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NEWSLETTER OF THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD

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Africa commissioned: inside and out

THE REPORT ON AFRICA, *OUR COMMON INTEREST*, COMMISSIONED BY PRIME MINISTER TONY BLAIR OF THE UNITED KINGDOM AS A PART OF A LARGER EFFORT TO EXPAND THE G8'S AID AGENDA FOR SUB-SAHARAN AFRICA, CONTAINS TWO CRITICAL SCIENCE- AND TECHNOLOGY-RELATED RECOMMENDATIONS THAT, IF SUCCESSFULLY IMPLEMENTED, COULD HAVE A DRAMATIC IMPACT ON THE FUTURE OF AFRICA.

Mohamed H.A. Hassan

First, the report makes a strong case for strengthening universities across Africa and calls on donor nations to invest US$5 billion over the next 10 years to achieve this goal.

Second and inter-relatedly, the report calls for the creation of regional centres of excellence capable of building scientific and technological capacities across national borders and asks donor nations to invest US$3 billion over the next 10 years to advance this initiative.

Many of the report's recommendations have been made before. The Academy of Sciences for the Developing World (TWAS), for example, has been advocating the creation of centres of excellence in science and technology since its inception more than 20 years ago. And blueprints to help Africa escape from the debilitating grip of poverty have been a part of the developed world's 'rhetorical' aid agenda for more than half a century, if not longer.

What is new is that Africa itself is beginning to address its own problems in meaningful and effective ways, turning to science and technology as essential elements in this campaign.

And now that the G8, the world's richest countries, have agreed to double aid to Africa from US$25 billion to US$50 billion a year by 2010, thanks, in part, to the publication of

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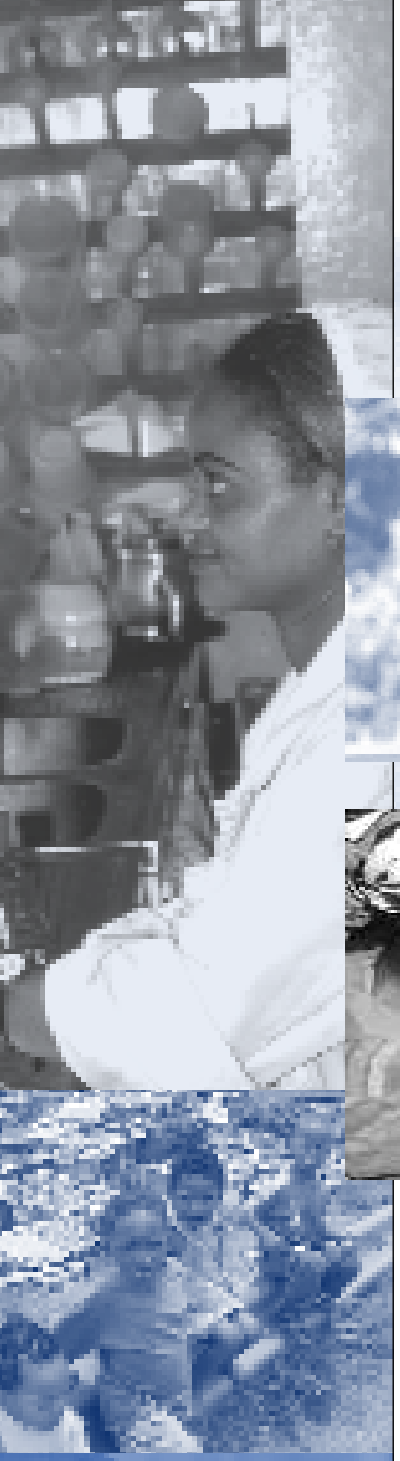
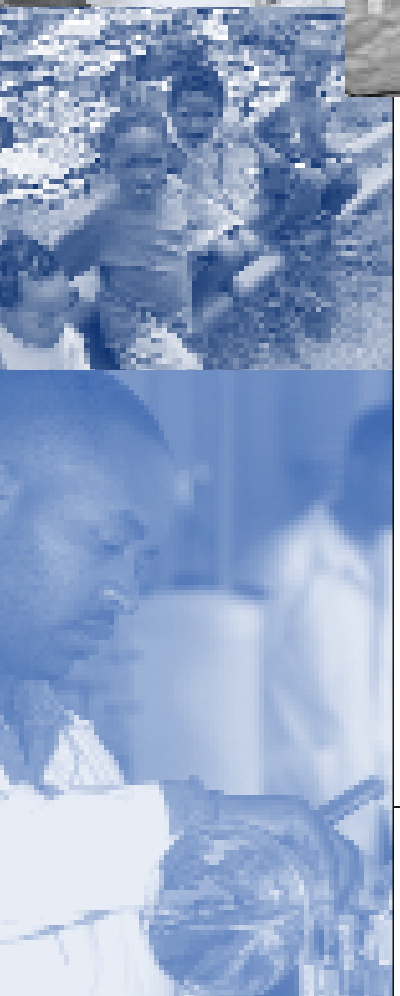




Our Common Interest, *there is a chance that Africa may finally be able to lay the groundwork for sustained economic growth.*

With nearly half of the continent's population living in extreme poverty (earning less than US$1 a day) and a third of the population remaining undernourished, Africa remains the world's most troubled continent. But the progress that has been made in integrating science into the larger agenda for sustainable development – by, for example, the African Union and the governments of Botswana, Nigeria, Senegal, South Africa and Uganda – indicates that at least some countries in the continent now have an opportunity to make headway on alleviating the deprivation that has afflicted Africa for far too long.

The additional aid promised by the G8 nations should seek, in part, to advance the science-based development agenda that Africa has set for itself. That means promoting excellence in science both at an individual and institutional level. And it means aiding initiatives that nurture pan-African cooperation so that the continent's more scientifically proficient countries can help their less scientifically proficient neighbours.

The way forward will not be easy but it must be led by Africa itself. The help the continent receives from friends is indeed welcome but self-help, both on a national and regional level, will ultimately be more important. That, in the final analysis, is reason enough to build scientific capacity in the region.

As the title of the Commission's report suggests, Africa's future is 'our common interest' but, first and foremost, that future is for Africa to determine and embrace. ■

Mohamed H.A. Hassan
Executive Director
Academy of Sciences for the Developing World (TWAS)
Trieste, Italy

President
African Academy of Sciences (AAS)
Nairobi, Kenya

TRIESTE SCIENCE PRIZE WINNERS

IN COLLABORATION WITH TRIESTE-BASED ILLYCAFFÈ, TWAS HAS ANNOUNCED THE FIRST TWO RECIPIENTS OF THE NEWLY LAUNCHED TRIESTE SCIENCE PRIZE, DESIGNED TO HONOUR THE DEVELOPING WORLD'S MOST EMINENT SCIENTISTS.

An Indian scientist, who has made fundamental contributions to our understanding of the physical forces that turn liquids into solids, and a Brazilian biologist, who has advanced our knowledge of how enzymes reduce high blood pressure and lessen the sensation of pain, are the first two recipients of the Trieste Science Prize, sponsored by illycaffè s.p.a..

The Trieste Science Prize, administered by the Academy of Sciences for the Developing World (TWAS) and funded by illycaffè, is designed to give international recognition and visibility to outstanding achievements made by scientists living and working in the developing world. The award includes a US$50,000 cash prize.

TRIESTE SCIENCE PRIZE IN PHYSICS

T.V. Ramakrishnan, one of the world's foremost condensed matter physicists and materials scientists, has won the first-ever Trieste Science Prize in physics and astrophysics.

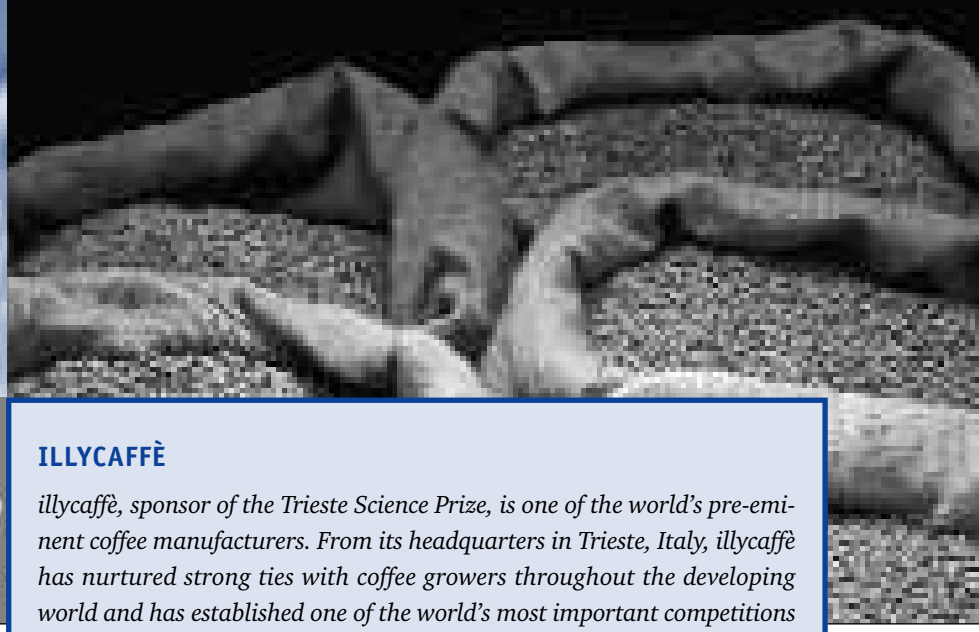
Ramakrishnan, distinguished associate in the Centre for Condensed Matter at the Indian Institute of Science (IISc) in Bangalore, and D.A.E. Homi Bhabha professor of physics at Banaras Hindu University in Varanasi, India, is being honoured for his fundamental theoretical contributions to our understanding of how liquids turn into solids. His insights into the 'transformational' behaviour of particles have had a profound impact on a wide range of subjects in condensed matter physics and materials science.

During the late 1970s, in a remarkable burst of insight and understanding, Ramakrishnan and his research associates uncovered two inter-related findings that have enabled researchers to advance the frontiers of international physics.

In 1977, while at the Indian Institute of Technology (IIT) in Kanpur, Ramakrishnan, with his colleague Mohamed Yussouff, first proposed that solids are atomically 'frozen' ordered versions of liquids in which strong correlations become even stronger. This seminal finding has helped to shape scientific understanding of dense classical systems and materials that undergo a change in their state of matter from liquid to solid.

T.V. Ramakrishnan

Two years later, Ramakrishnan, with his colleagues E. Abraham, Phillip W. Anderson, and D.C. Licciardello, conducted a series of studies that shed light on electron localization in disordered materials. This finding has exerted a wide-ranging influence in such areas of



ILLYCAFFÈ

illycaffè, sponsor of the Trieste Science Prize, is one of the world's pre-eminent coffee manufacturers. From its headquarters in Trieste, Italy, illycaffè has nurtured strong ties with coffee growers throughout the developing world and has established one of the world's most important competitions for the cultivation of coffee beans. The company is dedicated both to the manufacture and distribution of high-quality coffee and to forging strong ties between the North and South (see Coffee: A Science and a Pleasure, *page 7). For additional information about illycaffè, see* www.illy.com.

condensed matter physics as quantum transport, nanoscopic systems and metal-insulator transition.

Ramakrishnan has also played an instrumental role in the creation of a world-class research group in condensed matter and solid state physics at IISc.

The institute's rise in international prominence has been due to several factors, including Ramakrishnan's own world-class research and a rigorous degree-granting programme for the training of PhD students that is widely recognized for its excellence.

Ramakrishnan earned his bachelor of science degree in 1961 from Banaras Hindu University, majoring in physics and mathematics. He then moved to the United States to receive his masters and doctorate degrees in physics from Columbia University and spent the early part of his career in the late 1960s and 1970s at Princeton University and Bell Laboratories, working closely with the future Nobel Laureate Philip W. Anderson (Physics 1977).

Ramakrishnan moved from IIT in Kampur to IISc in Bangalore 1981 where he has continued his pioneering research in condensed matter physics (and, more specifically, dense classical systems) and played an instrumental role in elevating the institute into a world-class centre for scientific research.

Over the past two decades, his most notable contributions have been related to studies on superfluids, cold atom lattices and superconductors. He currently divides his time between IISc and the Banaras Hindu University where he is D.A.E. Homi Bhabha professor of physics. Most recently, he has worked with G.V. Shivashankar at the National Centre for Biological Research in Bangalore on studies of cell division and other biological functions that have required interdisciplinary understanding of biology and physics.

"Throughout his distinguished career," says C.N.R. Rao, president of TWAS, "Ramakrishnan has made outstanding contributions to research that have resonated across the international physics community. His accomplishments represent the best of science not only in the developing world but throughout the world, making him clearly deserving of the first Trieste Science Prize."

TRIESTE SCIENCE PRIZE IN BIOLOGY

Sergio Henrique Ferreira, an internationally renowned biologist whose research paved the way for the development of a new class of highly effective drugs to combat high blood pressure and who has subsequently explored potential remedies for easing inflammatory pain, has been named the winner of the first Trieste Science Prize in the biological sciences.

Ferreira, a professor of pharmacology in the Faculty of Medicine at Ribeirão Preto, Brazil, began his career in the early 1960s under the tutelage of John Vane who was awarded the Nobel Prize

[CONTINUED PAGE 6]

S.H. Fereira

THE TRIESTE SCIENCE PRIZE

The Trieste Science Prize, launched this year, is designed to bring recognition and distinction to the developing world's most eminent scientists who have often been overlooked by other international award schemes dedicated to honouring scientific achievement. Individuals who have received the Nobel Prize, the Tokyo/Kyoto Prize, the Craaford Prize or the Abel Prize are not eligible. The Prize, which carries a US$50,000 cash award, will be awarded annually and will rotate among the following scientific fields: biological sciences and physics or astrophysics (2005); mathematics and medical sciences (2006); chemical and agricultural sciences (2007); and earth and engineering sciences (2008). For additional information about the Trieste Science Prize, including the nomination procedure, see www.twas.org/honor/TSP_info.html.

in medicine in 1982 for his discovery of how the anti-inflammatory compound in aspirin helps reduce pain.

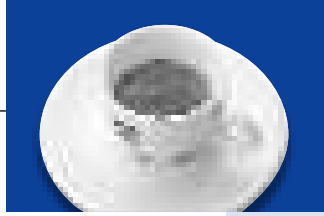
The study of molecular pathways, chemical mediators and cellular responses that shaped Vane's research have also guided Ferreira's work – first in efforts to reduce high blood pressure and, more recently, to explore therapies for inflammatory pain.

Working with Mauricio Oscar Rocha e Silva at the University of São Paulo in the early 1960s, Ferreira helped to uncover the so-called 'bradykinin potentiating factor' by isolating the venom of the native Brazilian snake, *Bothrops jararaca*, and then illustrating how the peptides (short chains of amino acids located in the venom's proteins) could serve as powerful 'vasodilators' capable of expanding the constricted blood vessels responsible for high blood pressure. The international pharmaceutical firm Squibb subsequently used this finding to create Captopril, the first in a new class of highly effective drugs for treating this disease. At the time, Brazilian and international patent laws did not allow the patenting of natural products. As a result, Ferreira and his university did not profit from their discovery.

In the 1980s, Ferreira returned to his second line of research, which he had explored 20 years earlier as a young scientist working with John Vane: devising strategies to better understand the pathways of pain in order to develop remedies for countering pain's debilitating effects.

Morphine and opiates have been used for many years to alleviate pain but these drugs also induce dependence, often causing patients to become addicts. Ferreira is convinced that a new set of analgesics, or pain relieving drugs, could be created by tinkering with the molecular structure of morphine and opiates in ways that would prevent the drugs' pain-relieving properties from crossing the blood-brain barrier. As a result, there would be no addiction. Some of the compounds based on Ferreira's research are currently undergoing tests for potential use as pharmaceutical products.

As C.N.R. Rao, the president of TWAS, notes, "Ferreira is a world-class scientist who received all of his university training in Brazil and who has worked in his home country for most of his career. He is a sterling example of the best of international science and a worthy recipient of the first Trieste Science Prize." ■



TWAS Newsletter, Vol. 17 No. 2, 2005

The official awards ceremony honouring the first two recipients of the Trieste Science Prize, T.V. Ramakrishnan and Sergio Henrique Ferreira, will take place on 11 October. The prize, which is co-sponsored by the Academy of Sciences for the Developing World (TWAS) and illycaffè, includes a cheque for US$50,000.

