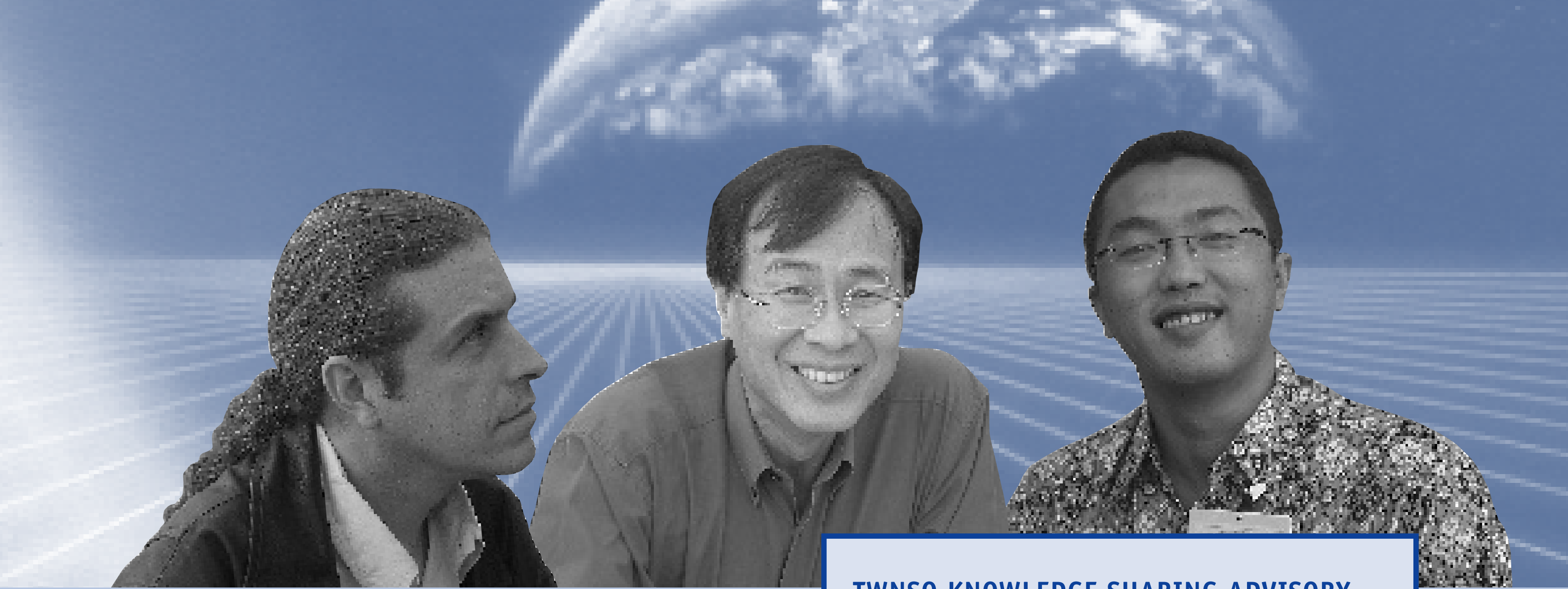
Today, information is being generated faster than ever before. Many people in the developing world, however, lack access to both libraries, our traditional repositories of information, and the internet, an ever-expanding and increasingly useful source of information.

Moreover, the libraries that do exist lack documentation of traditional knowledge that has been passed orally from parent to child for generations. Many societies in the South are particularly rich in traditional knowledge, whether it relates to the utilization of medicinal plants, how to harvest and store water, or how best to grow local crop varieties.

Sharing knowledge, whether the results of the latest scientific experiments or traditional health remedies, is essential. As Francisco Simplicio, Information Management Specialist at the UNDP-SSC, pointed out at the workshop, "Without knowledge sharing, there is no development."

Yet, as several of the case studies presented during the conference highlighted, knowledge sharing is not an automatic part of many projects but a component that must be worked at to gain maximum benefits.

Workshop participant Federico Dajas of Uruguay, representing the Latin American Network for Research on Bioactive Natural Compounds (LANBIO), offered one example of the challenge. Despite the wealth of species in Latin America, and the use that has been made of this biodiversity by native peoples, there is no institution in the region that can screen plants for potential medicinal properties, analyse the constituent compounds of potentially useful species, undertake relevant pharmacological tests and develop lead compounds into commercially viable products. By pooling their knowledge and resources, LANBIO scientists, working in 11 research institutions and university departments in



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six Latin American countries, have patented several products derived from natural sources.

"Initially, even the patenting process required a knowledge sharing exercise, which took place with colleagues from the University of Strathclyde in Scotland, since there was no facility – or funding – available in Latin America to help the scientists through the legal requirements," said Dajas. Even though LANBIO scientists have registered several patents, they have not all been commercial successes and, apart from scientific publications resulting from the collaborations, few practical benefits have so far arisen from the project.

In contrast, Kong Heong of the International Rice Research Institute (IRRI) in the Philippines described a knowledge sharing project that has helped more than two million people.

Typically, rice growers in Vietnam's Mekong Delta applied between three and four insecticide sprays each year to control such pests as the rice leaf folder. Research has shown, however, that the damage to leaves caused by these caterpillars during the early part of the growing season does not affect the final yield of the rice plants. Scientists, therefore, conveyed a simple message to farmers: "During the first 40 days after sowing spraying is not needed". The message was disseminated via leaflets, posters, newspapers and radio.

Together with some 500,000 on-farm demonstration trials conducted during the five-year project, which proved reduced insecticide use had no effect on yield, this simple information has persuaded farmers to limit insecticide sprays to less than two each year. Indeed, the number of farmers applying no insecticides at all has risen from just 1 percent to 32 percent. Applying fewer sprays has not only reduced environmental and health problems, but have boosted farmers' profits.

A second message, "Three reductions, three gains", urging farmers to use less fertilizer, lower seed rates and fewer insecticide sprays, has proven equally successful, further reducing input costs without affecting crop yields. Now, through a specially designed knowledge sharing initiative, some 2.3 million rice growers across the Mekong Delta are, literally, reaping the benefits of information that may otherwise have stayed 'locked away' in scientific journals.

Other case studies at the workshop focused on networks that, for example, allow collectors of medicinal herbs in Nepal to access current market information

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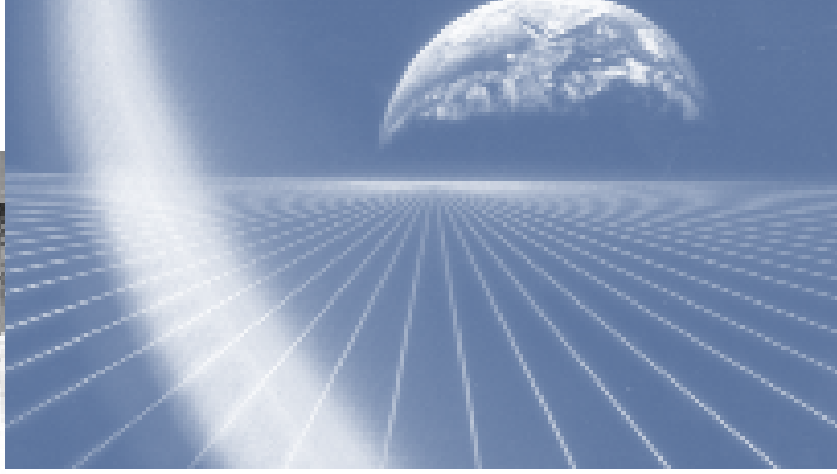


SHARING INNOVATIVE EXPERIENCES

The case studies presented during the TWNSO/TWAS/UNDP-SSC workshop will be edited into non-technical versions that will be published as volume 13 of the UNDP-SSC's Sharing Innovative Experiences *series, a project that has been undertaken in close collaboration with both TWAS and TWNSO. As with other books published in the series, this volume will be distributed free of charge. It will also be distributed during the World Summit on the Information Society (WSIS), to be held in Tunis, Tunisia, from 16-18 November 2005. For additional information on the* Sharing Innovative Experiences *publications, see* tcdc.undp.org/widenew/sharingsearch.asp.

and thus gain better prices for their products; connect head teachers in 10 east African countries so that they can share ideas and information on teacher training programmes and career development; use a combination of traditional and modern technologies to disseminate news and information to villagers in India (see following article, page 27); and teach video technology and film-making techniques to young villagers in Indonesia so that they can record local traditional knowledge and share it with others in the region.

Despite the diversity of the case studies presented, several commonalities that would help projects to achieve their knowledge sharing goals were identified.

As Mohammed Taeb of the United Nations University Institute for Advanced Studies, Japan, pointed out, "In each instance, the starting point to finding a positive outcome was to first clearly identify the problem. Only then," continued Taeb, "can a solution be developed, possibly by first nurturing human capacity and then providing a platform for dialogue and teamwork."

This platform – often referred to as a 'network' in many of the case studies – can take many forms, including networks of scientists and farmers, that enable them to speak to and learn from one another. Whatever the platform, however, there is still a need to share knowledge – a need for a 'multiplier effect'. "The IRRI case study, in which two million rice farmers 'participated', was successful because the programme received government support to achieve this multiplier effect," explained Francisco Simplicio.

Likewise, a network of scientists in Argentina and Brazil that has been active since 1987, *Centro Argentino Brasileño de Biotecnología* (CABBIO), has attained success thanks, in part, to long-term support from the two nations' governments. "Through CABBIO, we have developed several products, including virus-free garlic, a vaccine for foot and mouth disease and a technique for producing transgenic cattle," said Faustino Siñeriz of Argentina.

