4

YEAR 2009
VOL.21 NO.4

twas

TWAS newsletter

NEWSLETTER OF THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD

Published with the support of the Kuwait Foundation for the Advancement of Sciences

EDITORIAL

THE "RISE OF THE REST", AS THE RENOWNED JOURNALIST FAREED ZAKARIA CALLS IT, HAS PROFOUND IMPLICATIONS NOT ONLY FOR THE "REST" BUT ALSO FOR THE UNITED STATES, EUROPE, JAPAN AND OTHER RICH COUNTRIES AND REGIONS THAT ARE TODAY'S LEADERS IN TERMS OF WEALTH AND SCIENTIFIC AND TECHNOLOGICAL CAPABILITIES.

Raising the profile of science in the G20

Northern countries that have led the world throughout the post-World War II era will be ceding ground to an expanding group of countries in the South in the years ahead. How this profound transition plays out may be among the most critical challenge the world now faces. If we get the transition right, we have the potential to put in place an "enabling" process that could dramatically affect strategies for solving the broad range of problems confronting the world. If we get it wrong, global international relations are likely to spiral downward, trapped in a vortex of resentment, pride and division that will make it virtually impossible to address our shared problems.

Science can play a critical role in easing the transition on several fronts.

First, it can help ensure that progress among developing countries will continue. A growing number of the "rising" developing countries, including Brazil, China, India and South Africa, spend at least 1% of their gross domestic product (GDP) on research and development (R&D). These countries have reached a 'positive tipping point' in investments in R&D that has set them on a path towards sustainable economic growth, which is likely to accelerate in the years ahead.

Second, the deeply rooted culture of science among today's leading Northern countries can help mitigate the impact of unfavourable demographic and economic trends that now confront the world's developed countries. Europe, for example, will suffer a comparative loss of population (by 2025, only 6.5% of the world's population will reside in Europe compared

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Published quarterly with the support of the Kuwait Foundation for the Advancement of Sciences (KFAS) by TWAS, the academy of sciences for the developing world
ICTP Campus, Strada Costiera 11
34151 Trieste, Italy
tel: +39 040 2240327
fax: +39 040 224559
e-mail: info@twas.org
website: www.twas.org

EDITOR
Daniel Schaffer

ASSISTANT EDITORS
Tasia Asakawa
Brian Smith

MANAGING EDITOR
Gisela Isten

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

PRINTING
Stella Arti Grafiche, Trieste

to 60% in Asia). It will also have to confront the challenges posed by aging populations (by 2025, 30% of Europe's population will be more than 65 years of age, the highest percentage in the world). Moreover, even in good times, annual increases in GDP are unlikely to exceed 3% among the mature economies of Western Europe and the United States. And then there are the psychological ramifications of losing ground to 'upstart' countries. Yet, despite those worrisome trends, investments in science, technology and innovation will undoubtedly ensure the future prosperity of Northern countries.

Third, the emergence of information and communication technologies and such other frontier technologies as nanotechnology and genomics now make it possible to build world-class scientific and technological capabilities quickly – indeed, in less than a generation, as has been illustrated by the most successful developing countries. Emerging fields in science and technology can help level the playing field. When combined with the ease of rapid information exchange, such trends will likely allow a growing number of developing countries to participate in cutting-edge science as equal partners.

In a world scarred by divisions in knowledge, wealth and scientific capability, one of the greatest challenges we face may be to convince rich and poor countries alike that the "rest" can continue to "rise" without causing today's leading countries to stumble, and without creating a yawning South-South gap between countries on the fast track to science-based development and those that are in danger of being left behind.

The G8 has recently been transformed into the G20. Brazil, China, India, South Africa and other newly emerging – indeed surging – countries will now have a seat at the table at the world's top economic forum.

We would like to make a modest proposal: That the G20, working with the InterAcademy Panel (IAP), call on its

national science academies to create a standing forum where science-based development issues of importance to the G20 can be discussed. The forum, upon request, could also provide reports and statements to the G20 and serve as an expert advisory panel for a wide range of issues that will likely shape the G20's agenda in the years ahead. In addition, and again working with IAP, the G20 science academies could liaison with the Network of African Science Academies (NASAC) to pursue joint initiatives that would assist Africa, a continent that was a focal point of concern with the G8+5 and one that is likely to remain so under the expanded G20 framework that has been put in place. ■

Mohamed H.A. Hassan
Executive Director

Daniel Schaffer
Public Information Officer

TWAS, the academy of sciences for the developing world
Trieste, Italy

This article was originally published in *Public Service International Review*, November 2009 (www.publicservice.co.uk).

LEARNING TO GROW

SIGNS OF GROWTH IN AFRICA HAVE BECOME INCREASINGLY COMMON. OVERALL, THE CONTINENT'S ECONOMY GREW BY MORE THAN 5% EACH YEAR BETWEEN 2002 AND 2007. EQUALLY ENCOURAGING, EXPERTS NOW BELIEVE THAT AFRICA'S ECONOMY WILL CONTINUE TO GROW IN 2009 (BY A MODEST 1.5%) DESPITE THE GLOBAL FINANCIAL CRISIS.

Africa's economy, at long last, seems to be heading in the right direction. Yet, to keep moving forward, the world's poorest continent cannot neglect the primary source of economic growth in the 21st century: the depth and breadth of scientific and technological knowledge that can be put to work by a nation's people.