The ceremony will be held in Trieste, Italy, namesake of the prize and home to a number of international scientific organizations dedicated to the advancement of science in the developing world. These Trieste-based organizations are largely funded by the Italian government.

Before Trieste earned an international reputation as a 'city of science', it was well known as a 'city of commerce'. For more than 500 years, Trieste served as the primary port of the Austro-Hungarian empire. During the 19th century, the city emerged as a world-renowned coffee centre with coffee importers, wholesalers and shipping agents among its most important corporate citizens.

COFFEE: A SCIENCE AND A PLEASURE

illycaffè was established in 1933 as a family business headed by the company's patriarch Francesco Illy, a coffee connoisseur and inventor who created Illetta*, the world's first simplified machine for making espresso coffee. Under Francesco's leadership, illycaffè soon became one of the world's pre-eminent coffee companies, a reputation that continues to this day.*

illycaffè's sponsorship of the Trieste Science Prize marks a unique partnership between a publicly funded scientific institution and a private company.

In March, the editor of the TWAS Newsletter *sat down with Andrea Illy, chief executive officer of illycaffè, to discuss a broad range of topics, including his views on corporate social responsibility and why his company chose to sponsor the Trieste Science Prize. Excerpts follow.*

Tell us a little about illycaffè.

Illycaffè is a third generation family company that was launched by my grandfather, Francesco, in 1933. My father, Ernesto, took over the reigns of the company in 1956 and I assumed the title of chief executive officer in 1995. Our company has always been driven by a single uncompromising goal: to make the world's best coffee. That may sound a bit over-the-top in our publicity-saturated world but that has been our mission, our passion, our obsession. Three critical ingredients have determined our success: a knowledge of science (particularly biology and chemistry); a will-

[CONTINUED PAGE 8]

ingness to examine, test and use new technologies; and a desire to find and support the world's best coffee growers.

Andrea Illy

What is the nature of the relationship of illycaffe to the developing world?

Coffee has always been a global enterprise. The beans are grown in the developing world – for example, Brazil, Colombia, Guatemala and Kenya. They are processed in the developed world. And the coffee itself is brewed and consumed everywhere. Coffee companies that downplay the global nature of their business are destined to fail. The ability of illycaffè to produce the world's best coffee depends largely on the strength of our global supply chain. That is why we work directly with the growers, who we select one-by-one year-by-year. At any given time, thousands of growers are part of our supply chain. But we do a lot more than let them fend for themselves. For example, in cooperation with the University of São Paolo in Brazil, we have established a series of university-based courses and seminars that enable growers from Brazil to learn more about the science of growing coffee. So far, about 3,450 growers have enrolled in the programme. The University of São Paolo, with our support, has also established an aroma laboratory. In addition, we sponsor an aroma laboratory at the Area Science Park in Trieste that is operated in partnership with the University of Trieste. The taste of coffee is very much related to its aroma. Scientists estimate that coffee beans are capable of emitting about 1,000 different aromas. What you smell (and therefore taste) depends largely on the quality of the coffee plants, where they are grown, and the hybrids that are created. So it is very important for us to understand the biology and chemistry that lies behind the growth of plants and beans. Outside of Central and South America, particularly in Africa, we employ itinerant coffee experts — primarily agronomists, agricultural economists and technologists — who travel from place to place teaching growers about the most recent advances in the cultivation and harvesting of coffee beans. These experts also organize field demonstration programmes and agricultural cooperatives that are designed to share knowledge and create more efficient purchasing and sales systems. So far, about 1,000 growers have participated in this initiative. In addition, in the early 1990s, we developed awards programmes for growers in Brazil, Colombia, and Guatemala that have evolved into important, well-publicized events in each of these countries. The 2004 awards in Brazil – our 14th competition there – attracted more than 850 applicants. The winner, who received a US$10,000 cash prize, was selected by an expert panel that based its decisions on a careful review of 100 sacks of coffee, representing a large sample of the season's crop. The initiative illustrates how our efforts to assist growers in the developing world benefit our company as well. Growers receive additional cash and recognition (in Brazil, in addition to the first prize winner we gave US$100 cash awards to the 10 best applicants). At the same time, it also helps to promote quality and that, in turn, helps our company achieve our ultimate goal: to produce the world's highest quality coffee. In

fact, all of our efforts – our coffee university, itinerant experts, and awards and prizes – are intended to advance this goal by exchanging information and by honouring and rewarding those who make the best use of the current knowledge of coffee growing.

A CUP OF CULTURE

The corporate headquarters of illycaffè, where some 500 people are employed, is located in Trieste but the company's coffee can be found in 40,000 restaurants and coffee bars in more than 100 countries around the globe. Together, these restaurants and bars serve more than 5 million cups of coffee each day. For additional information, see www.illy.com.

Do you view coffee growing and processing to be a scientific enterprise?

In many ways, I do. Growing superior coffee beans requires knowledge about plant and soil science, hydrology, climate, and a host of other scientific fields. The more growers know about the science of coffee growing, the more likely they are to grow superior coffee beans. No one can predict the quality of beans from one year to the next. Too many variables and uncertainties are involved. Yet, I think it's encouraging to note that the ability of the best growers to cultivate high-quality beans from one year to the next has improved somewhat since we introduced our coffee courses and prize programmes. The clearest indicator of this trend is the fact that the number of growers in our Gold Club de Cafè – growers from whom we have purchased beans for three consecutive years – has increased threefold over the past several years. I also like to think that the expert processing of coffee beans and the making of the coffee itself requires extensive knowledge of science and technology. I was trained as a chemist and I can say from personal experience that my scientific background helps me do my job. I think that it's also useful to note that illycaffè's reputation as a world-class coffee producer is based in part on the company's technical innovations. For example, my grandfather, who founded the company, was responsible for inventing a process that allowed heat to be separated from pressure during the brewing process. One of the first machines to successfully make coffee like this is in a small museum located at our corporate headquarters in Trieste. Processes prior to this breakthrough required the water to be heated at very high temperatures, which often burned the coffee and made it much more bitter. At the same time, the pressure could not be sustained at high enough levels to remove all of the unwanted oils, which makes the coffee less smooth and therefore less tasteful. My grandfather also introduced a packaging process that relied on inert nitrogen gas instead of a vacuum. Like vacuum packaging, this protects the coffee from oxidation but, unlike vacuum packaging, it does not suck the flavour out the coffee. More recently, we have introduced a computerized identification machine-sorter that checks individual beans for colour, aroma and composition, removing those beans that do not meet our quality standards. In short, there is a great deal of science in the pleasure of coffee.

Why did illycaffè decide to fund the Trieste Science Prize?

As I mentioned previously, our company has long enjoyed strong ties with the developing world and has embraced science and technology as essential tools for our success. The prize, however, is neither for coffee growers nor for those conducting research to improve the quality of coffee.

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Rather it is to be given for global contributions to science in general made by scientists living and working in the developing world. As such, it is a reflection of our company's broader concerns for utilizing science to help improve the well-being of people living in poorer countries and to assist broader global efforts to set a course for sustainable development. Three pillars – economic, social and environmental – underlie the prospects for sustainable development. Science plays a critical role in each. Economically, sustainable development in the 21st century is driven by knowledge, especially scientific and technological knowledge. As a result, developing nations must embrace science and technology if they hope to improve the economic and social well-being of their people. Similarly, scientific knowledge is at the heart of innovation, which is the primary driver of economic development in our modern world. Over the past five years, we have seen a dramatic increase in the outsourcing of innovation to such developing countries as China and India largely because of their growing scientific and technological expertise. That has not only helped raise the standards of living in those countries but has raised the prospects for accelerated global progress in the future as we enlarge the circle of scientists and technologists. Such a trend should help enhance the prospects for achieving sustainable social progress, especially as the quality of life improves in the world's two most populous nations, which together are home to one out of three people living on Earth. Our world's most critical long-term risks – whether it's global warming, access to adequate supplies of safe drinking water, or ensuring adequate food supplies to feed the world's growing population – cannot be solved without the help of science and technology. My company's self-interest – our need for knowledgeable growers skilled in science and technology to ensure the cultivation of high-quality coffee beans – happily coincides with illycaffè's ethical principles and broader concerns for the creation of a more prosperous and secure world. All of these concerns, moreover, are propelled by an uncompromising quest for excellence. That is what the Trieste Science Prize is all about. It's a reflection of how self-interest and larger abstract concerns for a better world cannot only co-exist but can actually come together in ways that allow both individuals and institutions to 'do well' while 'doing good'. I only hope that the accomplishments of the prize-winning scientists are true to the broad principles that have led to the initiative in the first place. The winners, I am convinced, will not only prove to be an inspiration for citizens in the developing world but for young and old residents alike in the city of the prize's namesake, Trieste. That would enable the prize's overall goals, based on sharing knowledge and honouring excellence, to come full circle: Beginning here in Trieste, emanating to the rest of the world (particularly the developing world), and then returning to the place of its origins to enhance attitudes toward science and technology in the very city where the prize originated. illycaffè is proud to join TWAS in sponsoring this prize. ■

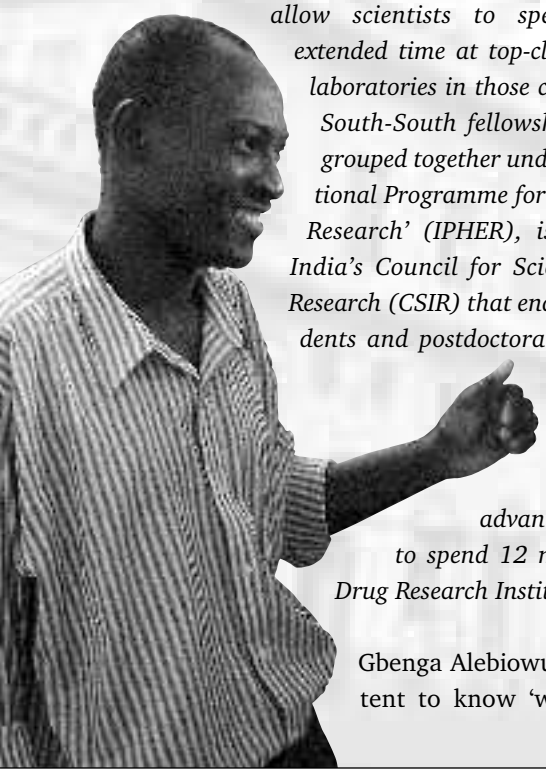
A UNIVERSITY OF COFFEE

In addition to its university-based workshops and seminars organized for growers in the developing world, illycaffè has established a University of Coffee at its corporate headquarters in Trieste. The facility is a state-of-the-art multimedia educational centre that is operated in cooperation with the MIB School of Management of Trieste. The university is designed to assist the professional development of bartenders and to disseminate the culture of coffee to as broad an audience as possible. Among the courses offered are the history of coffee, theory and training on the espresso coffee machine, coffee tasting and techniques for emulsifying milk. For additional information, see www.unicaffe.it.

NIGERIA TO INDIA

IN AGREEMENTS WITH SOME OF THE DEVELOPING WORLD'S MOST SCIENTIFICALLY PROFICIENT COUNTRIES, TWAS NOW OFFERS MORE THAN 200 FELLOWSHIPS EACH YEAR. IN APRIL 2004, FELLOWSHIP RECIPIENT GBENGA ALEBIOWU TRAVELLED FROM HIS NATIVE NIGERIA TO THE CENTRAL DRUG RESEARCH INSTITUTE IN LUCKNOW, INDIA, ON A ONE-YEAR ASSIGNMENT.

TWAS has signed agreements with several of the more advanced developing countries, including Brazil, China, India and Mexico, to allow scientists to spend extended time at top-class laboratories in those countries. Among these South-South fellowship programmes, now grouped together under the banner 'International Programme for Higher Education and Research' (IPHER), is an agreement with India's Council for Scientific and Industrial Research (CSIR) that enables postgraduate students and postdoctoral scientists to conduct research at any of the organization's 38 institutes. Nigerian Gbenga Alebiowu took advantage of the programme to spend 12 months at the Central Drug Research Institute, Lucknow.



Gbenga Alebiowu has never been content to know 'what' without understanding 'why'. Even while attending primary school in Ibadan in southwest Nigeria, he displayed an inquisitive mind.

"In elementary school," he recounts, "we were told that air has weight. How could that be?, I asked myself. You can't even see it."

With his interest sparked, Alebiowu continued his scientific studies in secondary school, roaming effortlessly from biology to mathematics to physics. "Entering the fourth grade at the age of 14, we had to choose our favourite subject," he explains. "I chose science, even though my school didn't have science teachers." This problem, common to many developing countries, did not deter Alebiowu, who went on to obtain his 'O'-level school certificates in these and other subjects. "But I did fail chemistry the first time round," he admits.

CAREER IN CHEMISTRY

Chemistry, however – or, more precisely, pharmacy – has played a major role in Alebiowu's career since leaving school. After working at various jobs for several years, he decided to rekindle his scientific interests and began

[CONTINUED PAGE 12]

studying physics and electronics at Ibadan Polytechnic. Assisting his father in his chemists shop, however, eventually persuaded Alebiowu that he should focus on pharmacy. He enrolled at the University of Ife, also in southwest Nigeria, and graduated with a bachelor's degree in pharmacy four years later.

After a one-year internship in a teaching hospital and another year spent in national youth service, which is still compulsory in Nigeria, Alebiowu returned to his studies, earning a master's degree in pharmaceutics at the University of Ife. Pharmaceutics is the science of dosage forms – in other words, the aspect of pharmacy that is concerned with the formulation of active substances into different delivery systems such as capsules, creams and tablets. He then spent three years in industry, mostly in marketing, but discovered he was not cut out for the business world. "My interest was always in finding out about things," he says. "The inquisitiveness I'd had as a child followed me to adulthood."

Again, the problem of science education and science practice in developing countries took centre stage in his evolving career. "I decided to enroll for a PhD programme, but there was no one at the University of Ife who

CSIR AND CDRI

Established on 8 March 1949 in Chattar Manzil, a grandiose palace built by the nawab rulers of the state of Uttar Pradesh in the 1700s, CDRI was officially inaugurated on 17 February 1951, shortly after India gained independence, as one of the constituent institutes of the newly created Council for Scientific and Industrial Research (CSIR).

Chhitar Mal Gupta (TWAS Fellow 2000 and director of CDRI) is not exaggerating when he says: "CDRI is part of the world's largest research organization."

Indeed, CDRI is one of the 38 institutes, each dedicated to a different area of research and development, that make up the CSIR – an organization that includes 80 field stations and employs some 20,000 staff, 15,000 of whom are scientists and technicians.

Funded by India's central government to the tune of 10 billion rupees a year (more than US$200 million), CSIR accounts for the major part of India's public investment in science and technology.

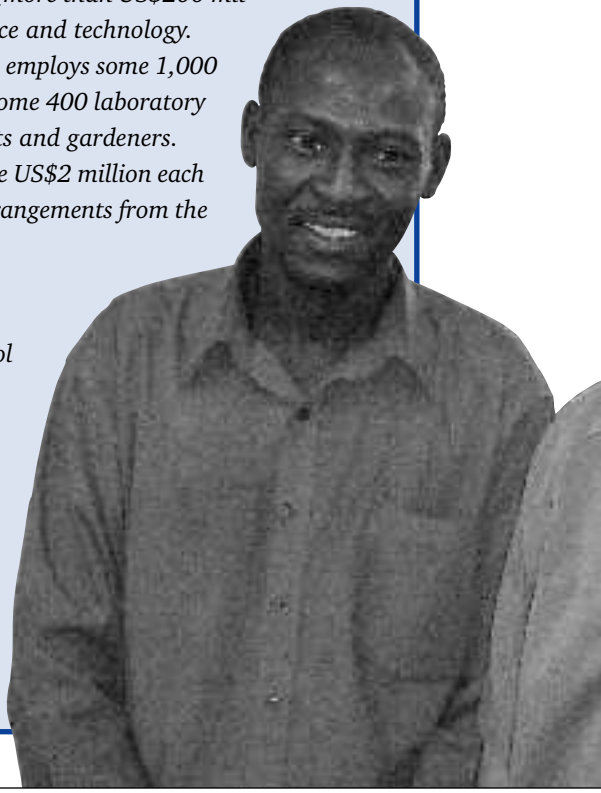
CDRI itself is dedicated to the discovery and development of new drugs. It now employs some 1,000 staff, including 200 scientists each with two or three graduate students and some 400 laboratory technicians. The staff also includes maintenance workers, cafeteria assistants and gardeners.