Discussions also centred on how developing countries may not be able to compete successfully in the production of information disseminating technology, such as communications software and high-speed internet connections – at least in the short- to medium-term. Yet, given the wealth of traditional knowledge and biodiversity present in the South, they could take the lead as 'content providers'.

As Winston Churchill once said: "If you have knowledge, let others light their candles with it." The South is knowledge-rich, and through this workshop and its follow-up activities (see box on this page), hopefully this knowledge – when shared – can be used to spur development in many sectors.

INFORMATION FOR ALL: INDIA'S OPEN KNOWLEDGE NETWORK

Little more than three years ago, a pilot knowledge sharing project was rolled out in three villages near Pondicherry in southern India. The aim was to create and gather information that could be shared with other villagers in their own local language. The project has since been expanded across India into Nepal, Sri Lanka and Africa, allowing villagers to share local and indigenous knowledge with others, no matter where they may be located.

What about the poor who have little or no access to computers or the worldwide web?

"The internet has changed the world," claims Subbiah Arunachalam of the M.S. Swaminathan Research Foundation (MSSRF), based in Chennai, India.

Arunachalam, an information scientist, and his colleagues at MSSRF have been collaborating with United Kingdom-based OneWorld International, an organization dedicated to promoting human rights awareness and fighting poverty worldwide, in implementing the 'Open Knowledge Network' programme.

"Most of us," says Arunachalam, "use the internet to find information. But what about the poor, especially those living in rural areas, who have little or no access to computers or the worldwide web?"

In many cases, even if such people do have the opportunity to browse online, there is often very little material in their own language that is relevant to their lives. "In that case, why should they bother?" asks Arunachalam.

That is precisely the situation in much of the South. And that is what the pilot Open Knowledge Network project, which has now been expanded into a fully-fledged programme, is all about.

"We are focusing on helping local people input their own local content in their own local language for very little cost," explains OneWorld's Peter Armstrong, who was instrumental in getting the idea of the Open Knowledge Network off the ground. "What people need is space to communicate, to express their ideas and raise their voices," he continues.

"What we do through the Open Knowledge Network is to help peo-

[CONTINUED PAGE 28]

ple acquire the skills to develop the content they want," adds Arunachalam.

HUMAN NETWORK

The Open Knowledge Network is a human network that turns to flexible technical solutions to collect and disseminate local knowledge. However, it is not particularly new. "We are building on what is already happening in many different fields and connecting the dots," says OneWorld's Armstrong.

It works like this.

First, local people create digital content in their own language at a 'community access point', often a small building provided by local panchayat, or village council, and staffed by 'community reporters'.

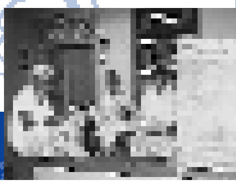
Such content may range from information about government schemes, to market prices for local goods and services, traditional remedies based on locally-available medicinal plants, or local farming and fishing practices – the kind of information that helps people live their everyday lives.

"Community reporters play a very important role in the Open Knowledge Network, serving as 'infomediaries', linking the community with the network and vice versa," explains Arunachalam.

Community reporters play a very important role in the Open Knowledge Network, serving as 'infomediaries'.

Since October 2002, when the project was officially launched, these access points have been able to channel their content to a 'hub' institution such as MSSRF from where this local knowledge can be disseminated to other villages connected to the hub. As most of the access points do not have full-time internet connections, this transfer of information takes place with the help of a range of technologies.

"The system we used in the pilot experiment involved sending or receiving short bursts of email messages or making brief internet connections to upload data to a WorldSpace satellite – information that



could be downloaded in different villages using satellite radio and then accessed offline," explains Arunachalam. "There is no need for continuous internet connectivity, which would cost more."

"The Open Knowledge Network," continues Armstrong, "is designed to be compatible with all kinds of information and communication technologies, both high- and low-tech."

Among the high-tech solutions are such shared software standards as metadata tags that 'envelope' packages of information. While the information may be written in a local language, metadata tags are written in English so that all the computers in the system understand how to 'open' the data envelope. Using such standardized software, any information can be effectively communicated around the world so that, for example, new ideas on pest control uploaded in Vietnam can be shared with people in Kenya or Colombia via a translation service using an intermediary language such as English or Spanish.

In contrast, low-tech solutions can involve simply posting print-outs of news and information on the walls of the community access point for people to read. Newsletters are also produced and inserted into a local community newspaper. People can also call the access points from the expanding network of roadside phone shops in India, which now total more than a million.

M.S. SWAMINATHAN RESEARCH FOUNDATION

Created by M.S. Swaminathan (TWAS Founding Fellow), in Chennai, India, the M. S. Swaminathan Research Foundation (MSSRF) was registered in 1988 as a non-profit trust. Its mandate is to help devise job-led economic growth strategies in rural areas by harnessing science and technology for environmentally sustainable and socially equitable development.

In addition to its broad initiatives in education, communication, training and capacity building, MSSRF carries out research in biodiversity and biotechnology, coastal systems, eco-technology and sustainable agriculture. For additional information, see www.mssrf.org.

"Using a wide range of community dissemination tools, which include radio programmes, puppetry and simple drawings, helps to increase the reach and impact of the Open Knowledge Network," notes Arunachalam.

GOING GLOBAL

Long before the inauguration of the Open Knowledge Network pilot project in March 2002, the MSSRF was already running a local-level knowledge sharing initiative, the Information Village Research Project, funded by Canada's International Development Research Centre (IDRC), in Pondicherry, a former French colony some 160 kilometres south of the MSSRF Chennai headquarters on India's eastern coast. This previous experience proved instrumental in OneWorld's decision to select

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OPEN KNOWLEDGE NETWORK

The Open Knowledge Network is a human network supported by flexible technical solutions that collects, shares and disseminates local knowledge. The coordinating organization behind the Open Knowledge Network is OneWorld International, but the Open Knowledge Network is made up of many partners, including the M.S. Swaminathan Research Foundation (MSSRF) and The Energy Resources Institute (TERI) in India, and Afribone and SchoolNet Uganda in Africa.

The network was instigated by the Digital Opportunity Task Force (DOTForce) set up by the G8 heads of state to help bridge the digital divide by encouraging "national and international efforts to support local content and applications creation". Members of the network's steering group include the Berkman Centre of Harvard Law School, the International Institute for Communication and Development (IICD), the International Development Research Centre (IDRC), MSSRF and OneWorld International.

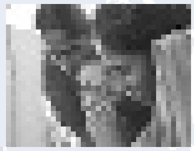
Funding for the Open Knowledge Network is obtained primarily from the UK's Department for International Development (DfID) and Industry Canada. The network's mobile channel is funded by the Vodafone Group Foundation while Sun Microsystems sponsors the network's servers. For additional information, visit www.openknowledge.net

MSSRF as its major partner for the Open Knowledge Network project.

Now, just three years later, the MSSRF acts as the south Indian hub for the Open Knowledge Network, connecting to a smaller hub in Pondicherry. From there, information is sent to – and received from – through a network of 'village knowledge centre' access points in some 12 villages within a 25-kilometre radius. Indeed, community reporters in Pondicherry, assisted by Ramasamy Thiagarajan of the MSSRF, are now producing 15-minute radio broadcasts. The programmes are transmitted in the Tamil language by the government-run All India Radio station based in Pondicherry, enabling the information to reach some 100,000 people.

Thanks to the participation of OneWorld South Asia, the knowledge sharing initiative has also taken root in northern India, where it was formally launched in November 2004. The Open Knowledge Network is now operating in both the rural and urban areas of Bikaner, Bundelkhand, Madhubani, New Delhi and Sirsa with the collaboration of civil society partners such as the Datamation Foundation, the Energy and Resources Institute (TERI) and TARAhaat.

"One year ago, we initiated Mission 2007," says Arunachalam. "The aim is to take the knowledge revolution to every one of India's 638,000 villages. To do this, we have created an alliance of some 150 organizations from government, private corporations, civil society and academia." The Mission 2007 National Alliance is chaired by M.S. Swaminathan (TWAS Founding Fellow), who also conceived the idea.



"Network activities have also been extended to Sri Lanka, where the Information and Communication Technology Initiative is our partner. Here we are disseminating information in the local Sinhala language," says Arunachalam. "Likewise, Open Knowledge Network centres are now operating in several African countries – Kenya, Mali, Senegal, Tanzania, Uganda and Zimbabwe."

"The Open Knowledge Network is also tapping mobile phones in Africa as a new two-way channel to encourage communities to create and share vital, up-to-date messages cheaply and quickly," adds Arunachalam. "Use of mobile phones is booming in Africa, providing increased flexibility in reaching audiences in specific geographic areas."

Use of mobile phones is booming in Africa, providing increased flexibility in reaching audiences in specific geographic areas.

A LIFELINE

In the MSSRF's Information Village Research Project, which works closely with the Open Knowledge Network, a combination of high- and low-tech communication tools have helped save lives. Before 1999, fishermen on the Pondicherry coast regularly faced the potentially deadly risk of getting caught at sea during storms. For the past few years, the MSSRF hub at Villianur, 13 kilometres west of Pondicherry, has been accessing wave-height information from a US Navy satellite. Wave-height information is broadcast 36 hours in advance throughout the coastal villages using a series of loudspeakers. Now, when rough weather is forecast, fishermen avoid going to sea that day.