Specifically, if Africa's recent efforts to advance science-based development are to be sustained over time, progress must be made on at least three critical fronts.

First, Africa's key universities and research centres must be revitalized. Indeed each African country should begin to take steps to build a world-class university within its borders. The primary source of funding for such initiatives will have to come from each country. External investments derived from bilateral agreements and foundations will help, but the global financial crisis makes it increasingly unlikely that donors will fully live up to their past commitments, let alone launch new ones. For example, when the G8 countries met in Scotland in 2005, they agreed to an USD8 billion, 10-year package for African science and technology development – USD5 billion of which to be devoted to improving higher education and USD3 billion for the creation of centres of scientific excellence.

Just several hundred thousand dollars has since arrived and the rest is unlikely to come anytime soon.

The message is clear: Africa's countries must be prepared to move ahead on their own and in concert with other countries on the continent.



Strengthening Africa's educational infrastructure will, of course, take time. That is why the second course of action must be to train Africa's next generation of scientific leaders by supporting talented students who do not have access to the quality classrooms and laboratories that they need to advance their careers.

On this front, one of the major initiatives at TWAS has been to provide fellowships for young scientists to study abroad, largely at universities and research institutes in emerging scientific powerhouses such as Brazil, China and India. With additional agreements recently signed with Malaysia, Mexico and Pakistan, TWAS's South-South fellowship programme can now support more than 300 young scientists yearly.

Why not send young African scientists to the US or Europe, which has been the conventional path for training and career development? From its inception more than 25 years ago, TWAS has sought to promote South-South collaboration in science. The reason is this: North-South collaboration has tended to benefit the North as much (or even more) than the South. Students trained abroad often do not come back. So from the start, TWAS has sought to have South-South ties take precedence over North-South ties whenever possible.

Today, this strategy seems more viable than ever. That's because of the explosion in the scientific capacity of China, India, South Korea and Brazil. The future of Africa lies in following in the footsteps of these countries and in working hand-in-hand with them whenever possible.

The third critical front lies in strengthening merit-based science academies in Africa, including the African Academy of Sciences (AAS). Academies have made significant strides in forging stronger links with government agencies and, more generally, society. But most are still a long way from becoming leading advisors to their governments on critical science-based issues.

Part of the reason for the absence of science academies in policy-making circles lies in the shortage of science academies in Africa. Today, for example, there are just 13 academies in sub-Saharan Africa, a region with 48 countries.

The number is increasing (there were just nine academies in the region five years ago). But this growth is not taking place fast enough. Moreover, the academies that do exist often do not have sufficient resources or skills to be effective. Capacity building efforts can help overcome this barrier and make academies more active and useful members of society.

Despite the profound challenges that remain, it may no longer be naïve to say that, when it comes to building scientific and technological capacity in Africa, we may finally be moving beyond false rhetoric to real action. Even in these difficult times, there is reason to hope that sustainable science-based development may finally be taking hold.

Additional progress on three fronts – university revitalization, research and training for young scientists and the growth and strengthening of national science academies – can help ensure that the advances that have been made are sustained and fully woven into the fabric of African society. TWAS stands ready to assist in efforts to turn what has now emerged as a promising start into a sustained force for science-based development throughout Africa. ■

TWAS IN SOUTH AFRICA

THE TWAS 20TH GENERAL MEETING AND 11TH GENERAL CONFERENCE TOOK PLACE IN DURBAN, SOUTH AFRICA, FROM 20 TO 23 OCTOBER 2009. THE GATHERING, WHICH INCLUDED MORE THAN 300 SCIENTISTS FROM 90 COUNTRIES, WAS HELD WITHIN SIGHT OF THE TROPICAL COASTLINE OF THE INDIAN OCEAN AND AT A MAJOR CROSSROADS LINKING AFRICA, ASIA AND EUROPE.