CDRI has an annual budget of some US$6 million. In addition, it receives some US$2 million each year from outside agencies, including royalties obtained through licensing arrangements from the sale of its six commercialized pharmaceutical products.

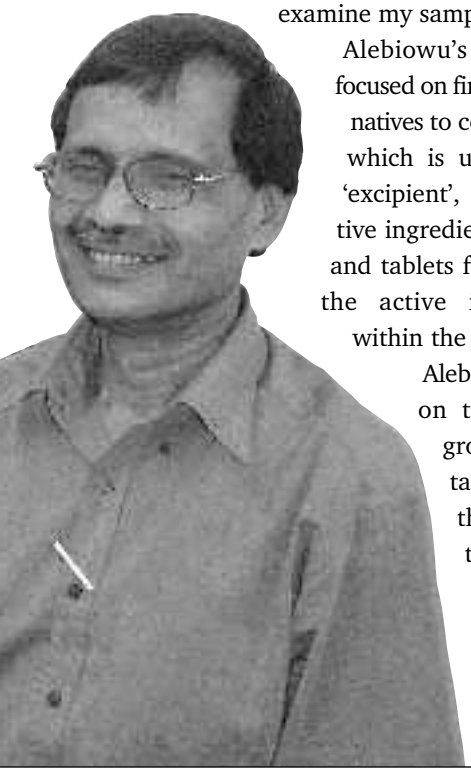
CDRI's mandate has three main elements:

- *Carry out basic research relevant to drug development.*
- *Develop new drugs, specifically for tropical diseases and population control measures.*
- *Build human resource capacities.*

This last area is important because, when CDRI was created, there were very few companies manufacturing drugs in India. The government charged CDRI with the task of nurturing the skills of its staff as the first stage in developing an indigenous pharmaceutical industry. Partly because of the human resource foundation that CDRI has built, the Indian pharmaceutical industry has experienced an annual growth of more than 20 percent over the past five years, twice the world average.



had the right background to supervise me in my particular area of interest: tabletting as a dosage form. Therefore, in 1995, I registered at the University of Ibadan," he explains. "Even there, the facilities left something to be desired. I often had to run from one laboratory to another to use different pieces of equipment to examine my samples."



Alebiowu's research focused on finding alternatives to corn starch, which is used as an 'excipient', or non-active ingredient, in pills and tablets for holding the active ingredient within the pill and/or diluting it.

Alebiowu concentrated his studies on the starches of two plants grown widely in Nigeria, plantain and sorghum. He analysed their physicochemical properties, including their mechanical and compressional qualities, as well as their abilities to release drugs from various powders and tablets. Plantain starch, he discovered, increases the hardness of the capsule and could have useful slow-release properties.

Having obtained his PhD in 2001 and then continuing his studies in the Pharmaceutics and Industrial Pharmacy Department of the University of Ibadan, it was the opportunity to carry out research on slow-release systems that prompted Alebiowu to apply for a TWAS-CSIR fellowship in 2003.

I did not expect to find such good facilities in a developing country.

PASSAGE TO INDIA

His application was approved and, in April 2004, Alebiowu travelled to the Central Drug Research institute (CDRI) in Lucknow, India, on a one-year TWAS-CSIR fellowship.

"The Pharmaceutics and Industrial Pharmacy Department of the University of Ibadan had four lecturers, and five PhD students," explains Alebiowu. "The division I was working in at CDRI had nine research scientists – immediately doubling the number of interactions I could have with other high-level scientists. Not all of the scientists were in my field – four, in fact, were pure chemists, not pharmaceutical technologists like me. But I was especially impressed with the number of trained scientists they had there, and I also did not expect to find such good facilities in a developing country."

[CONTINUED PAGE 14]

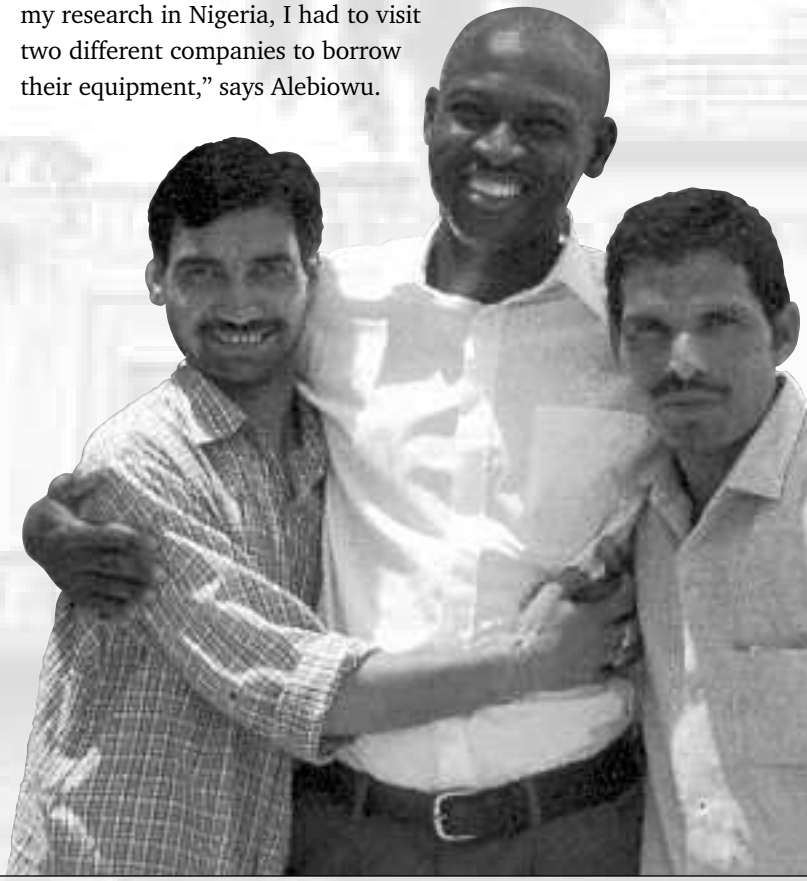
During his 12-months at CDRI, Alebiowu studied controlled drug delivery. In particular, he focused on an anti-inflammatory drug that is typically taken every few hours, three or four times a day, to ease the discomfort of such ailments as rheumatoid arthritis.

"Usually, a capsule, often made of gelatin, will dissolve in about three hours, releasing the drug into the body. In this case, the drug is metabolized and quickly excreted from the body. My aim was to develop a system whereby the drug 'trickles' into the system over 12 to 14 hours allowing a pill or capsule to be taken just once a day."

One advantage of working at CDRI was the availability of a range of polymers suitable for use in capsules as gelatin alternatives, each with different physico-chemical properties. With his supervisor, Satawayan Singh, head of the Division of Pharmaceutics, and another CDRI expert, Madhu Khanna, Alebiowu selected 10 of these polymers and produced a series of mixtures differing in the proportions of each. Just six weeks into his fellowship, he had formulated a number of compression tablets.

The next step was to put these tablets into a 'dissolution tester', which mimics the acidity, temperature and motion of the human stomach. Samples were then taken every 30 minutes and analysed to determine the rate of release of the active anti-inflammatory ingredient.

"The ultraviolet detector that I used for this process was the one that, back in Nigeria, was very old and had ceased to function. In fact, to carry out my research in Nigeria, I had to visit two different companies to borrow their equipment," says Alebiowu.



Despite the generally excellent facilities available at CDRI, Alebiowu did encounter some problems that reminded him of his native Nigeria. Equipment, especially if it was not being used by others in the laboratory, was not well maintained. When a newcomer such as Alebiowu arrived, delays were inevitable as technicians had to be brought in for repairs.

CULTURAL EXCHANGE

After completing his 12-month fellowship, Alebiowu returned to Nigeria in April 2005.

"Before traveling to CDRI, I had a lot of textbook knowledge of controlled drug delivery technology. The institute's Division of Pharmaceutics enabled me to gain hands-on experience in carrying out research on these systems," says Alebiowu. "In particular, I worked closely with Madhu Khanna, who is a meticulous researcher. She always had patience for me and I enjoyed working with her.

"I also observed that the Indian government, through the CSIR, is properly funding research by providing the facilities and materials that scientists need," adds Alebiowu. "The government of India should be given credit for this."

But it was not only the laboratory lessons that made the year a memorable one for Alebiowu.

"In India, I encountered a lot of wonderful people," he recalls, "not just in the laboratory, but in church and in the market places." He has also acquired a taste for the sub-continent's spicy cuisine.

"My fellowship in India provided a wonderful opportunity to learn not only through scientific research but also from people of another culture and other religions. For this opportunity, I am very grateful to both TWAS and CSIR," says Alebiowu.

My fellowship provided a wonderful opportunity to learn through scientific research and from people of another culture.

NIGERIA AGAIN

"The knowledge I gained at CDRI will be useless if I can't impart it to other people," observes Alebiowu, who, in his current position as senior lecturer at Obafemi Awolowo University, Ile-Ife, aims to teach a new generation of pharmacy students in his native Nigeria.

Buoyed by his experience on the TWAS-CSIR fellowship, he also plans to continue his research.

"I will apply what I learned in India to the work I did for my PhD," says Alebiowu. "I plan to test plantain starch again for its slow-release properties. I suspect it will be useful."

Having already benefited from one TWAS programme, he will soon apply for a TWAS Research Grant to help buy the equipment that was available to him at CDRI but is lacking at Obafemi Awolowo University. With his experience in India to back up his application – together with the three research papers that are now being drafted to report on the work he carried out there – his application is sure to be a strong one. ■

[CONTINUED PAGE 15]

SCIENCE IS STIRRING IN THE ARAB REGION

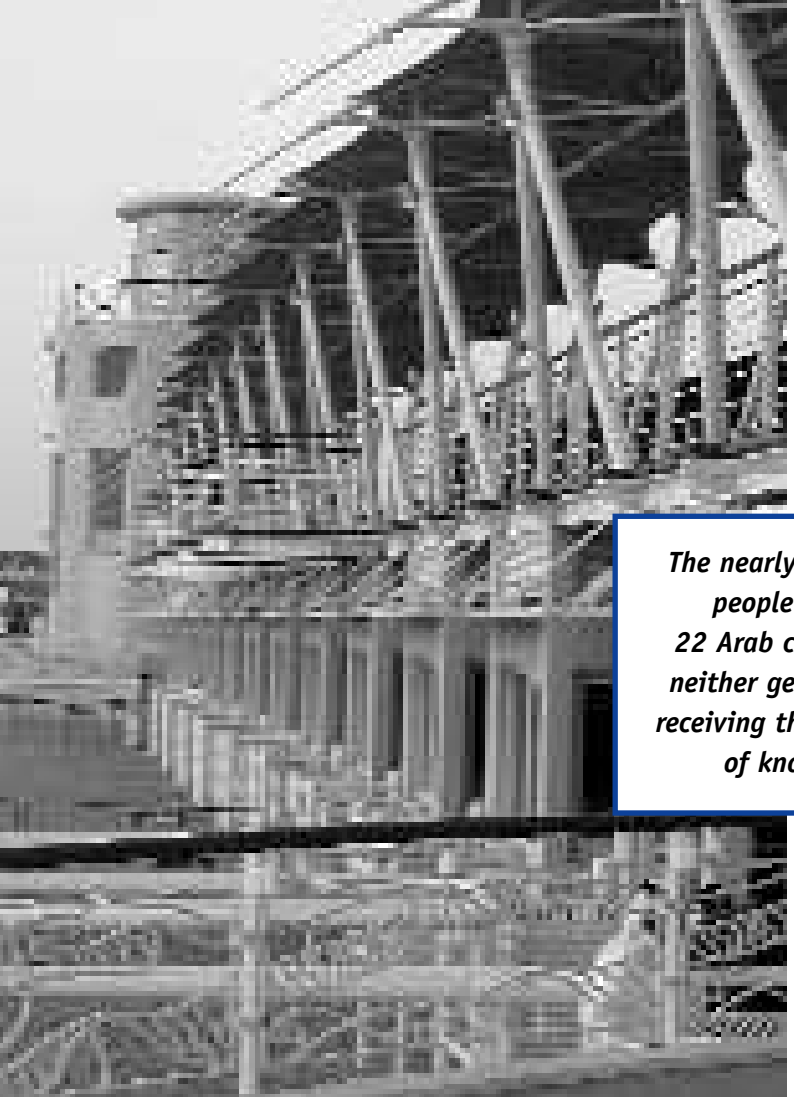
THREE RECENT INITIATIVES SUGGEST THAT SCIENCE MAY FINALLY BE ON THE RISE IN ONE OF THE WORLD'S MOST TROUBLED REGIONS. TWAS FELLOW FAROUK EL-BAZ EXPLAINS WHY.




According to the Arab Human Development Report: Building a Knowledge Society*, published in 2003 by the United Nations Development Programme (UNDP), Arab countries have among the highest illiteracy rates in the world – an estimated 25 percent for males and 50 percent for females.*

Not surprisingly, then, Arabs, who constitute 5 percent of the world's population, publish less than 1 percent of the world's literature. The number of books written in Arabic each year is far less than those published in Greek. And while the number and variety of magazines, newspapers, news broadcasts and web sites have experienced encouraging increases over the past several years (thanks largely to advances in satellite television and electronic communications media), the media still fails to provide Arab citizens with the broad range of choices that are available throughout much of the rest of the world.

Such figures and trends clearly indicate that the nearly 300 million people living in 22 Arab countries are neither generating nor receiving their fair share of knowledge.



Meanwhile, virtually no effective mechanisms are in place to translate the minimum amount of scientific knowledge produced by Arab scientists into useful products and services. As a consequence, the number of international patents registered by Arab scientists and technologists in the United States has been negligible. For example, between 1980 and 2000, South Korean scientists and technologists received nearly 50 times more patents than their small circle of counterparts in all 22 Arab countries combined.

The nearly 300 million people living in 22 Arab countries are neither generating nor receiving their fair share of knowledge.

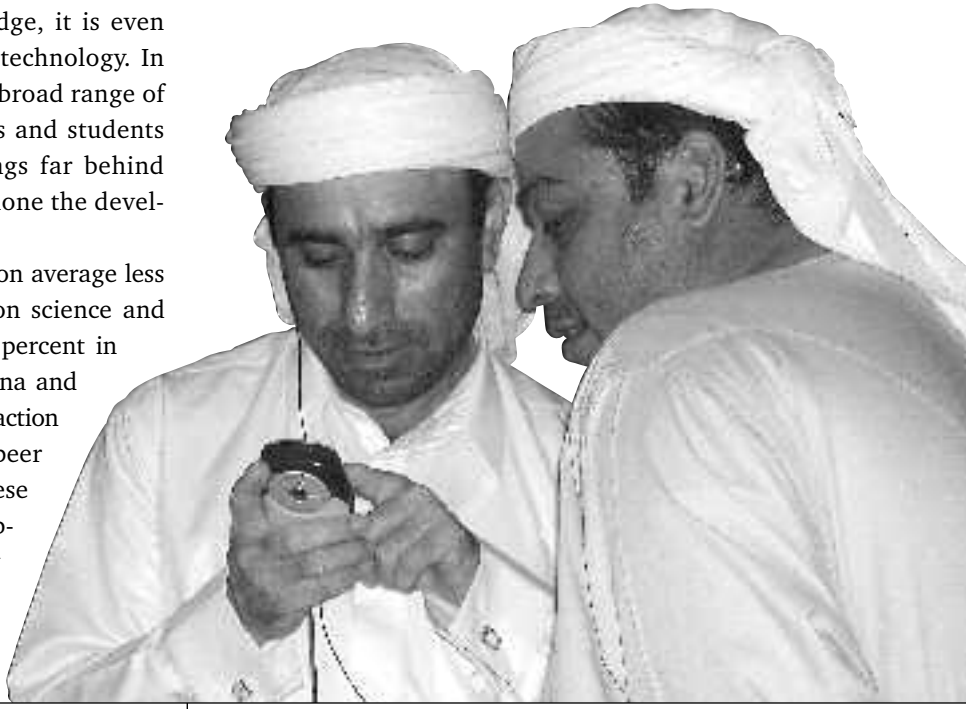
Needless to say, the Arab region is not even on the periphery of global activities in science, technology and innovation. And, in the modern world, where knowledge rules, those without it are bound to fail.