"The results speak for themselves," says Arunachalam. "Since 1999, when this service began, no fisherman has lost his life at sea."

On a more local scale, information shared through the Open Knowledge Network has helped many other people. Kattavaryan Varadhan of Embalam, for example, who advertised the sale of bricks for construction work through the net-

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work, has enjoyed increased sales since. Dharanaj Anjalatchi, also of Embalam, was approached by a self-help group from Pondicherry for training on how to weave sweaters. She received payment for her services, and the self-help group is now producing its own sweaters for sale.

Likewise, Krishnamurthi Bhanumathi has used herbal remedies published in a twice-monthly newsletter to treat a variety of ailments among her family members. She also read about opportunities for women to obtain loans to help them start their own businesses. She subsequently received a loan from a bank in Karikkalambakkam to purchase a cow. "Now I earn an income that enables me to meet the monthly loan repayments," she says.

These are just a few of the many examples of how the Open Knowledge Network helps people find work, locate buyers for their products or services, or discover traditional remedies for various ailments.

"In much the same way that the internet is a network for the relatively well-to-do, the Open Knowledge Network can become a worldwide network for the poor," claims Arunachalam.

The Open Knowledge Network can become a worldwide network for the poor.

PLANNING AHEAD

A major issue associated with the Open Knowledge Network is financial sustainability. To date, its creation and maintenance have been heavily subsidized through funds received by the MSSRF from OneWorld, which, in turn, is supported by the UK government's Department for International Development (DFID).

In the long-term, however, local communities themselves must figure out how to set up and manage network centres without the assistance of the MSSRF.

In response, telecentre entrepreneurs are starting to build their enterprises by buying customized

ONEWORLD INTERNATIONAL

OneWorld International is a nongovernmental organization that aims to widen the participation of the world's poorest and most marginalized peoples in global issues. Its network spans five continents and provides relevant content on its different web sites in 11 languages. In addition, it operates several thematic internet-based channels dedicated to such issues as education, HIV/AIDS and how information and communication technologies can be used to curb poverty and encourage sustainable development. Many of these web sites are managed in the South. For additional information, visit www.oneworld.net.

content feeds to increase sales, and there are many examples of people finding the ideas, contacts and training they need to increase their income opportunities. TERI, for example, is using the Open Knowledge Network to increase awareness in rural communities of its low-cost energy technologies and is networking with grassroots NGOs and local entrepreneurs to deliver its products and services.

Describing such success stories is a powerful way of encouraging an entrepreneurial spirit that fosters wealth creation. Once people realize they can earn money, they are more likely to pay a subscription to keep the system running.

Indeed, a business model commissioned by OneWorld shows that, with initial seed funding, the Open Knowledge Network could become self-sustaining in some 20 countries. "The cost of priming the pump for this proposal is some US$25 million over six years," says an Open Knowledge Network report. "But the business model indicates that, as the private sector scales up the network, sustainability can be achieved by the fifth year."

While funding is sought for these ambitious goals, the MSSRF continues to strengthen the Open Knowledge Network by using its website more effectively, publicizing its activities in local media, and establishing on-line discussion groups. There are also plans to link up with a local cable television network and, expanding on the model being developed in Africa, to explore the possibilities of distributing information via SMS messages to cell phones in India.

"Poor people must be able to express and communicate locally relevant knowledge in local languages if they are to shape the decisions that affect their livelihoods. Local content development is closely tied to human development, and the ultimate aim of the Open Knowledge Network is to empower local communities," concludes Arunachalam. ■

For additional information, contact
Subbiah Arunachalam
email: arun@mssrf.res.in

WOMEN IN SCIENCE

THE THIRD GENERAL ASSEMBLY AND INTERNATIONAL CONFERENCE OF THE THIRD WORLD ORGANIZATION FOR WOMEN IN SCIENCE (TWOWS) WILL BE HELD ON 21-25 NOVEMBER IN BANGALORE, INDIA. MORE THAN 200 EMINENT WOMEN SCIENTISTS FROM 60 COUNTRIES ARE EXPECTED TO ATTEND.

The theme of the conference, 'Women's Impact on Science and Technology in the New Millennium', not only conveys the major focus of TWOWS since its inception, but also projects the organization's hopes for the future.

Gender equity is not only good for women scientists but good for science. This is especially true today as nations worldwide place growing pressure on their scientific communities to pursue research agendas that have a direct bearing on critical social and economic needs.

The wider society is increasingly calling on scientists to be less insular than in the past and to focus their research, at least in part, on the needs of society. Women scientists, whose strengths have always resided in the agricultural, biological, medicinal and environmental sciences, have played and will continue to play a central role in addressing this challenge. What is good for women scientists has increasingly benefited science and, more generally, society too.

I was fortunate enough to be present at the series of meetings in the late 1980s that led to the creation of TWOWS, and I have been even more fortunate to have served as the president of the organization for the past 16 years.

Now, as I step down from this post, handing the mantle to my successor who will be elected by the TWOWS members at the organization's Third General Assembly in Bangalore, I believe that this is an opportune time to reflect on TWOWS's past and to present my views on the future.

My observations, I believe, apply not only to TWOWS, whose membership now exceeds 2,500, but to the role that women are playing in global science. By most measures, that role remains modest. Nevertheless, it is more prominent now than we had reason to hope when TWOWS was created.

TWOWS owes its existence to TWAS, the Academy of Sciences for the Developing World, which under the leadership of Nobel Laureate Abdus Salam (Physics 1979), first proposed the creation of an organization

dedicated to the promotion of women scientists in the developing world. The recommendation was made at the Academy's Second General Conference held in Beijing, China, in 1987.

The need was obvious to anyone who cared to look: women scientists were woefully underrepresented in the scientific community in the South – a community that, as a whole, was woefully underrepresented in the global science arena.

Gender equity is not only good for women scientists, but good for science and society.

As Salam often observed, the developing world was (and remains) home to 80 percent of the world's population but only 20 to 30 percent of the world's scientists. Of that 20 to 30 percent, less than 5 percent (indeed, most likely, less than 2 percent – reliable numbers have always been hard to come by) are women. TWAS, with only eight women scientists among its 188 members in 1989, reflected this state of affairs. Even today, only 39 of TWAS's 764 members are women.

When examining the overall status of developing-world science in a global context, women have been a distinct, often ignored, minority. Moreover, they have found themselves labouring in obscurity among a distinct, often isolated, group of men, who also have believed that they too were a powerless minority in the larger community in which they worked. Raising the profile of women in such a difficult situation has been no easy task.

Following the initial recommendation made in Beijing, TWAS, with financial support largely from the Canadian International Development Agency (CIDA),

BARRIERS TO SUCCESS

During the first months of its existence in late spring 1989, TWOWS identified the primary barriers standing in the way of young women wanting to pursue careers in science. While some of these barriers have become less formidable, virtually all of them have remained in place in some form over the past 15 years. The most compelling barriers include:

- *Lack of role models for young women interested in science.*
- *Gender stereotyping by the larger society.*
- *Fears that girls and young women may not be able to understand mathematics and science.*
- *Pressure for women to marry early and assume prime responsibility for raising children.*

Women scientists in the North face the same barriers as their colleagues in the South. The difficulties for women scientists in the South, however, are compounded by the developing world's chronic lack of funding, scarce employment opportunities, and absence of social security systems that provide health insurance, maternity leave and other family benefits.

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The meek may inherit the world, but it's the powerful who own it now.

organized a conference on 'The Role of Women in the Development of Science and Technology in the Third World', which was held in Trieste, Italy, from 4-6 October 1988. The meeting, attended by 250 female scientists from 65 countries, led to the formation of a study group that soon became an interim executive committee. Its mandate was to explore the possibility of establishing an organization for women in science in the Third World.

A little more than six months later, on 20-22 March 1989, the executive committee met to discuss the pros and cons of creating such an organization. The debate centred on issues that face all minorities seeking to improve their lot within society: How to effectively confront the powerful forces that largely determine a nation's priorities? How to gain a stronger voice in policy discussions? How to bring issues concerning access, participation and influence, which members of a minority find critical but others may find inconsequential, to the forefront of the policy agenda?

Indeed, while the issue at hand was the status of women scientists in the developing world, the discussions echoed the fundamental challenge that all minorities – whether based on gender, race, culture, or other factors – have faced for time immemorial. When it comes to discrimination, minorities have always lived in a world of harsh universal truth. The meek may inherit the world but it's the powerful who own it now.

Here are some of the key questions the members of interim executive board confronted. Would an independent women's organization have the resources, power and influence to make a difference? Would it be better, instead, to strengthen the presence of women within existing scientific organizations such as TWAS or the International Council for Science (ICSU)? Would an independent organization dedicated to the needs of women scientists ironically wind up stigmatizing women scientists, who after all worked in fields where excellence, based on 'blind', non-prejudicial reviews of per-

TWOWS AND CAPACITY BUILDING

The centrepiece of the TWOWS capacity building efforts is the organization's young women scientists' fellowship programme, which is funded by the Swedish International Development Agency's Department for Research Cooperation (Sida-SAREC). The programme enables talented young female researchers from the world's least developed countries, who have earned a bachelor's or master's degree, to enrol for postgraduate training at an academic institution within their own country for more advanced training. While they are required to earn their degree from the institution in which they enrol, they are given the opportunity to spend a large portion of their time – usually one to two years of study – at a centre of excellence elsewhere in the South. Funds from Sida-SAREC cover travel costs and living expenses abroad while the host institution provides training and laboratory supplies. Since its inception in 1998, more than 200 women from 39 least developed countries have been selected for the programme. To date, 36 women have received degrees. The initiative is one of the most successful postgraduate programmes for women scientists in the South. For additional information, see www.twows.org.