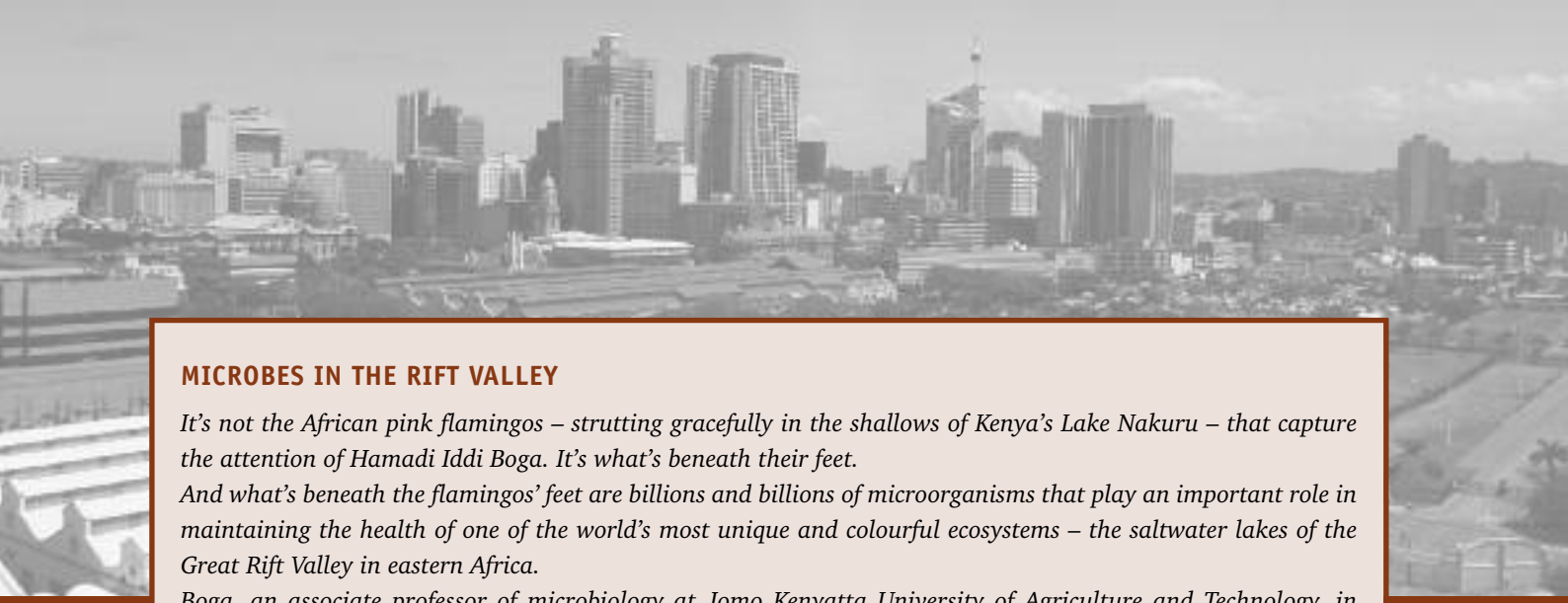
Fifteen years ago, South Africa was cut off from the global community, a pariah nation condemned for its apartheid policies. TWAS, like other United Nations organizations, was encouraged not to engage with South Africa's scientists as part of a larger global effort to isolate the country and place intense international pressure on its leaders to relinquish their racist policies that were oppressing the vast majority of the country's population.

Today, South Africa is the continent's leading scientific country and Africa's sole representative in the G20, a group of the world's wealthiest and most influential countries. It is also actively involved in the global scientific community, enjoying a growing reputation for excellence in a number of scientific fields, including astronomy, archaeology and mineralogy. South Africa's scientists, who were largely shunned during apartheid, have increasingly forged partnerships with TWAS and other international scientific organizations to pursue a wide range of research activities.

South Africa has come a long way in a short time and its efforts in science and economic development seem to be taking hold at an ever-more rapid pace. All of this was on full display at the TWAS 20th General Meeting and 11th General Conference where, as Mohamed H.A. Hassan, the Academy's executive director, noted, "South Africa took another important step in showcasing its science to the world, and the world took another important step in integrating South Africa's scientific community into the fold of global science."

Highlights included:

- A meeting between Jacob Zuma, President of South Africa; Jacob Palis, TWAS president; Mohamed H.A. Hassan, TWAS executive director; and Robin Crewe, president of the Academy of Sciences of South Africa. The meeting took place in the president's office in Pretoria and included the presentation of the TWAS Presidential Medal to President Zuma.



MICROBES IN THE RIFT VALLEY

It's not the African pink flamingos – strutting gracefully in the shallows of Kenya's Lake Nakuru – that capture the attention of Hamadi Iddi Boga. It's what's beneath their feet.

And what's beneath the flamingos' feet are billions and billions of microorganisms that play an important role in maintaining the health of one of the world's most unique and colourful ecosystems – the saltwater lakes of the Great Rift Valley in eastern Africa.

Boga, an associate professor of microbiology at Jomo Kenyatta University of Agriculture and Technology, in Kenya, is head of a university research team that receives financial assistance from the TWAS grants programme for scientifically lagging countries. He spoke about his team's work at the TWAS Conference in Durban.

*The Great Rift Valley is where archaeologists have uncovered skeletal remains of some of the earliest ancestors of humans, including 'Lucy' (*Australopithecus afarensis*), who is believed to have lived more than 3 million years ago. It's also home to the African pink flamingo (or lesser flamingo,* Phoenicopterus minor*) – the brightly coloured, spindly legged bird that is a global symbol of beauty and elegance.*

The region's geography is marked by a string of shallow alkaline lakes – five in all – that provide the habitat for soil-bound microorganisms capable of living in extreme environments saturated with sodium carbonate. Similar lakes can be found in Egypt, Malawi and Russia. But none have pink flamingos.

"Each cubic millimetre of water in these lakes – equivalent to the amount on the tip of an eye dropper – contains more than one billion microorganisms", says Boga. "Yet, the only evidence of their existence that humans can see is the languid green-tainted mats that stretch across the surface of the water."

Boga explains that the lakes' bountiful cyanobacteria – or blue-green algae – are photosynthetic organisms, which depend upon light and carbon dioxide as primary sources of energy for their sustenance and growth. Their vast numbers make them a primary source of biomass in the region. But the cyanobacteria's contribution to the ecosystem would not be possible without the work done by other microorganisms.

As the cyanobacteria decompose, anaerobic bacteria use light and chemical compounds as a source of energy. In the absence of oxygen, these bacteria turn the organic matter into acetate, lactate, butyrate, hydrogen and carbon dioxide.