In light of these disturbing trends, calls for reforming education at all levels, especially science teaching and technological training, have emerged with increasing regularity both from within and outside the Arab region.

In addition to three reports on Arab human development that have been published by the UNDP since 2002, other reports have been prepared by the World Bank and several research centres in the Arab world.

While the situation is discouraging in the humanities and in terms of general knowledge, it is even worse when it comes to science and technology. In these fields of endeavour, output on a broad range of fronts, including publications, patents and students receiving advanced degrees, often lags far behind the rest of the developing world, let alone the developed world.

Arab countries, for example, spend on average less than 0.2% of their national budgets on science and technology compared to more than 3 percent in Japan and more than 1 percent in China and India. Arab scientists account for just a fraction of a percent of articles published in peer reviewed international journals. Chinese scientists, in comparison, in 2004 published more articles on nanotechnology in international refereed journals than scientists in the United States.



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ARAB WOMEN MAKE SIGNIFICANT STRIDES IN EDUCATION

"Arab women are making significant strides in education," says Rafia Ghubash, president of the Arabian Gulf University, Bahrain, and head of the Arab Network for Women in Science and Technology (ANWST).

"Over the past decade," Ghubash says, "the literacy rate among Arab women has risen from 35 to nearly 48 percent. That's still a lower percentage than in most other developing regions but it represents a marked improvement over the past."

"The most significant progress in the education of Arab women," adds Ghubash, "has taken place at universities where women now often exceed 50 percent of the student population."

Most Arab women are pursuing university degrees in the arts and humanities but they also often represent a majority of students in medicine.

"As in many other regions of the world, the enrolment of women continues to fall short in science and engineering," says Ghubash. "For this reason, special efforts must be made to encourage women to seek degrees in these disciplines." ANWST, launched in Bahrain last February, is designed to provide an organizational structure for pursuing this goal.

The most significant problem facing the growing number of educated women living in Arab countries is what happens to them after they earn their degree and enter the workforce where strict cultural traditions and gender discrimination often prevent them from holding positions commensurate with their education.

"Contrary to prevailing global perceptions," says Ghubash, "women in Arab countries are now a formidable presence in universities. But for that investment to generate substantial returns to society, women must gain positions of responsibility and authority in both the public and private sectors. Only then will the full potential of women be realized. And that, in turn, will pay significant dividends not only to individual women but to the nations in which they live and work."

Despite the diversity of sponsors and authors, all of these reports share a common set of recommendations that include a need to establish democratic governance; improve education; expand and strengthen the private sector; and develop effective strategies for empowering women.

These critical goals cannot be advanced without the creation of a knowledge-based society. Freedom through democracy, for example, requires an understanding of an individual's responsibilities toward society and humanity; a growing economy requires an innovative and well-trained workforce; and gender equality can only take root and flourish in a tolerant, well-informed society.

For all of these reasons, it is clear that reforms in the region must focus on updating the educational system (from primary school through to postgraduate study), instituting career-long training programmes for the workforce, and increasing overall support of science and technology in ways that encourage and reward individual initiative and institutional risk-taking.

WAY FORWARD

With assistance from the United Nations Educational, Scientific and Cultural Organization (UNESCO), Arab scientists and technologists – living within the region and elsewhere – have launched a series of initiatives

designed to prepare Arab countries for a better future. These initiatives include: the Arab Science and Technology Foundation (ASTF), the Arab Academy of Sciences (AAS), and the Arab Network of Women in Science and Technology (ANWST, see box, page 18).

In April 2000, a group of concerned scientists gathered at the University of Sharjah in the United Arab Emirates (UAE) to establish ASTF as a nongovernmental, nonprofit organization dedicated to promoting and supporting scientific research in Arab countries. Seven months after the launch, the foundation received a US$1 million donation from His Highness Sultan Al Qasimi, Ruler of Sharjah, whose strong personal and financial support has proven instrumental in the foundation's early success.

Arab scientists and technologists have launched a series of initiatives designed to prepare Arab countries for a better future.

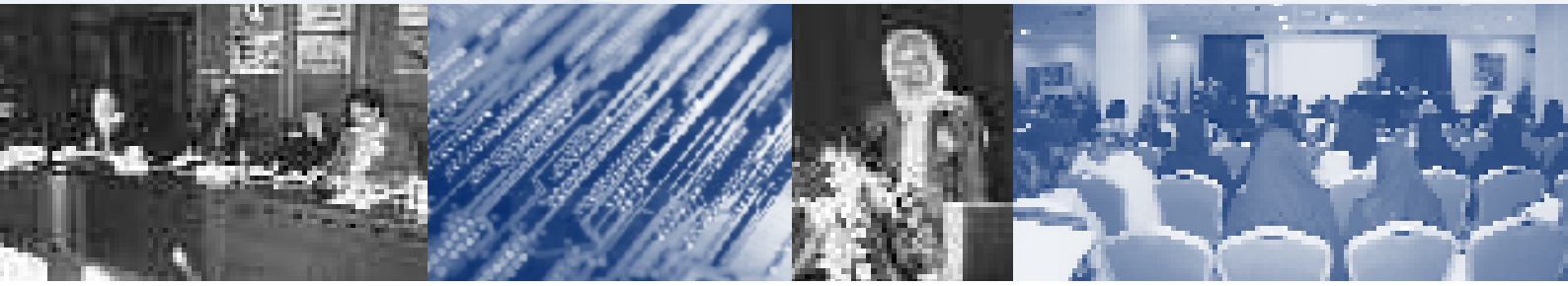
Abdalla Al-Najjar, professor of physics at the University of Sharjah, heads the foundation and Arab scientists from within and outside the Arab world have been appointed to its board.

ASTF is responsible for evaluating and approving a broad range of scientific research and technology programmes. The organization focuses much of its efforts on encouraging cooperation among Arab scientists. Yearly conferences are held to galvanize activities and publicize the significance of science and technology for innovation and sustainable economic development.

Specifically, ASTF has launched two major programmes. One, which is financed by the Libyan government and concentrates on solar energy, could ultimately help reduce the cost of producing desalinated water. This is a critical area of research for the Arab region where Gulf States alone boast more than half of the world's desalination plants. Such plants enable the region to make up for its chronic shortfall in fresh water but they do so by consuming enormous quantities of energy – namely oil and natural gas – which are not only costly in their own right, but represent lost export earnings and contribute to global warming. Greater reliance on solar energy, which is in ample supply in the region, could reduce regional dependence on nonrenewable energy sources for operating desalination plants. That, in turn, could have profound economic and social implications for a region with a growing population that is demanding ever-increasing supplies of fresh water.

The second programme, which ASTF has established jointly with the Sandia National Laboratory in the United States and UNESCO, sponsors international research projects that allow Iraqi scientists to conduct research and work with colleagues in other countries.

Iraq's science and technology sectors, including its universities (once among the best not just in the Arab region but throughout the developing world) have suffered enormously over the past 25 years. The precipitous decline in the quality of Iraq's science and technology sector, which began with the Iran-Iraq War in the 1980s, was subsequently exacerbated by the first



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Gulf War in 1991 and the United Nations embargo that followed.

The sector received another pounding – a final blow, if you will – during the United States-led invasion of Iraq in March 2003. The post-invasion state of lawlessness and chaos led to the ransacking of the few remaining functional laboratories. The ASTF scheme is designed to help initiate what will likely be a long process of recovery and renewal.

FUTURE GOALS

Individual, corporate and governmental contributions to ASTF's endowment fund were intended to serve as the backbone of the organization's funding. After a slow start, this strategy has begun to take off. Abdul-Latif Jameel, a successful Saudi businessman, has recently pledged US$1 million per year over the next 10 years to support scientific research projects that are open to a competitive peer-review system. Such developments – both financial and strategic – bode well for the foundation's future.

The peer-review framework created by ASTF has brought to the fore another critical issue that needs to be addressed if the Arab region is to strengthen its science and technology capacity – that is, the need to establish merit-based institutions, free of political pressure, that are capable of identifying and supporting eminent local scientists. Such organizations could also prove instrumental in elevating the profile of science in national budget debates as well as helping to enhance public awareness of the role of science and technology in nations' economic and social well-being.

In response to such concerns, the Arab Academy of Sciences (AAS) was launched in Beirut, Lebanon, in 2002 with the help of the Science Division of UNESCO (see *www.arabacas.org*). Adnan Badran (TWAS Fellow 1991), a prominent Jordanian scientist who had previously served as Jordan's minister of agriculture and UNESCO's deputy director-general for science, was named as the academy's first president. In April 2005, Badran was appointed Prime Minister of Jordan (see *People,*

Places, Events, page 46) but he will continue to preside over the AAS.

AAS is currently producing a five-volume encyclopedia on the state of sustainable development in the Arab region – an ambitious project sponsored by UNESCO and the Encyclopedia of Life Support Systems (see *www.eolss.net*).

The encyclopedia, scheduled for publication in late 2005, will be the largest collection of scientific knowledge ever assembled in the Arab region. The coordinating committee consists of Prime Minister Badran, D. Al-Goubaisi, UAE, and Mustafa El Tayeb, director of the UNESCO Science Policy Division.

STATUS OF WOMEN

As in many other regions in the world, the scientific community in the Arab region consists of a disproportionate number of men. There are many reasons for this gender imbalance: the traditional role that women play in society; chronic efforts – most unintentional, others not – to discourage women from entering fields in science and engineering; fear among young women that they cannot compete in these demanding disciplines; and the paucity of role models that can provide inspiration and encouragement.

Regardless of the reasons, proponents of creating a broad-based strategy for science-based sustainable development agree that their goal will not be met without expanding and strengthening the role of women within the Arab region's scientific community. This sentiment has led to the establishment of the Arab Network of Women in Science and Technology (ANWST, see box, page 18).

Launched in Bahrain in February 2005, ANWST is designed to lend support to women pursuing careers in science and engineering, and it will ultimately serve as a strong voice for the appointment of women to high-level posts in the management of science and in public administration.

UNESCO's Science Policy Division again proved instrumental in the establishment of the organization. The UNESCO Cairo Office (in cooperation with the Islamic Educational, Scientific and Cultural Organization,

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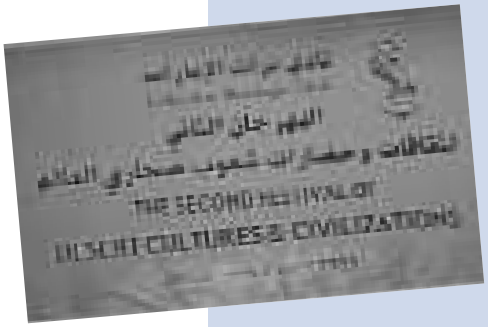
DUBAI CALL FOR GREATER S&T INVESTMENT IN ARAB REGION

The Arab Region Roundtable on Harnessing Science, Technology and Innovation for Sustainability, held on 17-18 April in Dubai, United Arab Emirates (UAE), concluded with a statement calling for Arab countries "to pay greater attention to science and technology to accelerate a regional transition toward sustainable development."

The roundtable, co-sponsored by the Initiative on Science and Technology for Sustainability at Harvard University (ISTS), the Academy of Sciences for the Developing World (TWAS), and the Zayed International Prize for the Environment, was held in conjunction with the Second Festival of the Cultures and Civilizations of World Deserts. More than 80 people from 25 countries participated in the roundtable discussions.

"Science and technology," the roundtable's concluding statement declares, "are vital components in understandng and confronting the challenges and issues in the region and in providing solutions for greater sustainability." For this reason, the statement urges Arab governments to spend at least one percent of their gross domestic product on science and technology (a five-fold increase over average expenditures today) and to launch a number of capacity-building programmes in science and technology, including transforming existing research institutions into centres of excellence (or building new centres if this is not possible) and funding an extensive research grants programme for Arab scientists.



Efforts to enhance regional scientific and technological

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capabilities, the statement acknowledges, will depend on other broad-based social and political reforms, including continuing efforts to reduce illiteracy rates (which currently average 25 percent for men and 50 percent for women in Arab countries), improvements in education (by focusing on the teaching of analytical skills instead of emphasizing rote memorization), and a strengthening and expanding of initiatives to promote good governance.

Scientists, the statement notes, must be engaged "to the greatest extent possible in the development of strategies and programmes aimed at achieving sustainable development." To advance this goal, governments must continue to broaden their efforts "to recognize and promote excellence" and to develop strategies for using "scientific knowledge and tools in sound decision-making."

The statement points to a number of resource issues that could serve as the centre-piece of a science-based agenda for sustainable growth in the region. These issues include water deficits, desertification, coastal ecosystems and dryland biodiversity.

The recommendations will be widely distributed both to governments within the Arab region and international organizations. The ultimate purpose of the statement is to help frame the programmatic agenda for the International Year of Deserts and Desertification scheduled to take place in 2006. ■

I am more optimistic about the future of science and technology in the Arab region now than at any other time in my career.

ISESCO), handled the logistics of the preparatory meetings that led to the creation of the organization as well as early drafts of ANWST's goals, objectives and bylaws.

Among its primary responsibilities, ANWST will recognize excellence in science among female scientists by overseeing a series of prizes and awards. The first ANWST award, sponsored by the Al-Nahda Society in Saudi Arabia, will consist of a yearly scholarship for graduate and post-graduate study abroad (see *www.undp.org/info21/saudi/nahda.htm*) to be awarded to a promising young female scientist from Saudi Arabia.

I am more optimistic about the future of science and technology in the Arab region now than at any other time in my career. The positive response from both governments and the private sector, combined with the widespread publicity that these initiatives have received, suggests that science and technology may finally be reaching a level of prominence and that such trends will ultimately have a positive impact on the region's overall development efforts.

Farouk El-Baz

Science is stirring in the Arab region. I think it is fair to say that if current trends continue, the transforming powers of science may prove to be a driving force for reform in a proud and resilient region that has been knowledge-poor for far too long. ■

Farouk El-Baz
TWAS Fellow 1985
Director of the Center for Remote Sensing
Boston University, USA

Adjunct Professor of Geology
Faculty of Science, Ain Shams University
Cairo, Egypt

GOOD NEIGHBOURS MAKE GOOD SCIENCE

GREATER COLLABORATION BETWEEN THE SCIENTIFIC COMMUNITIES IN INDIA AND PAKISTAN MAY FINALLY BE TAKING HOLD TO THE BENEFIT OF BOTH NATIONS, AND BIOTECHNOLOGY MAY BE LEADING THE WAY.

Despite their proximity and common histories, scientists in India and Pakistan have been isolated from one another for some five decades. Political differences have meant that exchange visits and collaborative research projects between the neighbouring countries have been almost non-existent. Over the past few years, tensions between the two governments have started to thaw – allowing scientists and science-based businesses to begin building bridges designed to address a number of critical problems. Anwar Nasim (TWAS Fellow 1987, Pakistan) and B.S. Bajaj (Federation of Asian Biotech Associations, India) describe the progress that has been made to date.

In April 2005, Pakistan's president, General Pervez Musharraf, attended a cricket match in India as the guest of Manmohan Singh, India's prime minister. This first official state visit between the two nations in some 50 years is indicative of the political progress that has recently been made in overcoming the divisive issues that have soured relations for the past half-century. Indeed, in the past few months, bus and train links across the disputed Kashmir border have been re-established, enabling many divided families to reunite after years of forced separation.

Against this background of a thawing in international relations, scientists in the two nations have been quick to see the advantages of exchanging information and developing collaborative research projects, given that the two countries – with their centuries-old common history – share many of the same challenges.

A glance at some figures reveals how closely linked the two nations are. The 2003 *UNDP Human Development Report*, for example, ranked India and Pakistan at 127 and 144 in the world, respectively. These positions

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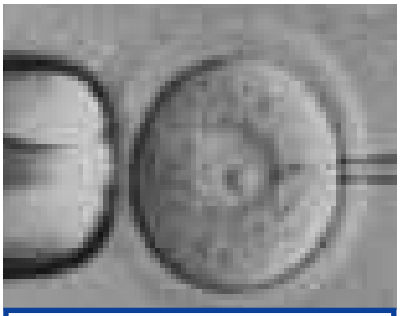
can be compared with those of other developing countries such as Brazil (65) and Mexico (55). Likewise, adult literacy rates in India and Pakistan are 58 and 44 per cent respectively, compared to 87 and 91 percent in Brazil and Mexico. And, although India has more than 1 billion inhabitants and Pakistan some 150 million, the per capita gross domestic products of the two countries are also similar – US$477 and US$391. Among the common problems afflicting these two giants of the developing world are such issues as health, agricultural production, and the management of water resources for both irrigation and human consumption – issues that scientific collaborations can help address.