WOMEN AND THE MILLENNIUM DEVELOPMENT GOALS

Women scientists must play an essential role in efforts to attain the United Nations Millennium Development Goals. Modern scientific know-how, combined with traditional knowledge, can greatly contribute to the alleviation of poverty and disease. The unique contributions of women, and particularly women scientists in the UN's global campaign against extreme poverty, ignorance and poor health, was a primary point of discussion at the World Summit on Sustainable Development (WSSD), held in Johannesburg, South Africa, in 2002, where TWOWS held a prominent position.

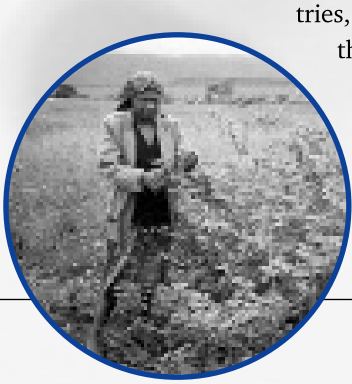
formance, was considered the sole criteria for recognition and reward? In principle at least, the concept of peer-review did not pertain to men only.

After deliberating over these issues, the members of the interim executive committee decided to recommend the creation of a separate organization, and they did so largely for one compelling reason: past efforts to gain influence and prominence within existing organizations had proven ineffective as evidenced by the miniscule number of women in science, a number that became infinitesimally small when examining gender percentages in leadership positions in science.

TWOWS seeks to move ahead, metaphorically speaking, by joining hands.

But there were other reasons for the creation of a separate organization as well. Historically, women have contributed immeasurably to the economic and social well-being of their families and communities. Now, with science and technology emerging as fundamental tools in the development process, members of the interim executive committee concluded that women could no longer remain unknowledgeable and unskilled in these areas if they hoped to continue to make a difference in the overall development process.

Members of the interim executive committee also concluded that what was good for women would also be good for their societies. That is, if a sustainable development process was to take hold in developing countries, women would have to be at the forefront of the effort – and with well-honed scientific and technological knowledge and skills, their contributions would exert that much more impact.



In March 1989, the statutes for the Third World Organization for Women in Science (TWOWS) were officially enacted, laying the legal groundwork for a non-profit, non-governmental international institution consisting largely of women scientists from developing countries. Men and women scientists from the North, however, were also invited to join; indeed, even institutions could become members. While the membership was designed to be inclusive

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and open to all those who shared TWOWS's vision, the organization's goals were sharply focused: "to unite women scientists in the South, with the objective of strengthening their role in the development process and promoting their representation in scientific leadership."

Specifically, the organization has sought to:

- Examine the status of women in science in the South and analyse the reasons for discrimination.
- Explore ways to promote women scientists for positions of scientific leadership in the developing world.
- Develop strategies for involving young women scientists in science and technology research initiatives in the South.
- Highlight the significant achievements of women scientists from the developing world.

As science becomes more global, will it also become more feminine?

Scientists – and especially physicists – like to say that today's eminent scientists stand on the shoulders of the great scientists of the past. The metaphor, while largely accurate (scientific progress, after all, is propelled by great discoveries often made possible by the insights of individuals of great intellect), it nevertheless conveys a distinctly masculine image – characterized by its sense of brawny individualism and austere single-minded adventure.

I would prefer to describe TWOWS's strategy for scientific progress by turning to a different metaphor.

ONE WOMEN'S JOURNEY

Lydia P. Makhubu was born in Usuthu Mission, Swaziland, and received her primary and secondary school education in Swaziland. In 1963, she earned a bachelor of science degree in chemistry and mathematics from Pius XII College (since divided into three separate universities – Botswana, Lesotho and Swaziland). She then travelled to Canada where she received additional degrees from the University of Alberta, including a master's of science in organic chemistry in 1967 and a doctorate in medicinal chemistry in 1973. Soon after, Makhubu joined the University of Swaziland, where she has remained ever since, serving as a professor of chemistry for the past three decades and as vice chancellor from 1988 to 2001. Makhubu has authored two books and more than 20 scientific articles on Africa's medicinal plants. She is particularly interested in exploring ways of melding traditional knowledge to modern science both in her scholarship and in her efforts to promote sustainable economic development. Makhubu has served on numerous committees in international organizations, including the UN Advisory Committee on Science and Technology for Development, the UN University's Special Committee on Africa, and the World Health Organization's Research Council. As she steps down from the presidency of TWOWS, she can be secure in knowing that she is internationally recognized as one the world's foremost proponents for elevating the status of women scientists in global science and especially in the developing world.

Instead of prominent scientists standing on each others' shoulders with the rest of the community (including women) looking on, TWOWS seeks to move ahead, metaphorically speaking, by joining hands. It is true that women scientists have their own pantheon of Nobel stars (see box on this page). Yet it is also true that the majority of the Nobel prizes won by women scientists have been in the life sciences. Equally important, many studies have shown that, in comparison to men, women work better in groups, are more likely to share information willingly, and are less likely to take complete credit for the work that is done.

As Ronald Léger, director of CIDA's International Non-governmental Division during the 1980s and a key advocate for the creation of TWOWS, said during TWOWS's inaugural meeting in 1988, "Women tend to view the world in a more holistic way and more spontaneously see and feel interdependence. Women also have the capacity to create bridges more easily than empires, hierarchies and walls."

Such sensibilities, which have defined how women have worked in the past, bode well for the contributions that women can make in future scientific research projects where the focus will increasingly rest on such issues as the environment, food production, health (including the prevention and treatment of AIDS) and resource management, and where the administrative structure of such projects will increasingly tilt towards groups of scientists working together on issues that require skills in a variety of disciplines and where teamwork and cooperation will largely determine the progress that is made.

Will these trends favour a leadership role for women in science, not only in the South but in the North as well? As science becomes more global, will it also become more feminine?

The answers to these questions may be yes, but only if women scientists themselves continue to take the lead in breaking down the barriers that have held them back in the past.

That's what TWOWS has been all about since its inception and that's what I anticipate its major focus will be in the years ahead: dismantling obstacles to success for 50 percent of the world's population so that we can all enjoy better and more secure lives. ■

NOBEL WOMEN

The Nobel Foundation was established in 1901. Two years later, Marie Curie became the first woman to receive a Nobel Prize. Since then, of the 312 individuals who have been awarded the Nobel Prize in science, only 12 have been women. The eminent women who have won science's most prestigious prize are among the elite in their professions and they deserve all the accolades that they have received. But their small numbers are also a reflection of the gender bias that has been a chronic problem in science – a problem that has yet to be fully addressed. The women who have won the Nobel Prize are:

- **Physics**

1903 Marie Curie
1963 Maria Goeppert-Mayer

- **Chemistry**

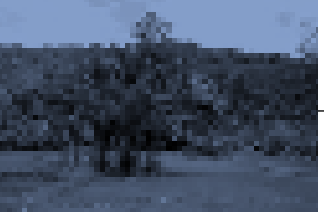
1911 Marie Curie
1935 Irène Joliot-Curie
1964 Dorothy Crowfoot Hodgkin

- **Physiology / Medicine**

1947 Gerty Radnitz Cori
1977 Rosalyn Sussman Yalow
1983 Barbara McClintock
1986 Rita Levi-Montalcini (TWAS Associate Fellow 1992)
1988 Gertrude Elion
1995 Christiane Nüsslein-Volhard
2004 Linda B. Buck

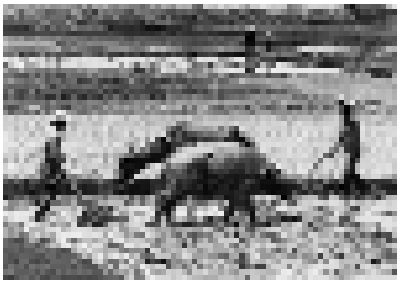
Lydia Makhubu
President
Third World Organization for Women in Science
Trieste, Italy

Professor of Chemistry
University of Swaziland
Kwaluseni, Swaziland
lmakhubu@iafrica.sz



ASSESSING THE IMPACTS OF CLIMATE CHANGE

FOR THE PAST FOUR YEARS, TWAS, TOGETHER WITH A GROUP OF PARTNER ORGANIZATIONS, HAS SPONSORED A DIVERSE SET OF RESEARCH ACTIVITIES AIMED AT ASSESSING THE POTENTIAL IMPACTS OF CLIMATE CHANGE AROUND THE GLOBE AND THE ACTIONS THAT CAN BE TAKEN TO ADDRESS THEM.