Then, microbes called Archaea *– which can live in environments as forbidding as hot springs – transform the soil-trapped hydrogen and carbon into methane, which is released into the atmosphere, marking the completion of the biological cycle.*

Invisible microorganisms that die, decompose and wind up as methane cannot, of course, match the allure of thousands of long-legged pink flamingos wading in the shallow lakes. But that doesn't minimize the microbes' importance to the health of the ecosystem.

TWAS launched its grants programme for research groups in scientifically lagging countries in 2002. The programme provides annual grants of up to USD30,000 for 18 months. For additional information, see www.twas.org.

- A conference session on the impact of the global financial crisis on science in the developing world that included presentations by Naledi Pandor, South Africa's Minister of Science and Technology; Sergio Rezende, Brazil's Minister of Science and Technology; and Prithvirai Chavan, India's Minister of Science and Technology. Additional presentations were given by Jean-Pierre Ezin, African Union Commissioner for Human Resources, Science and Technology, and Koji Omin, founder and chairperson of the Science and Technology in Society's (STS) Forum and former Minister of Finance in Japan. All discussed the need to retain – and indeed expand – investments in science and technology despite the steep economic downturn. While the governments of Brazil, China and South Africa seem to have been successful in their efforts to insulate their scientific enterprises from the financial storms sweeping across the globe, the African Union and many of its member states appeared to be less able to ward off the impact of budget shortfalls and a steep decline in funding from international organizations and foundations.
- Conference symposia that ranged from examinations of the state of astronomy in developing countries, to an analysis of the current state of knowledge of human prehistory, to discussions on the spread of HIV/AIDS, malaria, tuberculosis and other infectious diseases in sub-Saharan Africa, and to talks on current efforts to improve science education, especially in developing countries.
- The election of 50 new members into the Academy, which brings the total number of TWAS members to 950. The new members include nine women and seven scientists from South Africa – both record figures for the Academy.
- The selection of the new TWAS Council for 2010–2013. The council will consist of returning members: president Jacob Palis (Brazil); vice presidents Bai Chunli (China) for East and Southeast Asia, Atta-ur-Rahman (Pakistan) for Central and South Asia, and Romain Murenzi (Rwanda) for Africa; secretary-general D. Balasubramanian; council members Keto E. Mshigeni (Tanzania) and Ahmed H. Zakri (Malaysia). Newly elected council members include vice presidents F.M.A. Al-Kharafi (Kuwait) for the Arab region and Francisco J. Barrantes (Argentina) for Latin America and the Caribbean; council members Adel E.T. El-Beltagy (Egypt) and Harold Ramkissoon (Trinidad and Tobago); and treasurer Mohamed H.A. Hassan (Sudan), who has served as executive director of TWAS for the past two decades and will soon be retiring.
- The approval by the TWAS Council of the Academy's Fourth Strategic Plan, which is designed to guide the organization from 2010 to 2014. The plan calls on TWAS to focus on the needs of young scientists,

South Africa has come a long way in a short time.

increase the number of women in the Academy, pay special attention to the challenges faced by scientifically lagging developing countries, strengthen TWAS's regional offices, and take steps to enable the Academy to become more involved in science policy discussions.

- The announcement of the winners of the Ernesto Illy Trieste Science Prize 2009: Carlos Clemente Cerri, senior scientist at *Universidade de São Paulo*, Brazil, and Pramod Kumar Aggarwal, ICAR national professor at the Indian Agricultural Research Institute in New Delhi, India. They were honoured for their pioneering work in investigating the intricate relationship between climate change and agricultural production. Both have outlined a broad range of strategies for helping to ensure adequate food supplies in a world marked by continual increases in population and challenged by changes in regional climates that have yet to be fully assessed or evaluated.
- The presentation of the Abdus Salam Medal to C.N.R. Rao, TWAS founding fellow and immediate past president, who spoke about his long and rewarding journey to firmly establish advanced materials research as an important field of inquiry in his home country of India. From its tentative beginnings characterized by laboratories devoid of chemicals and equipment to today's increasingly improved facilities that allow a growing level of competence in terms of experimentation and study to take place, the past half-century has seen India make significant strides in material science research and development. The country is now poised to become a full partner in global efforts to advance this multidisciplinary science that encompasses not just chemistry but also physics and biology.
- TWAS 2009 Medal Lectures by Wieland Gevers (TWAS Fellow 2002), general secretary, Academy of Science of South Africa (ASSAf), on "Biomedical Science in Two Worlds" – the developed and the developing worlds. Gevers has witnessed developments in this field first-hand, first as a doctoral student and young researcher in the United Kingdom and then as one of South Africa's leading biomedical researchers upon returning to his home country in the 1970s; Li Zhensheng (TWAS Fellow 1990), research professor, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences (CAS), on the major achievements in wheat genetic improvement in China over the past half century, marked by a fivefold increase in grain yields that has been driven by an innovative plant hybridization system that Li played a major role in developing; Sergio Rezende (TWAS Fellow 2004), Minister of Science and Technology in Brazil, and professor, Department of Physics, Federal University

The election of 50 new members into the Academy brings the total number of TWAS members to 950.

PENGUINS AT BAY IN SOUTH AFRICA

African Penguin populations, living on the southern African coast, have declined from 2 million pairs in the mid-19th century to only 25,000 pairs today, says Phil Hockey, director of South Africa's Centre of Excellence at the Percy FitzPatrick Institute of African Ornithology, University of Cape Town. Hockey spoke about the African Penguin in a lecture titled 'Birds as Keys to Biodiversity Conservation', which he gave at the TWAS conference in Durban.