Among common problems afflicting India and Pakistan are health issues, agricultural production and water resource management.

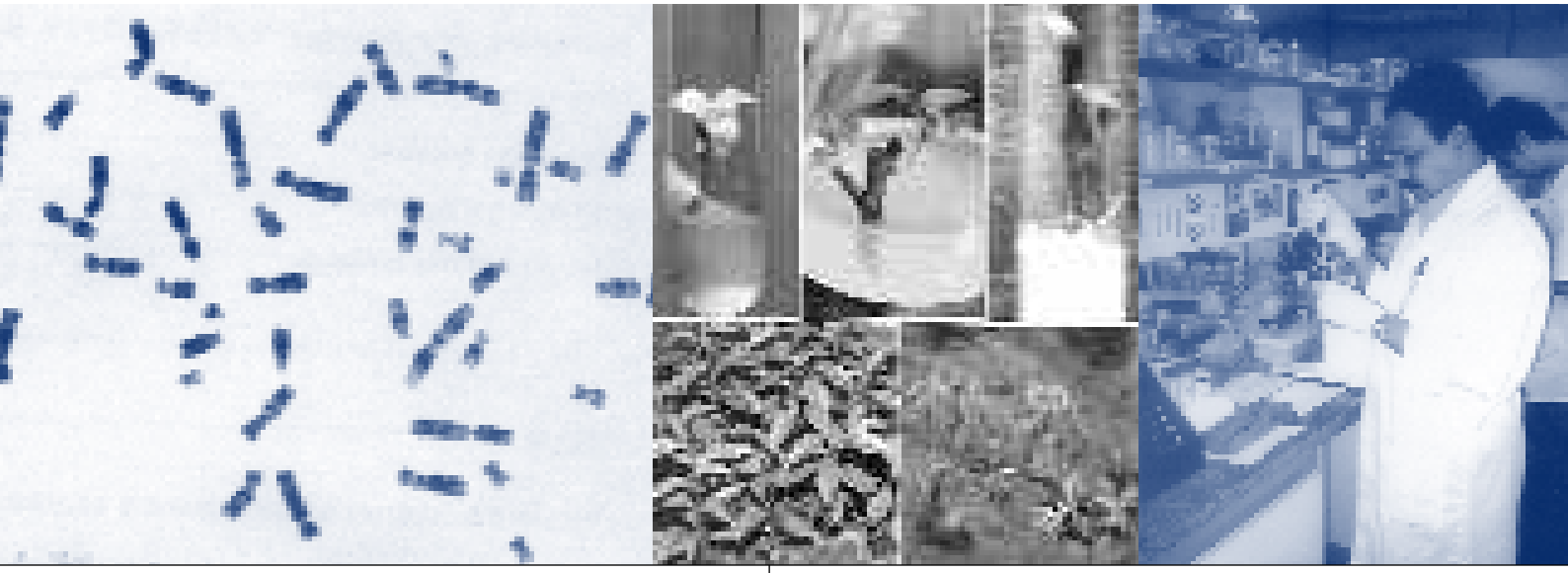
Among the scientific disciplines that are taking the lead in building bridges across the border is biotechnology – an area of science that is recognized as having enormous economic potential. Significant impacts of biotechnology in agriculture, the environment, health and industry, for example, have all been documented.

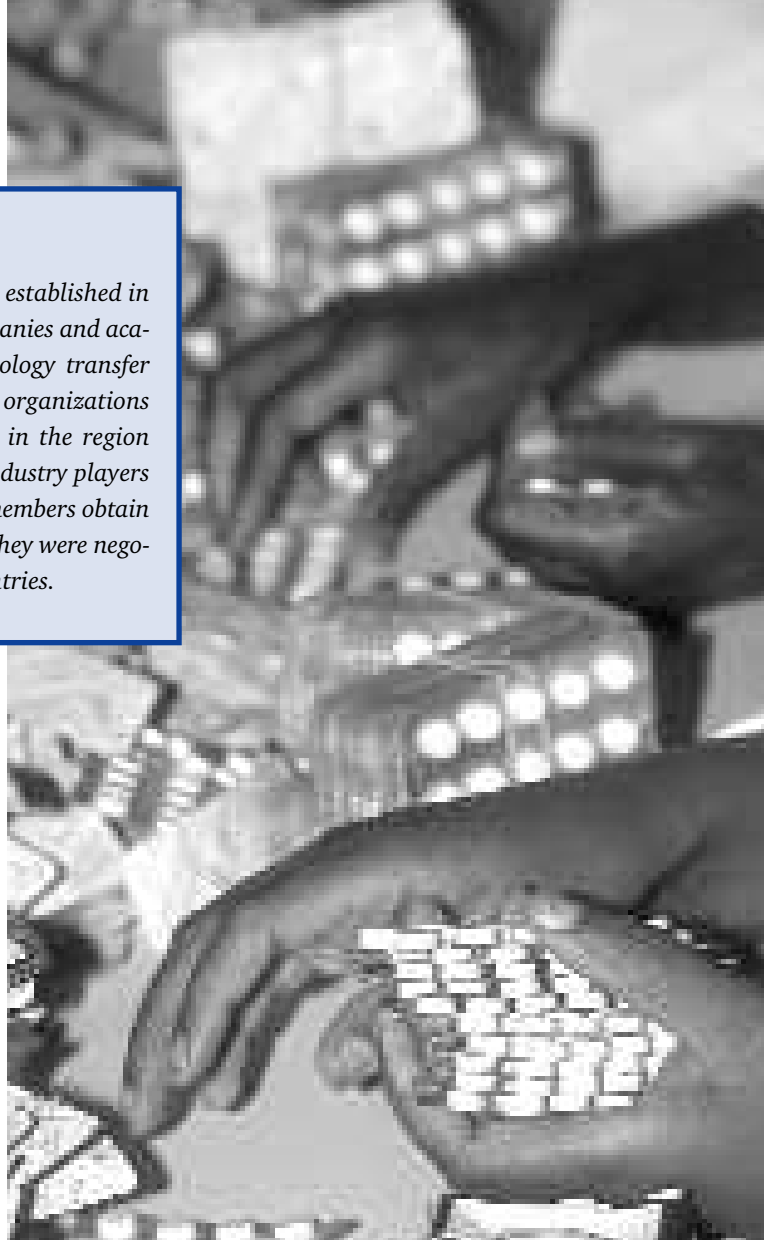
A combination of the economic potential of biotechnology and the need for regional cooperation led to the recent establishment of BioEurope, which specializes in biological products for plant nutrition. Both BioEurope and BioNorthAmerica, a similar effort aimed at bringing together scientists and those involved in the commercial production and marketing of biotech products in North America, served as models for BioAsia, which held its inaugural meeting in Hyderabad, India, in February 2004.

BioAsia's first event provided a unique opportunity to develop biotech-related business relationships with companies and investors from around the world. In particular, a side event, the B2B Forum, offered unparalleled opportunities for biotech companies, the pharmaceutical industry and investors to discuss business opportunities of mutual interest. The B2B Forum also featured an exclusive partnering programme that accommodated a large number of one-to-one meetings.

During the BioAsia 2004, several agreements were signed between industry, institution and association participants. These included:

- Biological E Ltd., Hyderabad, India, and AMSON Vaccines and Pharmaceuticals Pvt. Ltd., Rawalpindi, Pakistan, to export and import vaccines and pharmaceuticals, including anti-snake venom, and to share technologies.
- TransgeneBioteck Ltd., Hyderabad, and AMSON Vaccines and Pharmaceuticals Pvt. Ltd., Pakistan, to facilitate





FABA

The Federation of Asian Biotech Associations (FABA), was established in February 2005 with the aim of helping Asian biotech companies and academics forge business links through, for example, technology transfer agreements. A major objective of FABA is to help member organizations become familiar with biotechnologies that are available in the region through hosting trade shows and fostering links among industry players and between industry and academia. FABA will also help members obtain royalties, perhaps with better terms than they might get if they were negotiating on their own with companies from developed countries.

technology transfer and product acquisition through licensing arrangements.

• All India Biotech Association (AIBA), New Delhi, and Dr. Uzair-ul-Ghani, consultant, AMSON Vaccines and Pharmaceuticals Pvt. Ltd., Pakistan, to identify companies and entrepreneurs interested in technology transfer and product acquisition in both India and Pakistan; and to link companies and entrepreneurs interested in contract research and contract manufacturing in both countries.

• Magene Life Sciences Pvt. Ltd., Hyderabad, and the National Commission on Biotechnology, Islamabad, Pakistan, to develop customized biotechnology teaching modules and provide hands-on training in a 'wet lab' at Magene's headquarters.

• AIBA, New Delhi, and the Organization of Islamic Conference Standing Committee on Scientific and Technological Cooperation (COMSTECH), Islamabad, Pakistan, to exchange scientific literature and other relevant information on the development of biotechnology between AIBA and biotech associations in Pakistan, and to help forge partnerships between companies in both countries.

Such agreements testify to the success of BioAsia 2004, the first major initiative to allow the exchange of scientists between India and Pakistan. BioAsia has now become an annual event. A second meeting was held early in 2005 and another is scheduled for February 2006.

BioAsia has also received extensive press coverage, including a feature article in *Nature*, which ensured that news of the scientific *rapprochement* reached the global research community. The title of the *Nature* article, 'Biotechnologists seek to bridge South Asian divide', was of special significance and researchers on both sides of the border earnestly hope that these dreams will be realized in the not-too-distant future.

Indeed, such bridges are already being built. AIBA, for example, a network created to facilitate the exchange of information between different organizations, has transferred its experiences across the border and helped to create a similar body in Pakistan. In addition, the formation of the Federation of Asian Biotech Associations (FABA) was announced at BioAsia 2004, with eight founding members: India, Israel, Malaysia, Pakistan, the Philippines, Singapore, Sri Lanka and Thailand. When FABA was formally launched in February 2005, the inclusion of Iran and Saudi Arabia raised numbers

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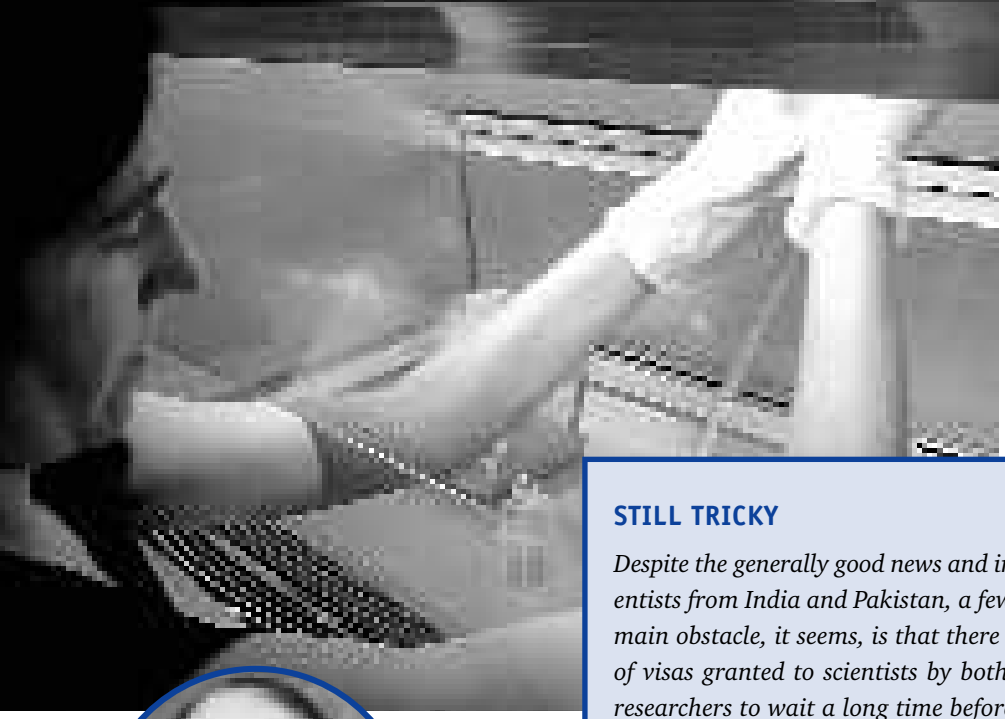

STILL TRICKY

Despite the generally good news and increasing collaboration between scientists from India and Pakistan, a few problems have been reported. The main obstacle, it seems, is that there are still restrictions on the number of visas granted to scientists by both governments. That often requires researchers to wait a long time before they can confirm their journey to their hosts in the neighbouring country. Moreover, travel between the two countries remains difficult as flights are often delayed or cancelled.

Anwar Nasim

of founding members to 10. FABA is designed to be a platform that will help nations tap each others strengths for the overall development of biotechnology in the Asian region (see box, page 25).

Such collaborations and interactions are of special interest to TWAS, committed, as it is, to the promotion of science and technology in developing countries. Indeed, such collaborations and interactions are fundamental components of many of its programmes, as highlighted in the Academy's current *Strategic Plan* (2004-2008).

BioAsia has now become an annual event.

At present, TWAS counts some 760 eminent scientists as Fellows, with 132 from India (the largest number of any country) and 31 from Pakistan. During TWAS's 9th General Conference, held in Beijing, China, in 2003, it was unanimously decided that the Academy should place special emphasis on helping the world's 50 least developed countries (LDCs). An initiative such as BioAsia can provide a model whereby biotechnology could be used as a vehicle for economic development in southern Asia (Bangladesh, Bhutan, Cambodia, Myanmar and Nepal, for example, are all LDCs) and sub-Saharan Africa, where many other LDCs are located. A focused and well-defined approach by TWAS, using a specific discipline such as biotechnology, may indeed be a model that merits serous consideration for adoption as a future programmatic activity of the Academy. In this regard, FABA looks forward enthusiastically to successful collaborations with TWAS. ■

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DIVERSITY RULES

PETER RAVEN (TWAS ASSOCIATE FELLOW 1993) HAS DEVOTED HIS CAREER TO EXAMINING THE EARTH'S BIODIVERSITY AND SEEKING WAYS TO INCREASE PUBLIC APPRECIATION FOR THE ROLE THAT BIODIVERSITY PLAYS IN HUMAN SURVIVAL AND WELL-BEING. HIS EFFORTS HAVE MADE HIM ONE THE WORLD'S MOST RECOGNIZED AND RESPECTED BIOLOGISTS.

He was born in Shanghai in 1936, an international city of intrigue controlled by British authorities, and raised in northern California during the 1940s, before suburban sprawl defined the landscape. Since 1971, he has lived and worked in St. Louis, Missouri, in the heart of America's heartland.

Today, at age 69, he still travels widely keeping a keen eye on our global environment and the biodiversity that helps to sustain us all.

He is Peter Raven, long-time director of the Missouri Botanical Garden and one of TWAS's most eminent members.

Raven (TWAS Associate Fellow 1993) recently visited the Academy's secretariat in Trieste to chair a meeting of Sigma XI's Scientific Expert Group of Climate Change and Sustainable Development on 29-31 March, sponsored by the United Nations.

"My interest in plant biology and by extension the environment began at an early age," explains Raven. "I was only eight years old when I joined an after-school programme sponsored by the California Academy of Sciences. The highlights of the programme, at least the activities that I remember most, were weekly lectures on scientific subjects and weekend and holiday field trips that allowed enthusiastic school-age children to explore the local environment. It was during this time that I first began to collect and study plants."

Excellent grades in primary and secondary school gained Raven acceptance to the University of California at Berkeley, where he was awarded a bachelor of science degree in botany in 1957. He then went on to the University of California at Los Angeles (UCLA), for graduate studies in plant sciences, earning a PhD in 1960.