Assessments of Impacts and Adaptations to Climate Change (AIACC) is a global initiative aimed at advancing the scientific understanding of climate change vulnerabilities and adaptation options in developing countries. AIACC, developed in collaboration with the United Nations Environment Programme (UNEP) / World Meteorological Organization's (WMO) Intergovernmental Panel on Climate Change (IPCC), is funded primarily by the Global Environment Facility (GEF); implemented by UNEP; and executed jointly by TWAS and the Global Change SysTem for Analysis, Research and Training (START, see www.start.org*).*

The project, which began in 2001, has commissioned some 24 three-year regional climate change assessments that will be completed by the end of 2005. These regional assessments, which are widely distributed geographically, also cover a variety of topics. Among them are investigations of climate change vulnerabilities and adaptation responses in the areas of food security and rural livelihoods in the Sahel; biodiversity conservation in southern Africa; agriculture in the Pampas region of South America; ecosystems and fisheries of the Rio de la Plata estuary of Argentina and Uruguay; livestock grazing in Mongolia; plantation agriculture in Sri Lanka; tourism and coastal systems in the Seychelles; and watershed and forest systems in the Philippines and Indonesia. Two regional climate-modelling projects have also been supported by AIACC, one in West Africa and another in sub-Saharan Africa.

BUILDING CAPACITY

Participating in the 24 regional assessments are some 235 scientists from developing countries and more than 60 graduate and undergraduate students, thus helping to fulfil another aim of the AIACC project, building scientific capacity and training young scientists in the South.

In addition to these assessments, 45 peer-reviewed papers from AIACC have been published, 18 student dissertations completed and more than 30 AIACC participants are contributing to the IPCC's Fourth Assessment Report, due to be published in 2007, as authors and review editors.

In the final stage of the project, participants are synthesizing the results of the 24 regional assessments, focusing on two components: vulnerability to climate variability and change, and adaptation responses that can lessen vulnerability.

For the vulnerability synthesis, case study papers were prepared and circulated among the authors who were then brought together at a workshop held at the Rockefeller Foundation's Bellagio Conference and Study Centre in northern Italy in March 2005.

Since the workshop, a joint synthesis paper and the case study papers on vulnerability have been reviewed and revised for inclusion in a book, *Dimensions of Vulnerability in a Changing Climate, Case Studies from the Developing World*, to be published in 2006. A similar exercise is underway to synthesize the lessons learned from the adaptation studies carried out as part of the AIACC project.

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TIME TO WIN: STRATEGIES FOR SUCCES

As part of the Assessments of Impacts and Adaptations to Climate Change (AIACC) programme, Rodel Lasco of the World Agroforestry Centre (ICRAF) in the Philippines, together with colleagues from the Environmental Forestry Programme (ENFOR) of the University of the Philippines Los Baños (UPLB), has been assessing the adaptation strategies that local people can undertake in response to climate change. To simplify the research, their studies have focused on a defined geographical area, the Pantabangan-Carranglan watershed, and have examined forestry and water resources, upland agriculture, and local communities. The aim now, say the scientists, is to provide policy makers with the information and tools they need to make win-win decisions.

The Philippines archipelago, consisting of more than 7,000 islands, lies just 13 degrees north of the equator and is home to some 88 million people. Three-quarters of the islands' 300,000 square kilometres is taken up by mountainous watersheds.

Like many other watersheds in the Philippines, the Pantabangan-Carranglan watershed, located some 175 kilometres north of the capital, Manila, is integral to the country's economy, providing not only water for irrigation but also hydroelectric power from the Pantabangan Dam. Also, like many of the country's watersheds, the Pantabangan-Carranglan watershed is suffering from a variety of environmental pressures, including deforestation and soil erosion.

The questions that Rodel Lasco and his colleagues set out to answer were: How will the thousands of people living in the Pantabangan-Carranglan watershed adapt to climate change, and will any of these adaptations adversely affect other watershed inhabitants or services?

The "Third Assessment Report" of the Intergovernmental Panel on Climate Change (IPCC), published in

2001, concluded that there is strong evidence that human activities – particularly the release of greenhouse gases from the burning of fossil fuels – have affected the world's climate. Many scientists argue that we are already seeing the effects of climate change in a warming of global temperatures.

Since 1990, for example, the Earth has experienced ten of the warmest years on record. In addition, 2005 is shaping up to be the hottest year yet and scientists are reporting that the blanket of sea ice covering the Arctic during this summer was 20 percent less than the long-term average. For the past four years, an area of summer sea ice equivalent to the area of Iraq has been lost each summer. Researchers fear that this melting will accelerate global warming because the ice cover reflects the sun's heat back into space whereas the exposed sea absorbs it. Indeed, increasing sea temperatures have been linked to the increased frequency and severity of hurricanes and typhoons.

Since 1990, the Earth has experienced ten of the warmest years on record.

GLOBAL OUTREACH

In 2004, AIACC hosted a second series of regional workshops, each of which was attended by about 100 scientists: the Second AIACC Regional Workshop for Africa and Indian Ocean Islands was held in Dakar, Senegal, in March; the Second AIACC Regional Workshop for Latin America and Caribbean was held in Buenos Aires, Argentina, in August; and the Second AIACC Regional Workshop for Asia and the Pacific was held in Manila, the Philippines in November. AIACC also organized a side event, 'Science in Support of Adaptation to Climate Change', organized in collaboration with the government of Argentina, UNEP, START and TWAS, at the Tenth Session of the Conference of Parties (COP 10), held on 6-17 December 2004 in Buenos Aires, Argentina, which marked the 10th anniversary of the entry into force of the United Nations Framework Convention on Climate Change. The proceedings of these workshops, together with a comprehensive collection of other AIACC publications, are available online at www.aiaccproject.org.

VIEWS AND OPTIONS

"Our study of the Pantabangan-Carranglan watershed focused on adaptation strategies for three sectors: forest and upland agriculture, water resources and local communities," explains Lasco.

Lasco and his team used various methods to identify climate change impacts, vulnerability and adaptation options in the study area. "These were based on previous studies with a similar focus and included household surveys, focus group discussions, multi-stakeholder workshops and key informant interviews, as well as global information system (GIS) analyses and computer modeling," explains Lasco.

"A wide range of adaptation options were identified. This suggests that there is a high degree of awareness on how to adjust to climate variability and extremes, which could provide solid building blocks for future climate change adaptation," says Lasco.

On lowland farms, for example, stakeholders identified the use of early maturing crop varieties or more drought-tolerant varieties as adaptation options if the seasonal rains came late. In contrast, if the rains came early, small water impounding projects (SWIPs) – for

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Stakeholder acceptance is greater when everyone is convinced of the desirability of common adaptation strategies.

example, the creation of mini-dams – would help farmers store water for use throughout the cropping season. Supplemental watering was also seen as a potential solution to climate variability on tree plantations.

Upland farmers also identified shifting to more tolerant varieties as a possible adaptation option, as well as the installation of fire lines – strips of land planted with trees and shrubs designed to help contain fires – and the adoption of more modern farming practices such as sloping agricultural land technology (SALT). SALT involves planting nitrogen-fixing trees and shrubs along the contours of the land to create so-called 'green terraces', and growing crops between them.

Other adaptation strategies that could be implemented in the upland areas include the cancellation of the total logging ban that is currently in force, but with increased enforcement of tree-harvesting regulations and more coordinated action between both local government units and government and nongovernmental organizations.

Not surprisingly, several of the options identified for farming and forestry impact water resources. Stakeholders identified a range of water conservation practices, including SWIPs. They also cited the adoption of SALT farming methods and the intensification of current reforestation programmes. To overcome water shortages, stakeholders suggested that more wells could be dug, irrigation techniques could be made more efficient, rice seeds could be sown directly instead of being grown and transplanted into paddies, and other water local sources such as the Atate and Penaranda rivers could be tapped. In response to floods, a series of different measures would be required, including closing the main irrigation canal (if possible), repairing damage, exploring alternative livelihoods, including rearing livestock and making fruit juice (fruit trees are more likely to survive flooding) and constructing fish ponds in areas prone to flooding.

"The institutional adaptations we found are even more varied than those for agricultural or water resources," says Lasco. "Interestingly, it seems that local

government units have been more responsive to climate variations, as reflected in the long list of adaptations they have identified."

Among this list are such strategies as tree planting and reforestation; the organization of water distribution; construction work that would divert overflow from rivers away from settlements and crops; repair and proper maintenance of roads, canals and wells; information dissemination, for example on farming techniques and what to do when a typhoon hits; provision of relief goods and free medicines; and creation of a task force and 'disaster brigade'.

DECISION MAKING

Having identified a range of possible adaptation strategies, Lasco and his colleagues then set about analyzing those that would be mutually beneficial and those that would have adverse impacts in other sectors.

"For example, the effects of adaptation strategies for forests and agriculture on water resources are gen-

erally positive," says Lasco. "In contrast, these same strategies have varying effects on the different institutions operating in the watershed. For most of the adaptation strategies there are clearly trade-offs that have both positive and negative effects on other sectors."

Among the technical adaptation strategies, for example, the use of early maturing or drought resistant crops would have the most positive effects on the other sectors. The establishment of fire lines also has a generally positive effect, but it would require additional labour to establish them. Likewise, the benefits of supplemental watering are mixed, with extra labour being required but with the likelihood of gaining a higher income from higher crop yields. In other cases, such as the construction of drainage structures, additional costs are involved.

"Indeed, most of the recommended adaptation strategies require additional investments," adds Lasco. "Under tight budgets, this could pose a significant hurdle to their implementation." Reforestation, for example, costs some US$900 per hectare over three years. "Such a level of investment may prove limiting for those organizations that would bear the costs," continues Lasco. "A possible mitigating measure is to explore the possibility of getting more community participation to reduce labour costs, which can consume up to 70 per cent of the cost of reforestation programmes."

The ultimate aim of the analyses, however, is to prioritize the different strategies, giving greater weight to those strategies that provide benefits across all sectors.