*Speaking to participants at the conference in Durban, Hockey explained that African Penguins (*Spheniscus demersus*), also known as Black-footed Penguins, have taken four "hits" over the past 150 years. In the mid-19th century, the removal of millions of tons of phosphate-rich guano, for the production of fertilizer, destroyed large areas of the penguins' nesting habitat. Burrows in the soft, guano-covered landscape had provided a sheltered habitat for the birds to breed. With the guano stripped away, the birds' eggs were left exposed on the rocky surface, vulnerable to predators, heat and rain.*

At the turn of the 19th century and during the first decades of the 20th, the commercial harvesting of hundreds of thousands of penguin eggs each year, primarily as a cheap food source, placed additional pressure on the penguin population. Some 50 years later, in the 1960s and 1970s, overfishing reduced the penguins' food supply. More recently, a yet-to-be-explained eastward migration of sardines, a key food resource for the penguins, has reduced their numbers even more.

This year, the South African government established a 20-kilometre 'no-fishing' zone around St. Croix Island in Algoa Bay, the site of a penguin breeding colony. Researchers are now following the foraging behaviour of the penguins there, using underwater tracking devices to see if they are travelling shorter distances for feeding, thanks to the ban. "Preliminary results are encouraging", Hockey says. Yet, he admits that the project is "an experiment". Additional studies will be needed, he says, before it can be determined whether the localized fishing ban has been effective.

If such measures fall short of their goals, then more stringent steps – such as placing more restrictive quotas on fish catches – will need to be considered. Such steps, Hockey notes, will likely spur fierce opposition from commercial fishermen, who will fear a loss in income. The 150-year decline in African Penguin populations is now putting their survival at risk. "If we fail to find effective conservation measures, and current trends continue, the species could be facing extinction within three or four decades", he says.

of Pernambuco, Brazil, on how magnetic materials have played a fundamental role in modern industrial society – for example, in the conversion of electrical to mechanical energy through motors and generators, and in microwave communication.

- Invited lectures by David Block, director of the Anglo-American Cosmic Dust Laboratory at the University of the Witwatersrand, South Africa, on the blind ambition and unquenchable quest for fame that drove the world-renowned astronomer Edwin Hubble to pursue global prominence apparently by stealing the work of less prominent colleagues (see box on p. 15), and by Michael Atiyah, Fields medallist and honorary professor at the University of Edinburgh, Scotland, on the endless yet joyful pursuit of truth and beauty that drives the field of mathematics, which the public tends to misunderstand as being distant, cold and forbidding (see box on p. 16).
- Lectures by the winners of the 2009 TWAS Regional Prizes. This year's winners are all prominent leaders

BIOMEDICAL SCIENCES IN TAIWAN, CHINA

"When I arrived in Taiwan in 1988", notes Cheng-Wen Wu, "few scientists from Taiwan had published their findings in peer-reviewed international scientific journals. Today, it happens all the time." Indeed, in 2007, scientists in Taiwan published nearly 18,000 articles in peer-reviewed international journals. That placed Taiwan eighteenth in the world in scientific publications, and fourth in Asia. "More than a quarter of these articles were in the field of biomedical research, making it the strongest scientific field in Taiwan."

For his efforts, Wu received the 2009 TWAS Regional Prize for Building Scientific Institutions from TWAS-ROESEAP, the Academy's Beijing-based regional office for East and South-East Asia and the Pacific. He spoke at the TWAS Conference in Durban.

Wu founded the Institute of Biomedical Sciences (IBMS) in 1988 upon returning to Taiwan from the United States, where he had worked for more than 20 years. "I was the first member of Academia Sinica *to come back", he says. "Taiwan had been sending some 3,000 scientists a year to the United States since the 1950s."*

Within a brief time, Wu persuaded some 30 members of the Asian diaspora to return. "I was able to convince the returning scientists that they could build a successful career at the institute", says Wu. "I also had the added advantage that Taiwan's economy was beginning to take off, which generated a sense of optimism for the future."

Within a decade after its creation, IBMS was a thriving enterprise, focusing on a broad range of research challenges that included the diagnosis and prevention of infectious diseases, neuroscience and novel treatments for cardiovascular disorders. But Wu had still larger plans for medical research in Taiwan. "At the time, we had just 4,000 biomedical researchers. In the US, a major university associated with a research hospital can have as many or even more biomedical scientists and clinicians on staff."

That's why Wu believed that the creation of a coordinating health research agency, modelled along the lines of the National Institutes of Health (NIH) in the United States, was essential. "I knew we needed to work together and to improve the efficiency of our operations to compete on an international level", Wu says.

The result was the creation of the National Health Research Institutes (NHRI) – a nongovernmental, but publicly funded, agency dedicated to "promoting and integrating research efforts undertaken by biomedical institutions in Taiwan."