Following his degree, Raven found himself at Stanford University, also in California, where he was an associate professor and youthful colleague of Paul Ehrlich, author of *The Population Bomb*, a book that, during the tumultuous late 1960s, helped to shape public debate about the relationship between population growth and the environment. Widely read and even more widely quoted since then, the book continues to spark controversy some 40 years after its publication.

[CONTINUED PAGE 28]

"The late 1960s were a defining moment for those of us engaged in America's second environmental movement," says Raven. (The first environmental movement in the United States occurred in the early decades of the 20th century and was led by President Theodore Roosevelt.)

"The issues that captured attention – pollution, preservation and environmental justice – were largely pursued within a domestic context. The notable successes that took place – the first Earth Day on 22 April 1970, which involved an estimated 20 million people; the creation of the US Environmental Protection Agency in 1970; and a dramatic increase in public concern for the environment – should not be minimized. Yet I think it's fair to say that discussions both within America's scientific community and among the public were largely fashioned by concerns within the United States."

The late 1960s were a defining moment for those of us engaged in America's second environmental movement.

Ehrlich's book, with its emphasis on the potential devastating impact of global population growth and species loss, helped to broaden the focus from domestic to global concerns. The transformational moment in this rapidly evolving 'environmental journey' took place in 1972 with the UN Conference on Environment in Stockholm.

Despite the summit's notable success in raising global awareness of environmental issues, Raven notes, "ties between the scientific and policy communities during this period remained tenuous." Indira Gandhi, the Prime Minister of India, was the only head of state to participate in the summit. "Compare that to the large turnout of high-level political officials at the Rio Earth Summit in 1992 and the World Summit on Sustainable Development in Johannesburg, South Africa, in 2002."

Raven was able to help refine the research agenda on biodiversity during this period by chairing a pair of gov-

ernment-sponsored studies: one on research priorities in systematics and evolution, and another on research priorities in tropical biology.

"Two forces – one social and the other scientific – were driving our thinking at the time. We had strong reason to believe that ecosystems were being damaged and destroyed at unprecedented rates worldwide. We also realized that new research tools, which were providing us with an ability to analyse macromolecules and handle data with increasing precision, gave us an unprecedented opportunity to examine the rate of biodiversity loss and to devise effective science-based strategies for reversing these ominous trends."

There was a growing consensus within the scientific community, Raven says, "that progress would not only depend on a vigorous research agenda but also on the creation of training programmes in developing countries to help build expertise in those parts of the world where biodiversity flourished but scientific know-how was in short supply.

"In fact, the two forces lent themselves to a mutually reinforcing strategy: the rapid destruction of ecosystems meant that we had to work quickly, and building scientific capacity in the developing world would enable us to do just that in parts of the world where the crisis was most acute."

In 1971, Raven was appointed director of the Missouri Botanical Garden, the oldest botanical garden in the United States. At the time, the institution consisted of about 85 staff and three or four doctoral-level scientists. With an impressive array of plants, it provided an alluring destination for residents in St. Louis and the surrounding areas who visited to learn more about the world's vast diversity of plant life. Research and global outreach, however, were not extensively pursued.

Today the Missouri Botanical Garden has an annual budget US$30 million and a staff of 450, including about 50 PhD-level scientists, some of whom work abroad. An additional 30 to 40 graduate students come from nearby Washington University, the University of Missouri-St. Louis and St. Louis University.

Despite its broader reach, the institution continues to cater to local citizens. Indeed, roughly one-third of the annual budget (some US$9 million) is derived from a dedicated tax placed on local properties and those revenues must be used for the benefit of citizens in St. Louis and the surrounding area.

The remainder of the budget – some US$20 million generated primarily by annual

[CONTINUED PAGE 30]

Wide-ranging research and training activities make the Missouri Botanical Garden a sterling example of North-South cooperation.

subscription fees from its 35,000 members and by grants, contracts, and the interest on its endowment fund – supports wide-ranging research and training activities that make the Missouri Botanical Garden one the world's sterling examples of North-South cooperation.

"Our success," says Raven, "has been due to our ability to send our scientific staff to where the biology is – and that means the developing world. By having our staff actually live and work in countries around the world for extended periods, we are able to do much more than would be possible through a series of short-term expeditions."

In Ecuador, for example, David Neal, one of the institution's most successful staff members, has trained some 150 scientists. Many are now hard at work studying regional ecosystems and biodiversity; others occupy important positions in government or private industry. As the number of well-trained scientists has grown into a critical mass, the prospects for institutional development have also improved. That, in turn, has helped in the creation or improvement of botanical gardens in Ecuador, Costa Rica and Madagascar.

"While resources are needed to build capacity, money is by no means the only determinant of success and it may not even be the most important," observes Raven. "In addition to building libraries, study collections and computer centres, we must also build enthusiasm, letting people know that others are interested in what they are doing.

"Field expeditions, led by prominent scientists from elsewhere and designed to catalogue a region's biodiversity are, of course, useful, but training local scientists how to organize expeditions and to assess the findings of field work is even more valuable and absolutely critical to the long-term success of our common efforts."

Raven does not mean to imply that the benefits of North-South cooperation have travelled in only one direction – from North to South. True to his research, he says that he is a great believer in diversity – not just biodiversity but cultural diversity too. He maintains that diversity not only makes the world more "lively, dynamic and productive", but it also helps to shed light on the limitations of our own perceptions and strategies, increasing our awareness of the full range of options that are available.

Raven maintains that his career-long emphasis on diversity "is consistent with the ideals of Abdus Salam", founding director of the International Centre for Theoretical Physics (ICTP) and the Academy of Sciences for the Developing World (TWAS) in Trieste.

"Salam," says Raven, "was interested in science not just for the sake of science but also for the increased opportunities that it provided for improving the well-being of individuals, institutions, nations and ultimately our global community. That vision has helped to guide my modest efforts as well."

Raven is optimistic that North-South cooperation in science and technology will grow even stronger in the future, "especially as institutions throughout the developing world continue to build their capacities."

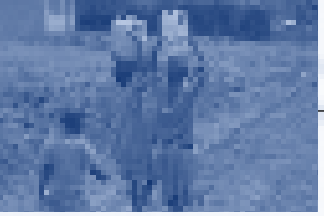
But his optimism is tempered by the expanded scope of the problems that we face. "When I was a child growing up in California in the early 1950s," he notes, "the Earth's population was 2.5 billion. Today, global population stands at 6.4 billion. The general feeling in California at the time was that the orange-tree dotted countryside would always be there. Today, both the orange trees and the countryside are largely gone. The sense of loss that such developments engender is increasing not only in California but throughout the United States and the rest of the world.

"I believe that change is taking place at an ever-accelerated pace, causing an increasing number of people to feel overwhelmed," Raven laments. But, as he also notes, "people throughout the world also believe that something must be done to counteract the most acute threats to our ecosystems, which seem more at risk today than ever before – due not only to population growth and habitat loss but also to such new concerns as invasive species and global warming."

The bottom line, he contends, is that we must work together as a global community if we are to reverse these adverse trends, and that the global scientific community must play a central role in this long-overdue campaign.

"The disturbing trends that were first detected during the early stages of my career," he concludes, "seem to be worsening and that's why we must redouble our efforts at international cooperation and capacity building. For better or worse, we share this Earth and are responsible for ensuring its health for future generations." ■

For additional information about the Missouri Botanical Garden, see
www.mobot.org



WATER WOES

CLEAN WATER, ONE OF THE WORLD'S MOST PRECIOUS RESOURCES, IS AT RISK. THE INTERACADEMY PANEL ON INTERNATIONAL ISSUES (IAP) HAS JUST LAUNCHED A GLOBAL INITIATIVE DESIGNED TO INCREASE THE PROSPECTS THAT FUTURE GENERATIONS HAVE ADEQUATE SUPPLIES TO MAINTAIN HEALTHY AND PROSPEROUS LIFESTYLES.

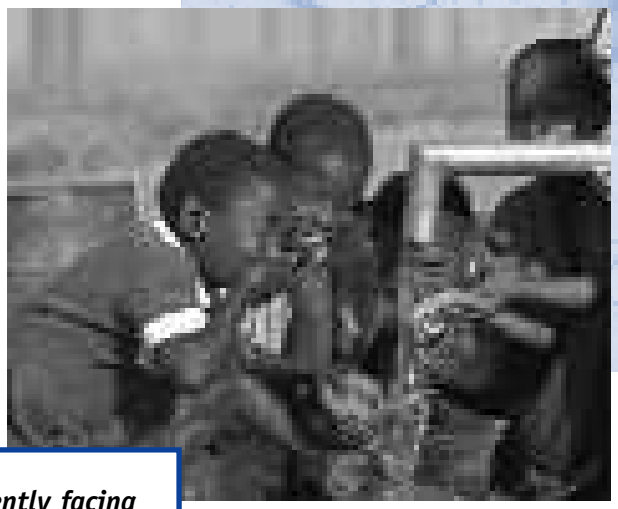
Water is plentiful on planet Earth – but many regions suffer from critical shortages or problems associated with pollution and poor management. In response, the InterAcademy Panel on International Issues (IAP) has established a Water Programme, led by the Brazilian Academy of Sciences. To discuss and develop the programme's initiatives, a workshop was hosted at the TWAS headquarters in Trieste on 28-29 May 2005. During the workshop, delegates representing five academies of science, four international organizations and six centres of excellence discussed an ambitious proposal to design a long-term strategy to improve water management throughout the South.

"We are currently facing a global water crisis," warns Jose Tundisi of the Ecology International Institute, São Paulo, Brazil, and chair of the IAP Water Programme. "This crisis is the consequence of a long history of the excessive and inefficient use of water, pollution and contamination, and increasing demand."

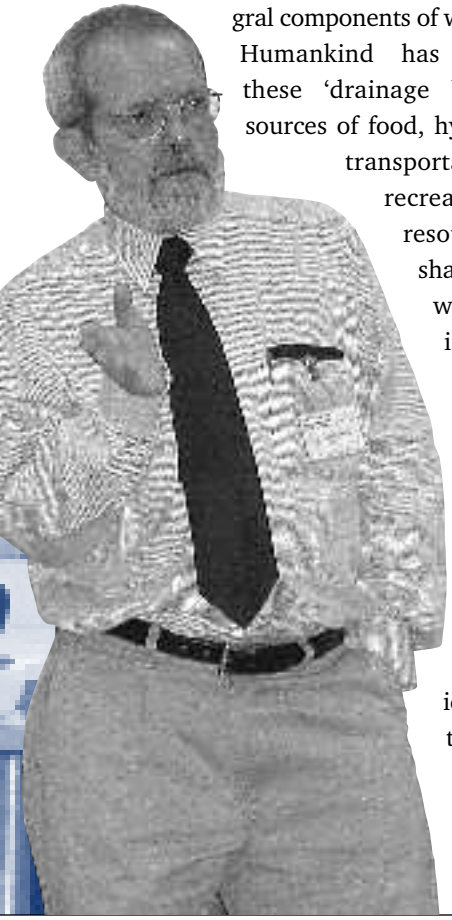
Without effective intervention – on a global scale – these problems will continue to grow. Increasing urbanization, for example, is creating a rising demand for fresh water in vast quantities. By 2025, there will be 30 megacities with more than 8 million inhabitants, and some 500 cities of one million inhabitants each. "Supplying safe drinking water in adequate quantities to these cities is a scientific, technological and managerial challenge," adds Tundisi.

WATER SOURCES

Water is present in the Earth's atmosphere as clouds and vapour, but most is present on the surface in seas, lakes and rivers, and beneath the surface in aquifers. Indeed, only 0.001 percent of the planet's water is located in the atmosphere. This tiny percentage, however, plays a crucial role in the water cycle because it allows the redistribution of the resource – as rain and snow falling on mountain tops, for example. Without such precipitation, rivers would soon run dry.



Wherever rain falls, the run-off is gathered into streams, rivers and lakes, integral components of watersheds. Humankind has exploited these 'drainage basins' as sources of food, hydropower, transportation and recreation. Such surface water resources also provide the major share of water consumed in the world but they are becoming increasingly polluted and degraded. Unregulated industrial discharges and run-off from agricultural land are causing many problems. Nitrates and other fertilizers can, for example, lead to the eutrophication of lakes and rives. Provided with nutrients, phytoplankton multiply rapidly, producing algal blooms. As these algae die and decompose, the life-giving oxygen dissolved in the water is depleted. Oxygen-starved fish and other aquatic creatures soon succumb, and the body of water becomes almost 'lifeless'.



"We are currently facing a global water crisis."

Then there is the problem of mismanagement in non-agricultural, more densely populated settings. For example, many towns in Latin America with 20,000 to 50,000 inhabitants are facing water crises due to the poor management of the water supply, including the discharge of untreated sewage by other towns situated upstream and deforestation that is impairing the recharge of aquifers. The almost complete lack of technical support for water management in these regions highlights the fundamental and urgent need for trained water specialists.

GROUNDWATER

"Despite our traditional reliance on surface water," Tundisi notes, "the great majority of the Earth's liquid fresh water is located beneath the surface." Indeed, excluding glaciers and permanent snow cover, more than two-thirds of fresh water is underground.

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Humans have been sinking wells and tapping groundwater sources since the beginning of civilization. However, until 100 years ago, abstraction was limited to near-surface water. Advances in technology now allow deep-lying groundwater to be exploited on a large scale. In many parts of the world, such deep aquifers are underutilized and could help solve many of the developing world's water-related problems. "However, in the last few decades, especially in arid and semi-arid regions and areas close to large cities, over-abstraction from aquifers is rapidly lowering water levels, leading to increased pumping costs and decreased yields. Another problem resulting from the exploitation of groundwater is an irreversible de-watering and compaction of underlying sediments that is leading to subsidence under some cities," adds Tundisi.

In Mexico City, for example, subsidence caused by the over-extraction of groundwater has become a serious concern. Pumping has been banned in the city centre since 1954. Even so, some areas have sunk as much as 6 metres compared to elevation levels 200 to 300 years ago. Today, Mexico City's central area continues to subside at a rate of some 6 centimetres a year and some monuments, including historic churches, have even had to have new steps added to their staircases to meet the sinking street level. On the southeast side of the city, pumping in the Chalco Basin is still lowering the ground surface by as much as 3 centimetres a month. "Since water is a basic asset for development, such situations are clearly unsustainable," warns Tundisi.

INTEGRATED PLANNING

Although all sources of water are linked in a global hydrological cycle, surface and ground water have typically been managed and exploited separately.

"The disconnection between policies and practices regarding these two main water sources is due, in part, to the failure of professionals – both scientists and managers – to recognize their interdependence and consider them as integrated units" says Tundisi.

The watershed – a physical unit with a hydrologically connected ecosystem of surface and ground water – has sometimes been adopted as a unit for integrating monitoring and research and for managing and administer-

PROGRAMME PARTNER: SIL

Limnology encompasses the study of the biological, physical and geological properties of ponds and lakes. The International Society of Limnology (SIL), founded in 1922, currently has some 300 members in 87 countries. Among its aims are: to understand how inland aquatic ecosystems arose, function and are maintained; to raise awareness of the value of these aquatic systems for the well-being and survival of all organisms, including humans; and to protect and conserve these ecosystems by promoting and fostering sustainable use. SIL focuses many of its efforts on developing countries, sponsoring some 60 members from the South through its endowment fund; initiating centres of limnological analysis in the South; and publishing teaching manuals for workers in developing countries. For additional information, see www.limnology.org.

EUTROPHICATION

Eutrophication of inland waters ranks as one of the world's most widespread environmental problems. Symptoms of eutrophication include: algal scum and toxins derived from algal blooms; massive infestations of aquatic plants; increased incidence of water-related diseases; turbid water; noxious odours and poor-tasting water; depletion of dissolved oxygen; and fish kills. Today, however, the contamination of groundwater by nutrients is the main concern faced hydrogeologists and managers. Nitrates in drinking water, for example, can cause methemoglobinaemia (or blue baby syndrome) in the very young and has been linked with such ailments as stomach cancer and hypertension. In addition, the presence of such nutrients in water sources increases the cost of water treatment and thus causes large-scale economic losses that impair economic development.

The prevention of eutrophication and the restoration of eutrophic lakes and aquifers require sound watershed management strategies based on an understanding of the relationship between nutrient sources and degrees of contamination. Filling this knowledge gap will be one of the main elements of the IAP Water Programme.

ing water resources. But the concept has been more rigorously examined in academia than in policy circles, causing a disconnect between knowledge and action.