One way of doing this is to produce a matrix chart in which the effects of each adaptation strategy on each sector can be entered as a colour code – a dark shade representing mostly positive benefits, a neutral shade for mixed benefits and a pale colour representing negative impacts. "In this way, the potential synergies and conflicts are easily visualized," says Lasco.

Such analyses could also help managers identify potential conflicts early in management programmes. "If

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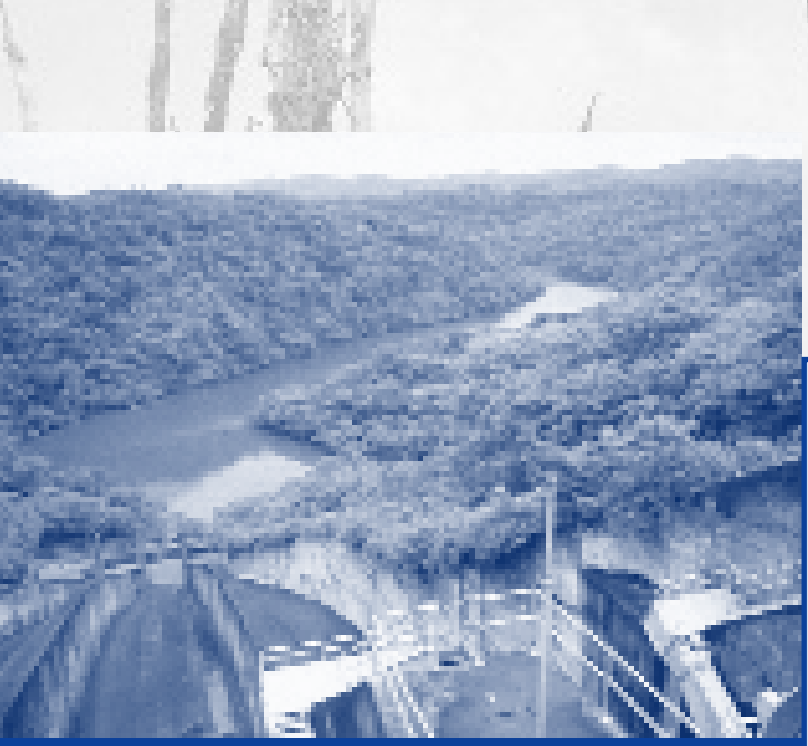


such effects are not considered, adaptation strategies may not be implemented due to the lack of cooperation from affected sectors," warns Lasco. "By identifying and considering such conflicts at the beginning, there will be greater opportunities for finding solutions."

While future research is likely to focus on quantifying the trade-offs between adaptation strategies in the different sectors, Lasco believes the current project has been a success.

"The primary objective was to demonstrate an approach to help policy makers think through the trade offs involved in implementing adaptation options to climate change," he says. "We have achieved this through our matrix chart.

"We have also identified climate change adaptation strategies that could address more than one sector and thus enhance synergy. A good example of this is tree planting and reforestation, which was identified as an adaptation strategy by all three sectors. By focusing on such strategies, conflicts are avoided. There is also a greater chance of stakeholder acceptance when everyone is convinced of the desirability of implementing common adaptation strategies." ■

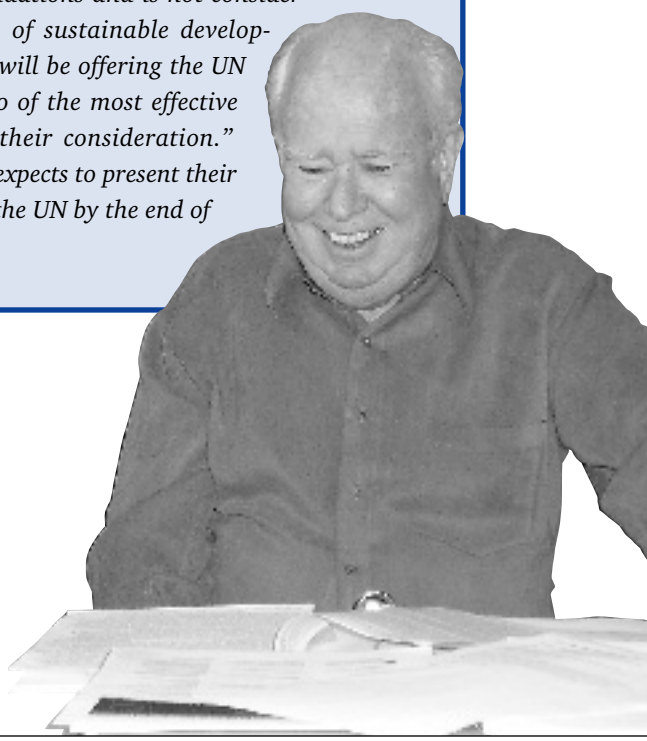
For additional information, contact
Rodel Lasco
email: r.lasco@cgiar.org

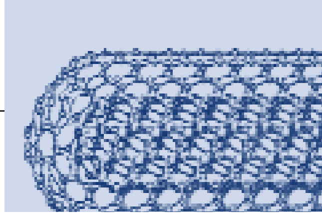
TWAS, SIGMA XI AND CLIMATE CHANGE

From 29-31 March 2005, TWAS hosted a meeting organized by Sigma Xi, a US-based scientific society with more than 70,000 members. Some 20 eminent scientists on Sigma Xi's international Scientific Expert Group on Climate Change and Sustainable Development attended the meeting, chaired by Peter Raven (TWAS Fellow 1993 and president of Sigma Xi). Sigma Xi has been commissioned by the United Nations to produce a document advising on ways to adapt to and limit future changes in the global climate.

The aim of the Expert Group is to identify effective steps that could be taken to decrease the loss of life, human suffering, property damage and economic and political disruptions that are the likely consequences of climate change.

"The analysis is not new," explains Raven, "but the mission is. Unlike the Intergovernmental Panel on Climate Change (IPCC), which cannot make policy recommendations and is not considering issues of sustainable development, we will be offering the UN a portfolio of the most effective steps for their consideration." Sigma Xi expects to present their report to the UN by the end of this year.





SMALL THINGS, BIG CHANGES

TWAS EXECUTIVE DIRECTOR, MOHAMED HASSAN, EXPLAINS WHY INVESTING IN NANOTECHNOLOGY WILL PROVE TO BE SO IMPORTANT FOR DEVELOPING COUNTRIES.

Nanotechnology could prove to be a 'transformative' technology comparable in its impact to the steam engine in the 18th century, electricity in the 20th century and the internet in contemporary society.

Scientists are already developing nano-applications that are radically transforming a host of products and services, including battery-storage capacity, computer-chip minimization, drug delivery, facial creams, food processing, solar energy, and water purification. The list is endless (or so it seems) and touches virtually every aspect of human endeavour.

Despite its enormous potential, criticisms have been levelled at current and future applications of nanotechnology by such advocacy organizations as the Canadian-based ETC Group, which claims that because of their novel properties, nanoproducts should undergo more stringent health and safety tests.

Popular critics, including the famed US writer Michael Crichton, ominously suggest that self-replicating nanomachines could defy human control and run amok. Other well-known figures, most notably Prince Charles, speak of endless copies of these machines spreading like 'grey goo' across our globe – an image not likely to generate unwavering confidence and support.

Another major concern spurred by nanoscience and nanotechnology is that it will exacerbate the North-South divide in science and technology. The United States will spend an estimated US$3.7 billion on nanoscience and nanotechnology between now and 2008. Japan plans to spend more than US$3 billion during the same period. The European Commission authorized US$1.7 billion in its Sixth Framework Programme for Research and Technological Development (2002-2006), a figure that will likely rise to US$7.5 billion in its Seventh Framework Programme (2007-2013).

Mohamed H.A. Hassan

DOWNSIDE UP

Clearly, those who have the resources have placed their bets on this next new thing. Will such heavy investments lead to a North-South nanodivide comparable to the divide that has characterized biotechnology and global information technologies?

The answer appears to be no. In fact, nanoscience and nanotechnology may prove to be the first cutting-edge field to reflect the new realities of global science in the 21st century for two reasons.

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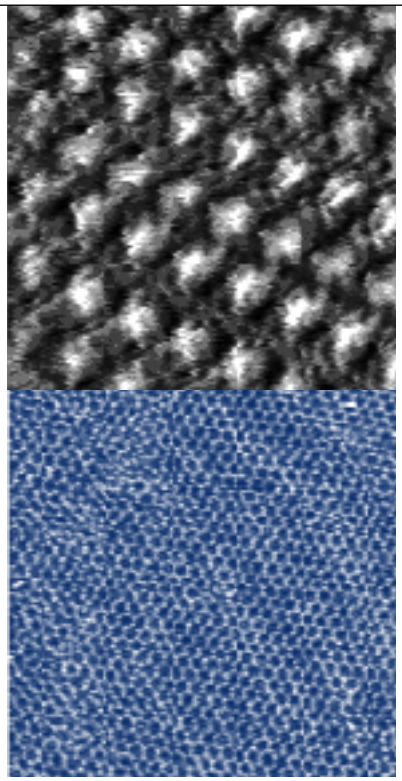


First, the capabilities and accomplishments of scientists and technologists from the developing world who choose to continue to work in their home countries are growing. Second, governments in the South are devising ever-more sophisticated and effective science and technology polices.