"Excellence and relevance have propelled our success", says Wu. "That's where the lessons lie for other scientific institutions in the developing world seeking to build strong and sustainable scientific institutions."

in science who have made lasting contributions to scientific capacity building in their countries and regions: Adnan Badran, former Prime Minister of Jordan, who has spent a large portion of his career building institutions of higher education in his native country; Luis Bevilacqua, emeritus professor at the Federal University of Rio de Janeiro, who has been engaged in developing an open curriculum degree programme at his university that promises to greatly impact the way in which university students in Brazil are taught; Atta-ur-Rahman, former Minister of Science and Technology and Federal Higher Education Commissioner in Pakistan, who has been the chief architect of unprecedented national reforms in university research and training; Cheng-Wen Wu, who has spearheads the drive to build world-class medical research facilities in Taiwan, China (see box on facing page); and Venansius Baryamureeba, a member of the Makerere University Faculty of Computing and IT, who has championed efforts to forge long-tem collaborations with local and international IT companies to nurture and sustain university research and innovation in Uganda.

Conference events were videostreamed live across the globe.

• A talk by Akissa Bahri, this year's recipient of the C.N.R. Prize and director for Africa, International Water Management Institute, Accra, Ghana, examining the role that water plays in agricultural productivity and public health in Africa, and outlining the measures that need to be taken to ensure that the people of Africa have access to sufficient quantities of safe drinking water.

• Presentations by 2008 Prize Lecturers. The talks ranged from an analysis of noncommunicative geometry as a key to unlocking the secrets of the dimensions of space-time, to fabrication and func-




tionality in soft materials, to value-added applications of biotechnology in agriculture, to public health efforts to curb HIV among young women in South Africa. For a complete listing of the prize winners and a brief outline of their research, see www.twas.org.

- Lectures by scientists who have led or participated in initiatives by research units in scientifically lagging countries that have been supported by TWAS. Projects discussed ranged from efforts to assess the level of air pollution in Cotonou, Benin, to the impact that arsenic-laced groundwater contamination in Bangladesh is having on public health and agriculture, to the use of electrochemical sensors to monitor and assess water pollutants and devise cleanup strategies, to studies of Africa's population structures to better understand genetic susceptibility to disease, and to an examination of the key role that microbes play in the ecological health of the Great Rift Valley in Africa (see box on p. 8).
- Presentations by TWAS Young Affiliates, scientists under 40 years of age who receive five-year appointments that allow them to attend TWAS meetings and participate in Academy activities. Topics ranged from the relationship of growth factors to the rising incidence of diabetes in the developing world, to the multiple nutritional and medical uses of the food plant Moringa, to the impact of magnetic coupling on the properties of ferromagnetic nanoparticle systems, to quantum entanglement, and to efforts to uncover value-added byproducts derived from Nile perch.
- The publication of a comprehensive assessment of the state of science and technology in South Africa, edited by Roseanne Diab, executive director of the Academy of Science of South Africa, and Wieland Gevers, former president of the academy, which presents a detailed history of scientific research in South Africa. The publication opens with a discussion of the post-World War II boom in science and continues with an examination of the nation's scientific policies and initiatives over the past half century through to South Africa's present efforts to create a world-class scientific enterprise. The book promises to become a benchmark for similar publications that will be published in the future. For additional information about the volume, *State of Science in South Africa,* see www.assaf.co.za.

The TWAS endowment fund now totals more than USD15 million.

NEXT UP: HYDERABAD, INDIA

The 21st General Meeting of TWAS will take place in Hyderabad, India, next autumn. The meeting will be generously funded by the government of India. For additional information, please see the TWAS website at www.twas.org.

SCIENCES' UNSUNG HEROES

At an invited lecture at the TWAS 11th General Conference in Durban, David Block, director of the Anglo-American Cosmic Dust Laboratory at the University of the Witwatersrand, South Africa, made an impassioned and convincing argument that Edwin Hubble, the legendary astronomer, stole many of his iconic ideas from less famous colleagues. Block's research is published in Shrouds of the Night, *a book about dark matter he co-authored with Ken Freeman last year. He spoke about his findings at the TWAS Conference.*

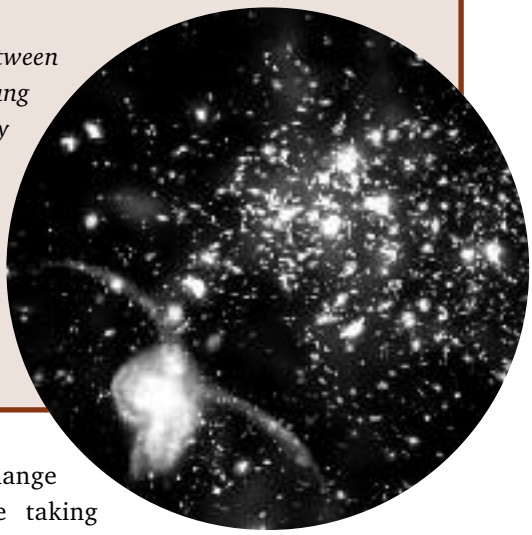
For example, Block says that the Hubble "tuning fork" – a way of classifying galaxies that was supposedly published by Hubble in 1926 – was in fact invented in 1929 by a Sir James Jeans. Hubble, Block says, only used the tuning fork in a 1936 paper, without giving Jeans any credit.

According to Block, Hubble also stole another galaxy classification system and the "Hubble" luminosity profile – a way of modelling the light intensity emitted by a galaxy – from a mysterious "Mr Reynolds" who penned an article on it years before Hubble mentions it in his work. Block believes this to be a J.H. Reynolds, an amateur astronomer living at the same time. Incidentally, his telescope eventually found its way to Egypt where for a long while it was the most powerful telescope to study the southern skies.