"Effective management will depend on a deep understanding of the processes regarding water, such as the recharging of aquifers, as well as such catchment area issues as agricultural practices, the location of landfill sites and the sewage treatment," adds Tundisi. "Given that there is a common set of problems, including pollution and over-extraction, the current dichotomy regarding surface and ground water issues can be overcome by developing an integrated, holistic approach."

The new IAP Water Programme proposes to close the gap between knowledge and action.

And this is precisely what the new IAP Water Programme proposes.

PROGRAMME PROPOSAL

Delegates at the IAP workshop agreed that there is an urgent need to improve programmes for water conservation and wastewater treatment, and to control pollution and eutrophication. To achieve this, a four-part plan of action was devised. The plan includes:

- Sharing information on best practices in water conservation and use.
- Assisting academies in efforts to inform decision makers and the public on critical issues related to water.

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PROGRAMME PARTNER: GEMS

Established in1978, the Global Environment Monitoring System (GEMS), operated by the United Nations Environment Programme (UNEP), is charged with assessing the current status of the world's lakes, rivers and groundwater, and identifying emerging issues and hotspots. It achieves these goals through a network of more than 1,500 sampling stations in participating countries around the globe, each of which provides data that is held in a central database. On World Water Day 2005, much of this information was made available to researchers around the world as the GEMS water quality database went on-line at www.gemstat.org. *In addition, GEMS helps to build capacity in developing countries and provides quality control tools and resources so that laboratories around the world can be sure that their measurements are valid. For additional information, see* www.gemswater.org.

• Devising an effective programme for capacity building, led by IAP-member science academies, that would focus on training the next generation of water experts.

• Building centres of excellence in water research and management, especially in Africa.

In total, 42 academies of science have expressed an interest in the IAP Water Programme. Led by the Brazilian Academy of Sciences, TWAS will also be involved, along with academies ranging from those that are large and influential, such as the Chinese Academy of Sciences and the US National Academy of Sciences, to small, developing academies such as those from Albania, Ghana, Palestine and Tajikistan.

The major focus of the action plan will be the development of strong scientific and technical capabilities focusing on integrated watershed management, especially in the South.

"Managerial capacity must be improved and, for this to happen, research designed to enhance management practices is essential," says Tundisi. "Then, as progress takes hold, there will be an on-going need to improve and further build capacity. Education at all levels plays a fundamental role, and researchers, water resources managers and water technicians must all be part of the process."

Tundisi also emphasizes the need for forging strong links between researchers, managers and technicians to develop and improve water management programmes using integrated, predictive and ecosystem approaches. "Integrated management should be adaptive, producing new ideas and tools, and can only be achieved with local participation and political and managerial support," he says.

To build human resource capacity, IAP is proposing to develop a network of centres of excellence, or inter-

national training centres (ITCs). Although plans are still in the early stages of development, it is likely that these regional centres will be located in Brazil, China, Jordan, Poland and South Africa.

"Such centres will emphasize the integrated management of surface and ground waters and will act as nuclei for the training of personnel, developing and testing new technologies, and providing field facilities and demonstration sites," says Tundisi. "The centres will also be linked to one another to facilitate the exchange of scientific data, research information and training programmes."

In many regions of the world, such capacity building facilities for advanced, specialist training are few and far between.

"Several programmes for training MSc and PhD students exist, but they tend to focus on local problems," explains Tundisi. "It is necessary to expand the scope of these programmes and place them in a broader context."

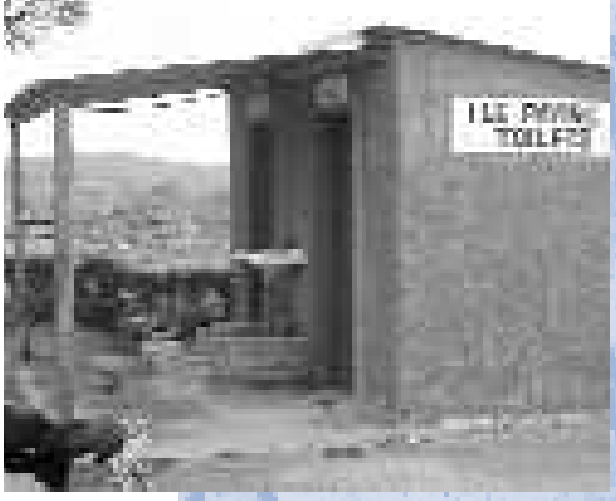
The network of regional ITCs being proposed by the IAP Water Programme would offer training in water resources management. Besides the regional context, each ITC would receive visitors from other countries, including graduate students and water resource managers who, it is expected, will interact in a productive and creative atmosphere, stimulated by the international environment and the top-class facilities for research, field work and access to specialized literature.

"Such dynamic, multi-disciplinary facilities are lacking at present," adds Tundisi. "Nevertheless, the creation of the ITCs will rely on existing local and regional infrastructure already in place that is dedicated to water resources research and management. The strategy will be based on building and strengthening existing infrastructures rather than creating new institutions from scratch."

Forty-two academies of science have expressed an interest in the IAP Water Programme.

Staff with local expertise will be recruited to teach at the ITCs, but an additional aim is to involve a number of visiting scientists in each training activity. "This will enhance the quality of the programme and will stimulate the development of joint research projects," predicts Tundisi.

Training programmes will emphasize comparative studies, fieldwork, practical lectures, use of field facili-



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UN WATER FOR LIFE DECADE, 2005-2015

On 22 March 2005, World Water Day, the UN announced its Water for Life Decade, 2005-2015. During this international decade for action, efforts will be made to fulfil global commitments made to improve access to clean water and water. Among the themes highlighted by the UN are: water for women, which promotes the involvement of women in sanitation, education, training and decision making; water for biodiversity, which aims to promote awareness of the value of environmental resources; water for sanitation and health, which aims to implement hygiene programmes in schools and invest in sanitation infrastructure such as latrines and toilets; and water for energy, which will promote small-scale, stand-alone hydropower schemes and effective energy policies. For additional information, see www.un.org/waterforlifedecade/.

ties and demonstration of water management problems while training modules will be designed to promote an integration of science with management, providing the trainees with the best technological and scientific tools to develop effective research and management agendas.

WAY AHEAD

The next step in the development of the IAP Water Programme is to produce a report assessing the capacities and needs of science academies worldwide. The report, which will be compiled by the Brazilian Academy of Sciences, will be distributed this autumn.

Training modules will be designed to promote an integration of science with management.

Water plays a fundamental role in the natural functioning of our planet Earth, providing ecological, hydrological and economic services to humankind. To continue to obtain the benefits of each of these services in a long-term, sustainable manner, hydrogeologists, limnologists, engineers, ecologists and others must work together on cross-sectorial and regional approaches to water management. By bringing together the world's science academies and a host of other national, regional and international organizations, the IAP Water Programme hopes to achieve this ambitious goal. ■

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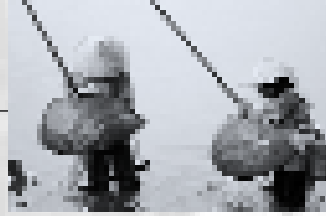
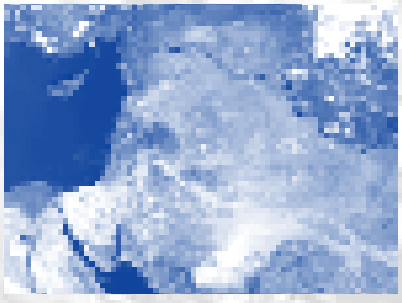


HEALTH CHECK-UP FOR EARTH ECOSYSTEMS

WHAT IS THE STATE OF THE WORLD'S ECOSYSTEMS? NOT GOOD, BUT IT IS NOT TOO LATE TO IMPROVE THEIR HEALTH IF WE ACT NOW. TWAS FELLOW ABDUL HAMID ZAKRI, CO-CHAIR OF THE MILLENNIUM ECOSYSTEM ASSESSMENT, EXPLAINS HOW WE SHOULD MOVE FORWARD.



The recently released Millennium Ecosystem Assessment marks the first global effort to examine the state of Earth's ecosystems and to assess their ability to provide the ecological services that we all depend on for our survival and well-being. The findings are not encouraging but the world's ability to take strong corrective measures – if it desires to do so – gives reason for cautious optimism. Abdul Hamid Zakri (TWAS Fellow 1996), who co-chaired the assessment, explains why.

Following four years of extensive work by 1,360 scientists in 95 countries, the initial publications of the Millennium Ecosystem Assessment (MA) were officially launched in March at a series of news conferences held in Beijing, Brasilia, Cairo, Delhi, London, Nairobi, Paris, Tokyo and Washington, DC.

Ultimately, the multi-volume assessment, which is expected to total more than 3,000 pages, will include synthesis reports on biodiversity, desertification, wetlands, and business and industry as well as more than 30 regional assessments of areas as far apart and diverse as Canada, Papua New Guinea and South Africa.

The overall effort marks the most comprehensive assessment ever of the world's ecosystems, one that will not only provide a 'health check-up' on our ecosystems today but also serve as a benchmark for determining future ecosystem trends – both positive and negative.

Why is this important? The simple but compelling reason is that the air we breathe, the food and water that sustain our lives, and the timber that provides us shelter are all products of the planet's life systems.

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To assess how these systems are faring, the MA examined 24 different ecosystem services ranging from food and water to disease control to recreational benefits. It explored how changes to the global environment – often induced by human actions – are likely to affect human social and economic well-being.

The MA's overall prognosis is cause for concern. The health of the planet, as reflected in the data that was collected, is deteriorating, and the developing world is bearing the brunt of the adverse impacts.

The Millennium Ecosystem Assessment's major prognosis is cause for concern.

For example, only four of the 24 ecosystem services examined were found to be increasing their ability to benefit human populations. Three of these relatively healthy ecosystems involve food production (crops, livestock and aquaculture); the fourth is carbon sequestration, which has increased on a global scale since the mid 20th century thanks largely to the regrowth of forests in temperate zones and environmentally friendly alterations in agricultural practices.

In one of the few examples where human actions have enhanced an ecosystem service, food production has outpaced population growth during the last 40 years, a positive finding tempered by this paradox: some 32 million more people are undernourished today than were undernourished a decade ago. That means about 850 million people worldwide currently do not have access to sufficient food supplies to ensure adequate nutrition. Virtually all of these people live in the developing world. Given current trends, one of the primary targets of the UN's Millennium Development Goals – to reduce the number of people suffering from malnutrition by half by 2015 – will not be met. Moreover, even under the most optimistic scenarios, global food security will not be attained even by 2050.

Of the remaining ecosystem services examined by the MA, 15 are in decline and five are stable. Those in decline include such vital services as the provision of

freshwater, fisheries and the purification of air and water.

Moreover, many of the human-instigated ecosystem changes that spell trouble for the delivery of ecological services will also likely create disproportionately large and abrupt environmental impacts that will pose additional threats to human well-being. Such potential disruptions include the emergence of new diseases, sudden deteriorations in water quality, the spread of coastal 'dead zones', and the collapse of fisheries. Poor nations will again bear the brunt of these ecological trends.

There are many cautionary lessons to be drawn from the MA's findings. Of critical concern are the implications for developing countries where some 4 billion people or more than 80 percent of the world's population live – figures that are are expected to grow in the decades ahead. As a result, the developing world will face enormous increases in demand for ecosystem services at the same time that these services will face an unprecedented array of stresses due to overall global demand for resources, most notably for food, clean water and energy.

Ecosystem degradation has aggravated poverty in many parts of the developing world and, in some cases, has itself become a cause of poverty. When soil erodes, for example, due to deforestation (as it has in Madagascar), subsistence farmers can no longer grow enough food to meet the needs of the population. When fisheries collapse due to overfishing (as is the case in coral reef fisheries in Indonesia and the Philippines), not only do jobs disappear but so do critical and inexpensive sources of protein.

FISHERIES IN TROUBLE

Cod from the eastern seaboard of Canada have been exploited since the 1600s – until 1992, that is. At the peak of the exploitation of these fisheries, in 1968, some 800,000 tons of cod were landed. Seven years later, in 1975, this had declined to 300,000 tons. Despite repeated warnings from scientists, fishermen continued to overexploit the Newfoundland cod stocks, which finally collapsed in 1992. By 1995, scientists estimated that there were just 1,700 tons of cod in the entire area. Some 40,000 people lost their jobs when the fisheries were closed in 1992. Cod stocks have yet to recover.

Unfortunately, this is not an isolated case. Within the EU, there have been repeated warnings about the imminent collapse of North Sea cod stocks. Meanwhile, the West African Marine Ecoregion that spans 3,500 kilometres along the coasts of six countries (Mauritania, Senegal, Gambia, Cape Verde, Guinea Bissau and Guinea), is also being over-fished. These fisheries generate some US$400 million in revenues a year, making them the region's single most important source of foreign exchange and a key source of revenue for economic and social development. In Senegal alone, the jobs of more than 600,000 men and women depend directly on fishing and fisheries related industries. In addition to domestic industrial and traditional fishing fleets, many foreign powers – in particular the EU, Japan and China – have agreements that allow their boats to fish in these countries' waters. Traditional fishermen now complain that the diversity of the fish they catch has been reduced and only the lowest quality fish species remain. Elsewhere, illegal fishing methods such as the use of dynamite or cyanide poison are damaging not only fish stocks, but also the ecosystems that sustain them.

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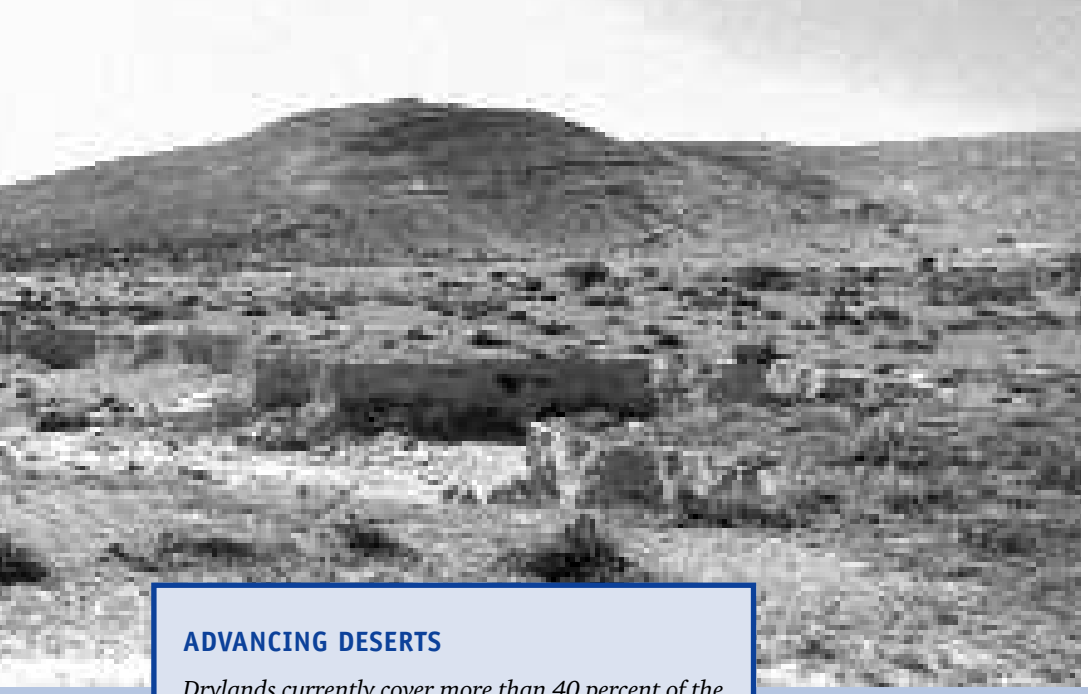
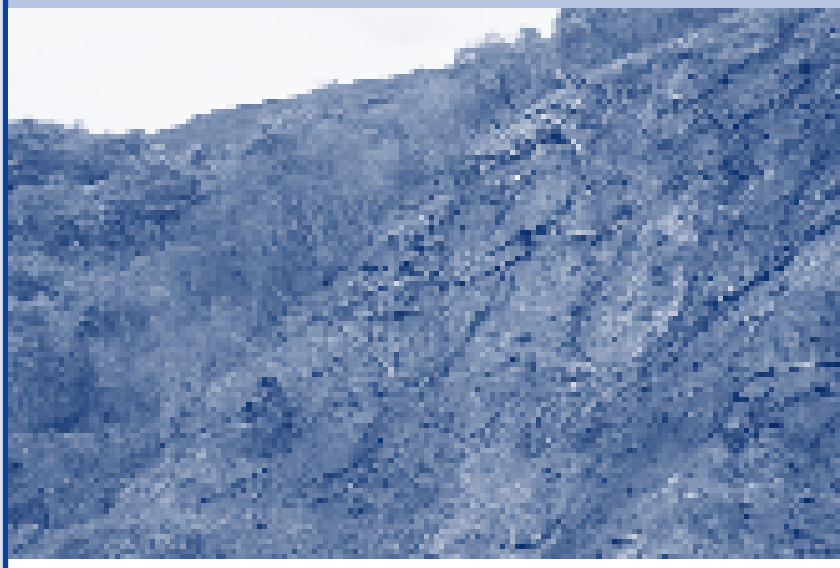


ADVANCING DESERTS

Drylands currently cover more than 40 percent of the Earth's landmass, including large parts of northern Africa and vast areas of central Asia. A report published as part of the Millennium Ecosystem Assessment project, Ecosystems and Human Well-being: Desertification Synthesis*, concluded that preventing the 'desertification' of drylands is an immense global challenge. Indeed, an estimated 10 to 20 percent of drylands are already considered degraded.*

Among the main causes of the degradation of drylands identified by the report is the transformation of rangeland into cultivated land. Without a protective cover of vegetation the whole year round, topsoil is either blown or washed away. Poor crop management and the misuse of irrigation exacerbate the problems. Population growth and global climate change are adding to the pressures on drylands, which, if they degrade further, could cause the migration of millions of 'environmental refugees' in the years ahead. With some two billion people living in the world's dryland areas, the report warns that "desertification is potentially the most threatening ecosystem change impacting livelihoods for the poor."