On the downside, there is a disturbing emergence of a South-South gap in capabilities between scientifically proficient countries (Brazil, China, India and Mexico, for example) and scientifically laggard countries, many of which are located in sub-Saharan Africa and in the Islamic world.

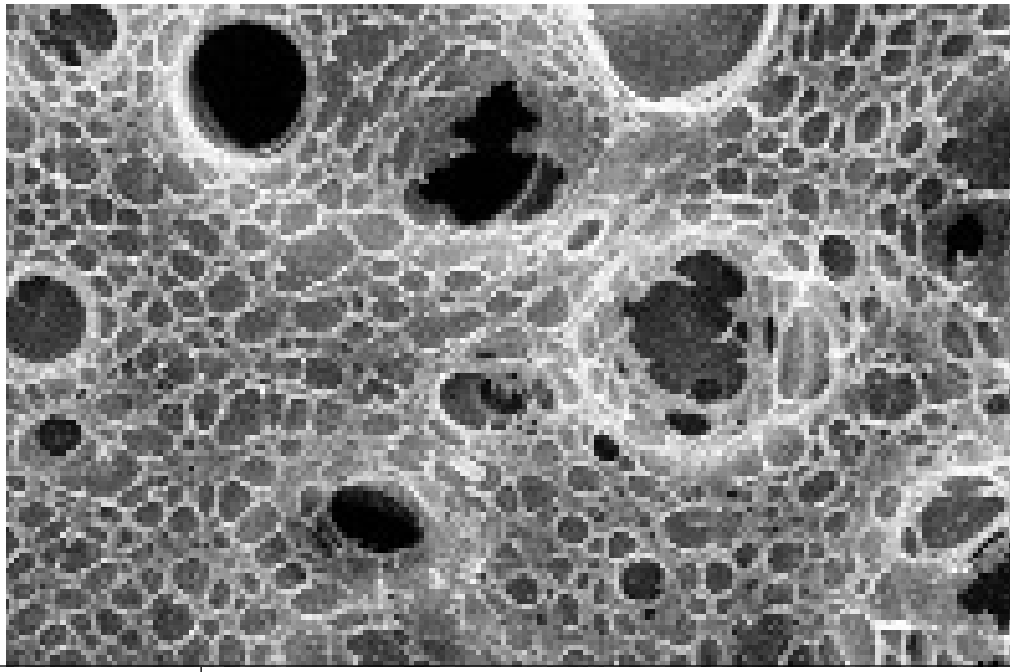
Several reliable indicators confirm these trends. Investments in nanoscience and nanotechnology in several developing countries, for example, are both substantial and accelerating. Between 2003 and 2007, China's central government will invest some US$240 million in nanoscience and nanotechnology and the nation's local governments, by some estimates, will provide US$360 million more. Brazil plans to invest more than $US25 million between 2004-2007 and India US$23 million between 2004-2009. Last year South Africa invested an estimated US$6 million in nanoscience and nanotechnology and Argentina recently announced that that it will invest US$10 million over the next five years. Chile and Mexico are also pursuing modest but growing programmes.

Smaller and poorer developing countries have also decided that nanoscience and nanotechnology represent strategic investments in their future economic and social well-being that they cannot afford to ignore. Thailand and the Philippines, for example, are both devoting a portion of their small science and technology budgets to nanoscience and nanotechnology.

Such investments seem to be paying off. In 2004, for example, scientists in China published more articles on nanoscience and nanotechnology in international peer-reviewed science journals than scientists in the United States, and it now ranks third behind the United States and Japan in nanotechnology patents. In a 2004 listing on nanotechnology and nanoscience literature, three developing countries were among the top 10 nations in the publication of peer-reviewed articles. In addition to China, these countries were Brazil and India.

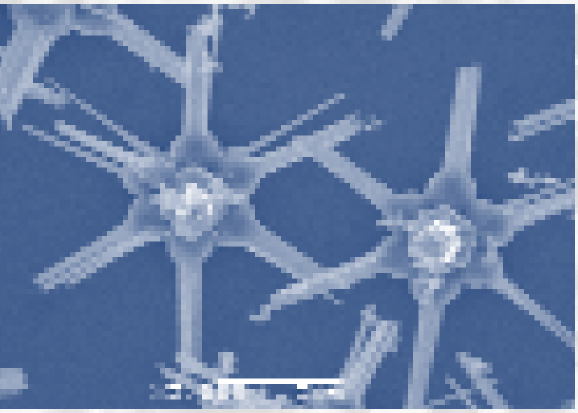
RETURN OF INVESTMENTS

What accounts for this dramatic change in fortune that seems to be turning the nanodivide into nanoconvergence? The short an-



swer is the anticipated return on investment. The US National Science Foundation estimates that nanotechnology will represent a US$1 trillion global market by the end of this decade.

That market would likely remain the sole domain of developed countries except for several interrelated factors. First, the developing world's interest in nanoscience and nanotechnology parallels a trend in global science that has been unfolding over the past 20 years. This trend is highlighted by



a number of developing countries that have embraced science and technology as critical elements in their overall economic development strategies.

Therefore it should not be surprising to discover that the developing countries leading the way in investments in nanoscience and nanotechnology are the same developing countries that have been investing unprecedented sums of money in science and technology in general. China, for example, now devotes 1.1 percent of its gross domestic product (GDP) to science and technology (it has recently become the world's third largest investor in research and development in absolute terms). Meanwhile, the budget for China's National Natural Science Foundation (modelled on the US National Science Foundation) has skyrocketed from US$10 million in 1986 to US$300 million in 2003. India likewise now invests approximately 1.2 percent of its GDP in science and technology and has emerged as one of the world's (not just the developing world's) leading countries in the application and, increasingly, the development of information technology, home to such world-class companies as Infosys, Tata Consultancy Services and Wipro. Brazil now spends an estimated 1.1 percent of GDP on science and technology and graduates some 7,000 PhD students in a broad range of scientific disciplines each year.

Second, the investment in nanoscience and nanotechnology represents not just an unprecedented commitment to science and technology on the part of some developing countries but also a paradigm shift in their science-based development strategies. As Turner T. Isoun, Nigeria's Federal Minister of Science and Technology, recently noted, "developing countries will not catch up with developed countries by investing in existing technologies alone. To compete successfully in global science today, a portion of the science and technology budget of every country must focus on cutting-edge science and technologies. Any nation that invests solely on existing science and technology is bound to remain several steps behind the most scientifically and technically advanced nations."

This change in strategy explains, in part, China's extensive investments in biotechnology and information technologies. It explains the recent decision by the Brazilian parliament to sanction stem cell research. And it explains South Africa's decision to become the chief sponsor of the Southern African Large Telescope, which rests on the Karoo Plateau in southern South Africa. The telescope, measuring 11 metres in diameter, is the largest such instrument in the Southern hemisphere when it officially opens this autumn. The ceremony for its official launch took place this autumn.

The developing world's investment in nanoscience and nanotechnology is thus part of an overall upward trend in investment in science and technology in general – a trend that is likely to continue and even accelerate in the years ahead.

UPSIDE DOWN

The North should welcome the increased presence of skilled scientists and technologists in the South. That's because the participation of developing world scientists at the highest levels of research is likely to quicken the pace of global progress.

Equally important, it is likely to help avoid a repeat of the public concerns that have hampered the

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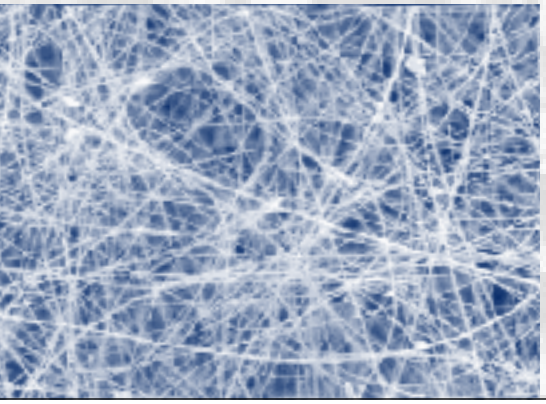
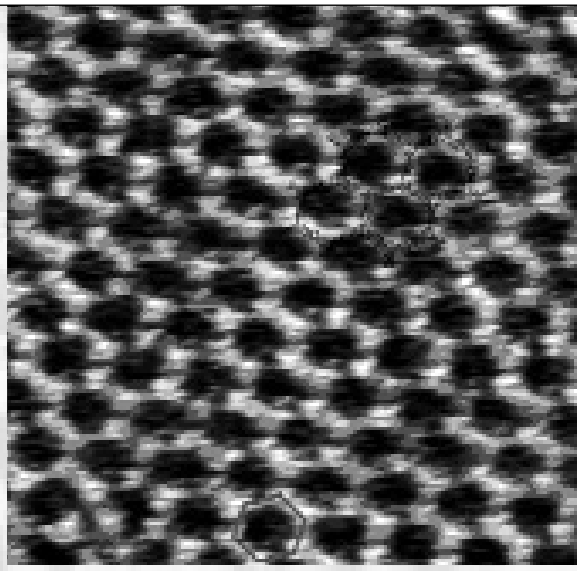
development of genetically modified crops.

Here's why. Beyond the worries about the potential impact of biotechnology and genetic engineering on public health and the environment, there is another deep concern: that the North's – and, more specifically, the United States' – monopolization of the research and development of genetic engineering may have enabled corporations in the United States to protect their own commercial interests at the expense of the rest of the world. Prohibitions against the cultivation and sale of genetically engineered crops in Europe and boycotts against genetically engineered seeds in Zimbabwe and other nations in sub-Saharan Africa have been two of the most visible manifestations of this sentiment.