Figures like Reynolds and Jeans are the unsung heroes of science, Block said. Without a doubt, it should be the Jeans tuning fork, the Reynolds luminosity profile and the Reynolds galaxy classification system, he said.

Why Reynolds or Jeans never spoke up about the blatant plagiarism of their ideas is a mystery. Reynolds and Hubble corresponded, and Block has unearthed strong evidence that Hubble borrowed ideas from Reynolds in old letters.

This begs another important question: Scientific collaborations between Northern and Southern scientists are not always equal. How many unsung scientific heroes from the developing world had their ideas nabbed by people who had the power and networks to claim them as their own?



The above text is an excerpt of the blog that Linda Nordling wrote for SciDev.Net during the TWAS 11th General Conference. Other entries can be browsed at scidevnet.wordpress.com/category/twas-11th-general-conference.

- An announcement by the government of Brazil that it would provide an additional USD200,000 to the TWAS Endowment Fund. The Fund now totals more than USD15 million.
- Events at the conference were videostreamed live across the globe and were the subject of a lively blog of personal commentaries and observations by Linda Nordling, a freelance journalist working for the news portal SciDev.Net (see above box). This marked the first time the activities at a TWAS conference could be heard and read live by those who were not in attendance.
- The conference concluded with the issuance of the Durban Declaration, which urges negotiators at the climate change conference taking place in Copenhagen this December to "fully consider the impact of climate change on food, energy and water security" issues that will prove vital to the South's efforts to adapt to climate change and "continue on the path of sustainable development."

Durban is located in South Africa's KwaZulu-Natal province. As the country's third most populous city, this cosmopolitan metropolis is home to 3.5 million people. With a sizeable Indian population (Indian migrants came to South Africa in the mid-19th century

TRUTH AND BEAUTY IN MATHS AND POETRY

Michael Atiyah, widely considered one of the world's most influential mathematicians, gave an invited lecture at the TWAS 11th General Conference, where he noted that science has been viewed as an impersonal and objective human endeavour driven by a search for truth. Art, in contrast, is seen as a personal and subjective endeavour driven by a search for beauty.

Where does mathematics fit into this intellectual dichotomy? For Atiyah, as the only discipline where absolute certainty can be achieved, maths is too often regarded as a sort of hyper-science – a "cold and forbidding" pursuit which rarely touches either its practitioners or observers.

Mathematicians, not surprisingly, do not want their discipline to be viewed in this simplistic and negative way. Instead, Atiyah suggests that the field of mathematics should be compared to that of architecture. He notes that, like architecture, mathematics enjoys its own design and structural principles, is elevated by lofty visions, relies on carefully engineered frameworks and materials, embraces graceful details meticulously shaped by its skilled practitioners, and often displays real purpose in the real world. In brief, Atiyah claims that both mathematics and architecture "have beauty and utility".

Yet, what is beauty? We can define it, says Atiyah, in terms of simplicity, originality and elegance. But, in the final analysis, Atiyah maintains, beauty yields to this simple definition: "You know it when you see it".

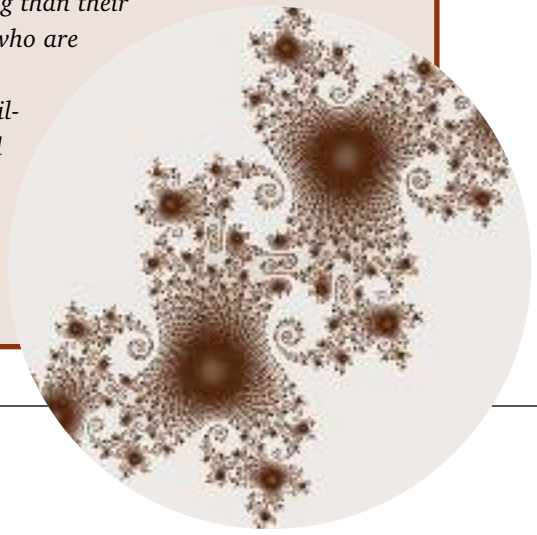
In mathematics, Atiyah says that beauty is on display, on a small scale, in a prime number – an integer that cannot be divided except by one and itself. On a large scale, mathematical beauty can be discerned in abstract symmetries – vast intellectual structures that carry implications which span across the discipline. Indeed, he says, abstract symmetries dominate the mathematical landscape much like the Cathedral of Notre Dame dominates the cityscape of the Ile de la Cité *in Paris.*

For mathematicians, it is the beauty of their discipline – its elegance and simplicity, its enduring foundations and its intricate and integrated frameworks – that drives their passion. Truth may emerge from their pursuits, says Atiyah, but it is beauty that explains their passion. In short, Atiyah says that mathematicians, in their work, "search for beauty and find truth along the way".

Atiyah is not surprised to find that a number of mathematicians have also been poets. He cites Omar Khayyam and Lewis Carroll, who are better known for their writing than their mathematics, and William Rowan Hamilton and James Clerk Maxwell, who are better known for their mathematics and physics than for their writing.

To help dispel the false dichotomy between science and art, and the prevailing notion among large segments of the public that mathematics is "cold and forbidding", Atiyah turns not to a mathematician but a poet – John Keats, who, in his "Ode on a Grecian Urn", famously wrote:

Beauty is truth, truth beauty – that is all
Ye know on earth, and all ye need to know.