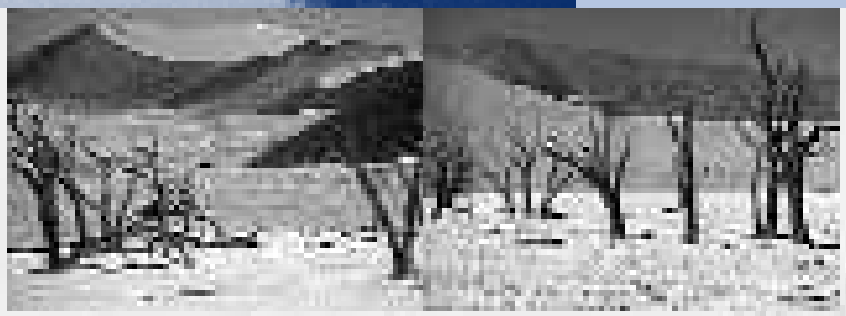


The MA's findings show a pattern of winners and losers in ecosystem change, and the losers are most often the world's poorest people living in the world's poorest countries. Moreover, the people most victimized by these trends include a disproportionate number of children, women and indigenous peoples. In short, the most vulnerable people are most at risk.

The assessment, however, also concludes that no country, not even the wealthiest, will be able to insulate itself from chronic, steep declines in ecosystem services.

People and nature are inextricably linked irrespective of political boundaries. Natural disasters, drought and famine, for example, will drive populations across national borders in search of relief. The emergence of new strains of viral diseases in poor nations will find their way to rich nations.

As a result, we must all heed the warnings of coming ecological challenges and engage in a collective effort to address their most serious adverse consequences.



The good news, as the MA also points out, is that there is still time to avert future problems — if we implement changes now.

At the global level, this means closer coordination between trade and environment negotiations to ensure that efforts to increase global economic activity do not take place at the expense of the environment, which after all serves as a primary source of trade. It also requires an emphasis on mitigating climate change so that all nations contribute to global efforts to address one of the world's most daunting environmental challenges.

More generally, developed countries need to invest in clean technologies, increase access to markets (especially in the developed world where farm subsidies have prevented developing world farmers from selling their food and fibre products at competitive prices), and ensure an equitable sharing of benefits that arise from the development and use of genetic resources for increased agricultural yields and the development of new pharmaceuticals.

Government policies must ensure that market prices reflect the value of ecosystem services.

At the national level, government policies must ensure that market prices reflect the value of ecosystem services – that is, the real costs of using (and polluting) air, water and land, which too often have been viewed as 'priceless' common goods, especially in developed nations. Until such measures are put in place, consumers will have no incentive to use these resources efficiently. As stated above, government subsidies, such as those supporting European and US agriculture, must be reduced and eliminated, not only for ethical reasons (eliminating the subsidies would make agricultural goods from the developing world more competitive in developed world markets, thus increasing income levels for developing world farmers) but because it would also help to expose the true environmental costs caused by such subsidies, which, for example, increase the pollution of streams and rivers by encouraging pesticide use. At the same time, policies to conserve forests and other biodiversity 'hot spots' must balance protection with the need to use these resources in a sustainable fashion. And

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OCEAN DEAD ZONES

Just as freshwater ecosystems can be affected by eutrophication (see box, page 35), so too can the marine environment. To date, some 150 marine areas have been classified as annual, episodic, periodic or persistent 'dead zones'. Nearly all of these are coastal areas associated either with major urban populations that release sewage and other pollutants into the environment, or with large watersheds that deliver large quantities of nutrients, including nitrogen fertilizers from agricultural runoff. These nutrients allow phytoplankton to flourish but their rapid growth and decomposition starves the water of oxygen. Fish migrate from the affected waters, while slower-moving creatures such as crabs, shellfish and sea urchins die en masse. *Many of the dead zones are located around the coasts of the North and Baltic Seas, as well as the Gulf of Mexico, where they are fed by the nutrient-rich waters of the Mississippi River. The northern Adriatic Sea, encompassing the lagoons of Venice and the waters around Trieste, where TWAS is based, are also affected by annual dead zone conditions.*

The number of new cases has increased each decade since the 1970s, mostly around the coasts of the world's industrialized countries. Among the dead zones affecting developing countries are those of the coast of Rio de Janeiro, Brazil, and around Hong Kong and Taiwan, China. However, there is concern that more oxygen-starved areas will emerge off parts of Africa, Asia and Latin America as industrialization and more intensive agriculture increase the discharge if nutrients.

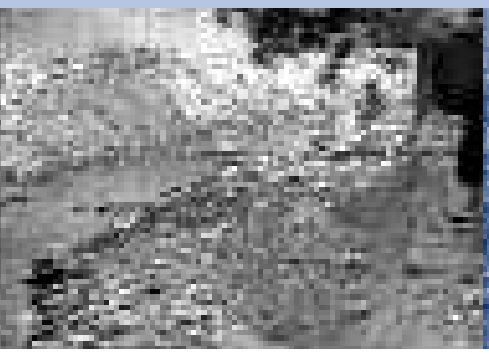
sophisticated, adequately funded, national institutions must be built and maintained to ensure implementation and compliance with the regime of laws and regulations necessary for the conservation and protection of ecosystems.

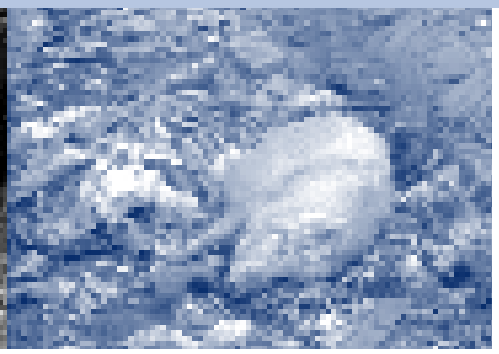
At the local level, citizens must be encouraged to become active participants in decision-making processes that affect resource management. Experience shows that ecotourism and the sustainable harvesting of forest products, for example, become much more effective and ultimately profitable when local citizens are meaningfully engaged in the decision-making process from the beginning of the discussions and are given their fair share of the benefits when judgments are finally rendered.

The MA's findings should serve as a wake-up call to world leaders to take action to ensure that the world's ecological capital is not depleted.

Virtually all of these initiatives – whether designed to improve access to safe drinking water, curb overfishing, increase energy efficiency and encourage greater use of renewable energy, combat global warming or conserve biodiversity – place a premium on science and technology.

Most assaults to ecosystems and damages to the services that they provide are likely to take place in developing countries where the stresses are most severe and the resources are most limited. Therefore, it was essential for the MA to focus a great deal of attention on the South, and it is even more essential for follow-up strategies and actions to concentrate on challenges and opportunities that reside in the developing world.





The MA – both through its consultative four-year process and now its first publications – has helped to bring together the scientific community, in consultation with governments, international institutions, businesses and nongovernmental organizations, in a common quest for better approaches to ensure the health and well-being of the world's ecosystems. Future efforts must promote even greater involvement of scientists and other experts from the developing world. Without their participation, the legitimacy of such efforts will be called into question and their effectiveness compromised.

Those who participated in the assessment do not view it as an academic exercise to be relegated to classroom discussions, scholarly seminars or parlour room policy debates. Instead we believe the MA's findings should serve as a wake-up call to world leaders to take action to ensure that the world's ecological capital is not depleted as a result of misguided economic development strategies that may seem to work in the short term but cannot be sustained in the long run.

Two abiding principles have shaped the MA's conclusions about the state of the world's ecosystems: first, that the need for change is critical and, second, that the situation is not desperate but that we must act now. We can only hope that decision-makers choose to embrace the MA's findings with the same spirit of deep concern and cautious optimism. ■

A.H. Zakri
TWAS Fellow 1996
Director
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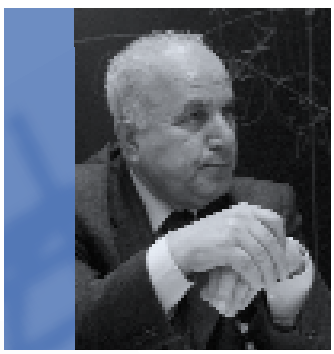
Pacifico-Yokohoma, Japan

Co-chair
Millennium Ecosystem Assessment (MA)

For additional information about the MA, see
www.millenniumassessment.org

BADRAN FOR PM

• **Adnan Badran** (TWAS Fellow 1991) has been named Prime Minister of Jordan by King Abdullah II. Badran, most recently president of Philadelphia University in Amman and president of the Arab Academy of Sciences in Beirut, Lebanon, has held a number of high-level government posts in Jordan, including minister of education and of agriculture and secretary general of the Higher Council for Science and Technology. He has a long track record of successful involvement in education and science and technology policies, having served both as deputy director-general (1993-1998) and assistant director-general for natural sciences (1990-1996) at UNESCO. Badran was TWAS secretary general between 1992 and 1998, and vice-president from 1999 to 2003.



Adnan Badran

FRENCH AWARDS FOR PALIS AND RAO

• TWAS president, **C.N.R. Rao** and secretary general, **Jacob Palis**, have both been awarded the *Légion d'Honneur* by the President of France for their outstanding contributions to both research and their efforts to promote science in developing countries. Rao has also been awarded the Dan David Prize by the Dan David Foundation, based at the University of Tel Aviv, Israel, which recognizes and encourages innovative and interdisciplinary research. The award is unique in that laureates must donate 10 percent of the prize money to graduate students working in their fields, thereby helping to foster a new generation of scientists.

THREE FELLOWS HONOURED

• **Raghunath A. Mashelkar** (TWAS Fellow 1993) head of the Council for Scientific and Industrial Research (CSIR), India, **Ranulfo Romo** (TWAS Fellow 2003), head of the Department of Biophysics at the National Autonomous University of Mexico (UNAM), Mexico, and **Claudio Teitelboim** (TWAS Fellow 1991), director of the *Centro de Estudios Científicos*, Chile, have been elected Foreign Associate Fellows of the US National Academy of Sciences (NAS). This honour, which has been given to only 360 scientists in the 140-year history of the NAS, recognizes the consistently by high quality of the scientific output of the trio and the dedicated efforts of each to develop science in the South.

METABOLIC AWARD FOR WAKIL

• **Salih J. Wakil** (TWAS Associate Fellow 1998), L.T. Bolin Professor and chair of the Verna and Marrs McLean Department of Biochemistry and Molecular Biology at Baylor College of Medicine, Houston, USA, has been awarded the 6th Annual Bristol-Myers Sqibb "Freedom to Discover" Award for Distinguished Achievement in Metabolic Research. Wakil is being honoured

Raghunath A. Mashelkar

for his pioneering work in fatty acid metabolism, including his groundbreaking discoveries on the pathways of fatty acid synthesis. His most recent work has provided new insights into how fat is metabolized in the body and identifies a potential drug target for the treatment of obesity and diabetes.

CLIMATE CHANGE PUBLICATION

• **Mohan Munasinghe** (TWAS Fellow 1994), chair of the Munasinghe Institute for Development, Sri Lanka, and vice chair of the Intergovernmental Panel on Climate Change (IPCC), has published a book, *Primer on Climate Change and Sustainable Development* (Cambridge University Press, 2005), with his IPCC colleague, Rob Swart. The text offers a condensed and accessible review of the latest state-of-the-art assessments of the IPCC.

Climate change publication

OPTICAL AWARD FOR AZZAM

• The International Society for Optical Engineering (SPIE) has awarded its 2005 G.G. Stokes prize to **Rasheed M.A. Azzam** (TWAS Associate Fellow 1991). Azzam, professor of electrical engineering at the University of New Orleans, was honoured for his significant contributions to the science of optical polarization over the past three decades.

Rasheed M.A. Azzam

CHINESE RECOGNITION FOR PANZA

• **Giuliano F. Panza** (TWAS Associate Fellow 1996), head of the Structure and Non-Linear Dynamics of the Earth (SAND) group at the Abdus Salam International Centre of Theoretical Physics (ICTP) in Trieste, Italy, has been appointed honorary professor of the Institute of Geophysics, China Earthquake Administration, Beijing, for his "outstanding contribution to seismology especially in the field of earthquake hazard and strong ground motion as well as intermediate-term earthquake forecasting."

PLANTS PUBLICATION

• Volume 10 of *Sharing Innovative Experiences*, a series produced by the United Nations Development Programme (UNDP) Special Unit for South-South Collaboration, in partnership with TWAS and the Third World Network of Scientific Organizations (TWNSO), has been published. The volume, based on a workshop hosted by TWNSO and held in Trieste, Italy, in February 2004, contains "examples of the development of pharmaceutical products from medicinal plants", and includes 17 case studies from 14 developing countries. To receive a copy of the publication, contact TWNSO at *info@twnso.org*

Sharing Innovative Experiences

TWNSO WORKSHOPS

• On 4-6 July 2005, TWAS and TWNSO hosted a workshop in Trieste on the theme of 'Knowledge Sharing for Local Development in the South'. During the three-day meeting, 13 particpants from 12 countries presented and discussed their case studies. The next issue of the *TWAS Newsletter* will include a feature article on the workshop. The case studies will be published as Volume 13 in the TWAS, TWNSO, UNDP-SSC series, *Sharing Innovative Experiences*. The aim is to publish the book in time to present it at the World Summit on the Information Society, to be held in Tunis, Tunisia, from 16-18 November 2005.

• Another TWNSO/UNDP-SSC workshop, originally scheduled to take place in Trieste this August, will now be hosted by the University of Mauritius on 27-29 October. The wokshop will focus on 'Natural Disaster Mitigation in Small Island Developing States (SIDS)'. For additional information, please visit *www.twnso.org*.

IN MEMORIAM

• **Kun Huang** (TWAS Fellow 1985), a world-renowned solid-state physicist, has passed away. He was aged 86. Huang, who acted director of the Institute of Semiconductors, Chinese Academy of Sciences (CAS), from 1977 to 1983, helped lay the foundations of solid-state physics and semiconductor physics in China with his pioneering research in such areas as lattice dynamics and multiphonon transition processes.

Kun Huang

In 1995, he was awarded the prize of the Ho Leung Ho Lee Foundation for Scientific and Technological Achievement and, in 2001, the State Pre-eminent Science and Technology Award of China. As well as being a member of TWAS and CAS, Huang was also a foreign fellow of the Swedish Academy of Sciences.

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 700 members from 81 countries, 66 of which are developing countries. A Council of 13 members 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. 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 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 2,000 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.interacademies.net/iamp**

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 some of 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