If the development of nanoscience and nanotechnology becomes a truly global phenomenon, and if scientists in both the North and South can convince their citizens that their nano-related health and environmental concerns are unfounded, then the public is likely to be more accepting.

Blunting the sharp divisions between those who discover and apply nanoscience and nanotechnology and those who are recipients (sometimes reluctant recipients) of the new technology will not solve all of the problems associated with public acceptance but it will make advances seem less imposed and more participatory. Put another way, sharing both investments in and benefits from nanoscience and nanotechnology is likely to help both the South and North.





ALL TOGETHER

As advances in nanoscience and nanotechnology continue to unfold on a global scale, there are nevertheless some ominous trends that may stand in the way of fully utilizing these advances to address critical health and environmental needs in the South.

While increased investments in nanoscience and nanotechnology in a number of developing countries have closed the North-South nanodivide, such investments have widened the South-South nanodivide. Today the environment for research and development in nanoscience and nanotechnology in Brazil, China, India and South Africa bears closer resemblance to the research environment in Europe, Japan and the United States than it does, for instance, to the research environment in the Dominican Republic, Laos or Rwanda.

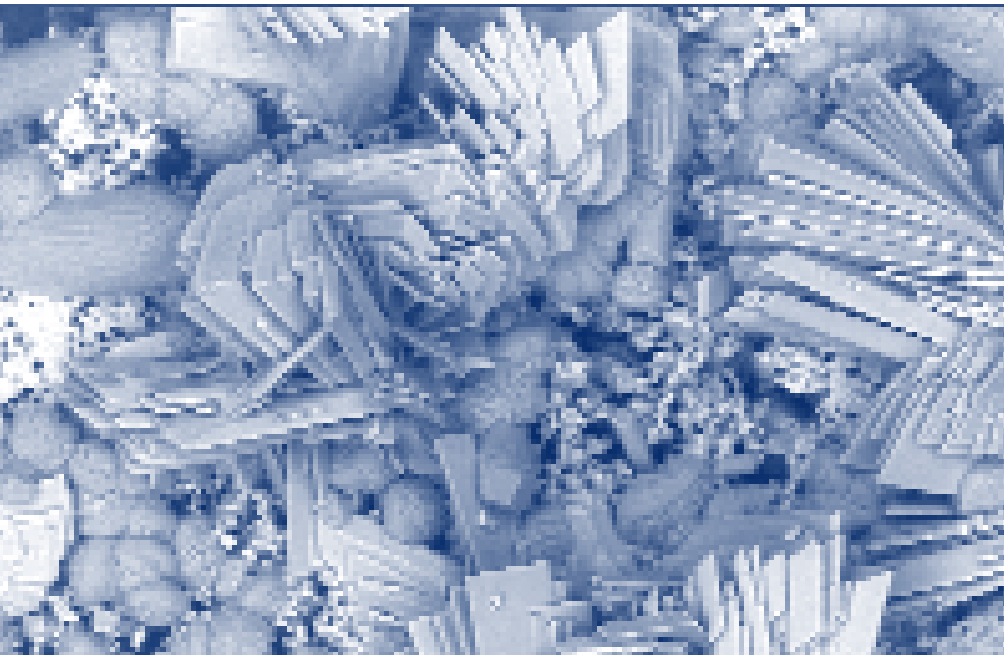
This is no small matter for two reasons. First, closer ties between scientists and technologists in the North and South run the risk that the research and development agenda will be dictated by the North. Nanoscience and nanotechnology raise many intriguing questions from a research perspective and, at the same time, have many potentially valuable societal applications ranging from the creation of more efficient filtering systems for producing clean drinking water (through the creation of filters that prevent viruses and toxins from entering the water supply) to the development of fibres that can lead to longer-lasting tennis balls and make clothing more resistant to stains.

In an ideal world, there would be room for nanoscientists and nanotechnologists to pursue both the cosmetic and the consequential. But there remains the possibility that the majority of resources and expertise – both in the North and South – may be applied to frivolous products and services that hold the most promising market potential in the North where the richest consumers live.

To avoid this potential pitfall, governments throughout the developing world must focus on and

support national nanoscience and nanotechnologies policies that address critical social and environmental concerns in their own countries.

Specifically, the governments of those developing countries now investing heavily in nanotechnology should avoid 'hitching' their nanotechnology research and development programmes to those in the North. To prevent the creation of a South-South nanotechnology divide, such developing countries as Brazil, China, and India should devise broad-based strategies that include ample investments in South-South cooperation. In this way, advances in nanoscience and nanotechnology could ultimately lend a helping hand to developing countries that are currently less scientifically proficient – a move that could, in the long-term, help achieve progress on many of the Millennium Development Goals.



NANO-CENTRES

It is for this reason that the global scientific community should pursue the following policies for the advancement of nanoscience and nanotechnology:

• Creation of nanotechnology centres of excellence in sub-Saharan Africa and other least developed regions capable of partnering with other advanced nanoscience and nanotechnology centres on joint projects.

• Forging of networks with research agendas focusing on nanoscience and nanotechnology between universities and research centres in scientifically proficient developing countries and universities and research centres in scientifically laggard countries, particularly those in the least developed countries.

• Development of national nanotechnology policies that explicitly call for investments in research projects that focus on issues of critical importance in the developing world, including access to safe drinking water, the development of low-cost yet efficient sources of renewable energy and the creation of gels that can reduce the risk of HIV/AIDS transmission.

Proponents of nanoscience and nanotechnology claim that this transformative science and technology could radically alter fundamental aspects of our global society. If the research is organized in an effective manner, the pursuit of these larger social and environmental goals could also help build the capacities of nations that have been excluded from the pursuit and benefits of state-of-the-art science and technology for too long.

We are off to a promising start. The challenge now is not to be diverted in directions that will only widen the divide between the 'haves' and 'have-nots.' Of all the benefits promised by nanoscience and nanotechnology, the potential to lift the quality of science and technology on a global scale may be the most important of all. ■

Mohamed H.A. Hassan
Executive Director, TWAS
Trieste, Italy

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WHAT'S TWAS?

The Academy of Sciences for the Developing World (TWAS) is an autonomous international organization that promotes scientific capacity and excellence in the South. Founded as the Third World Academy of Sciences by a group of eminent scientists under the leadership of the late Nobel Laureate Abdus Salam of Pakistan in 1983, TWAS was officially launched in Trieste, Italy, in 1985, by the Secretary General of the United Nations.

TWAS has more than 750 members from 81 countries, 66 of which are developing countries. A 13-member Council is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a small secretariat, headed by the Executive Director. The secretariat is located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Ministry of Foreign Affairs of Italy.

The main objectives of TWAS are to:

- Recognize, support and promote excellence in scientific research in the South.
- Provide promising scientists in the South with research facilities necessary for the advancement of their work.
- Facilitate contacts between individual scientists and institutions in the South.
- Encourage South-North cooperation between individuals and centres of science and scholarship.

TWAS was instrumental in the establishment in 1988 of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of 160 scientific organizations from developing countries, whose goal is to assist in building political and scientific leadership for science-based economic development in the South and to promote sustainable development through broad-based partnerships in science and technology. **www.twnso.org**

TWAS also played a key role in the establishment of the Third World Organization for Women in Science (TWOWS), which was officially launched in Cairo in 1993. TWOWS has a membership of more than 2,500 women scientists from 87 developing countries. Its main objectives are to promote research, provide training, and strengthen the role of women scientists in decision-making and development processes in the South. The secretariat of TWOWS is hosted and assisted by TWAS. **www.twows.org**

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 90 science academies worldwide established in 1993, whose primary goal is to help member academies work together to inform citizens and advise decision-makers on the scientific aspects of critical global issues. **www.interacademies.net/iap**

The secretariat of the InterAcademy Medical Panel (IAMP), an association of 52 academies of science and medicine, relocated to Trieste in May 2004. IAMP and its member academies are committed to improving health worldwide, especially in developing countries. **www.iamp-online.org**

WANT TO KNOW MORE?

TWAS and its affiliated organizations offer scientists in the South a variety of grants and fellowships. To find out more about these opportunities, check out the TWAS website:
www.twas.org

FELLOWSHIPS

Want to spend some time at a research institution in another developing country? Investigate the fellowships and associateships programmes:
www.twas.org/Exchange.html
TWOWS offers postgraduate fellowships to women from least developed countries (LDCs) and other countries in sub-Saharan Africa:
www.twows.org/postgrad.html

GRANTS

Are you a scientist seeking funding for your research project? Then take a look at the TWAS Research Grants scheme:
www.twas.org/mtm/RG_form.html
Is your institution seeking funds to collaborate with a research institute in another country in the South? The TWNSO grants programme may be able to provide support:
www.twnso.org/grants.html

EQUIPMENT

But that's not all TWAS has to offer. For instance, do you need a minor spare part for your laboratory equipment – no big deal, really – but you just can't get it anywhere locally? Well, TWAS can help:
www.twas.org/mtm/SP_form.html

TRAVEL

Would you like to invite an eminent scholar to your institution, but need funding for his/her travel? Check out the Visiting Scientist Programme:
www.twas.org/hg/vis_sci.html

CONFERENCES

Are you organizing a scientific conference and would like to involve young scientists from the region? You may find the help you need here:
www.twas.org/mtm/SM_form.html