Durban served as an ideal place to showcase South Africa's substantial scientific capacity.

to work the sugarcane fields), it is also one of the country's most demographically diverse provinces. Nearly 20% of its population is Indian and nearly 10% is white. Yet Durban serves as the capital of a province that is considered to be South Africa's "most African province", ancestral home to the Zulu tribes and their rich cultural traditions in music, dance and ceramics.

Vasco da Gama passed by what would ultimately become Durban, 500 years ago, as he journeyed around the Cape of Good Hope in search of a route that would link India to Europe. It is also the place where Mahatma Gandhi resided for nearly two decades at the turn of the 19th century. In Durban, Gandhi devised and perfected his strategies for nonviolent resistence, tactics that he would subsequently bring to India in a 30-year campaign for independence.

Today, Durban is a thriving city, home to the busiest container port in Africa, and a prime tourist destination for visitors seeking to relax in the sun and sand. As a vibrant multicultural centre of commerce and trade, Durban is a microcosm of South Africa's present as well as a window on its future. It thus served as an appropriate setting for the TWAS 20th General Meeting and 11th General Conference – an ideal place to showcase South Africa's substantial scientific capacity and to illustrate the steps that Africa's richest country is taking to pursue a future enriched by science-based sustainable development.

It was also, not surprisingly, an ideal place for TWAS to once again put on display the expanding prowess of science and technology in the developing world and the growing networks of scientists and scientific institutions that are helping to advance social and economic well-being across the South. ■

TWAS 20TH GENERAL MEETING & 11TH GENERAL CONFERENCE

Durban, South Africa, 20–23 October 2009

AIDING AFGHANISTAN THROUGH SCIENCE

A CONFERENCE HELD THIS SPRING IN TRIESTE, ORGANIZED BY TWAS WITHIN THE FRAMEWORK OF THE G8 FOREIGN MINISTERS' MEETING, SOUGHT TO FIND WAYS TO SET AFGHANISTAN ON A PATH TOWARDS POVERTY REDUCTION AND SUSTAINABLE DEVELOPMENT. THE CONSENSUS AMONG THE PARTICIPANTS WAS THIS: IT WON'T BE EASY, BUT IT CAN BE DONE – IN PART BY FOSTERING ROBUST REGIONAL COOPERATION IN SCIENCE AND CULTURE.

Three decades marked by foreign intervention, war, and political and religious extremism have left deep scars on Afghanistan. Today, the gross domestic product (GDP) of the country, which is home to some 28 million people, stands at USD35 billion (at purchasing power parity). That places Afghanistan 115th in the world in terms of national wealth. Two-thirds of the population live on less than two dollars a day. More than 65% of the population is illiterate. Among women, the figure stands at more than 80%. Over 10% of the nation's children die before they reach the age of five; nearly 40% are malnourished. Just 22% of Afghans have access to safe drinking water and only 30% to adequate sanitation. Life expectancy is 44.

Poverty, conflict, violence and hopelessness have not only undermined Afghanistan's economy and frayed its social fabric, but have also sparked a lucrative illicit drug industry. Drug trafficking, moreover, plays a central role in the funding of the Taliban, which economists estimate derive USD100 million annually from opium production (largely by taxing farmers who grow poppy and by levying 'protection fees' for opium that is transported through territories under its control). Although opium production in Afghanistan has dropped significantly, farmers still earned more than USD400 million this year by growing poppy. An estimated 90% of the world's opium comes from Afghanistan.

Consequently, despite enormous investments by both developed countries and international organizations to assist in the reconstruction of Afghanistan, and despite the limited reform measures that Afghanistan itself has taken, the nation remains very much at risk.

It is no simple task to determine what is to be done given the current state of affairs. Hopelessness often eclipses hope in such an environment of despair. Yet, the countries of the world acknowledge that Afghanistan's woes are by no means confined to its borders and that it is incumbent upon the global community to do all that it can to help improve the living conditions of this impoverished, conflict-ridden country. Such efforts are not only a moral imperative but will also play a key role in global security.

Just 22% of Afghans have access to safe drinking water, and only 30% to adequate sanitation.

The complex political and diplomatic environment that characterizes Afghanistan today served as the backdrop for a conference on "Afghanistan and its geographical context: the development of a regional network of cultural and scientific cooperation." The event, organized by TWAS in collaboration with the Italian Ministry of Foreign Affairs, took place in Trieste, Italy, on 26 June 2009 as part of the G8 Foreign Ministers' Meeting, which was held in Trieste from 25 to 27 June 2009 as a run-up to the G8 Summit in July.

The conference's opening session included speeches by Franco Frattini, the Minister of Foreign Affairs of Italy; Rangin Dadfar Spanta, Minister of Foreign Affairs of Afghanistan; and Makhdoom Shah Mahmood Qureshi, Minister of Foreign Affairs of Pakistan. About 100 people, largely scientists and science administrators, attended the conference, including representatives of the Afghan, Chinese, Egyptian, Indian, Pakistani, Russian and Turkish academies of sciences and research centres. The directors of Trieste's scientific institutions were also present.

"Scientific cooperation can make a unique contribution to the cause of regional stabilization in Afghanistan and its neighbouring countries", noted Minister Frattini. Unfortunately, he added, "the enormous potential for regional cooperation has not yet been exploited."

The Trieste conference, he stated, was designed to address this challenge by providing Trieste-based and international scientific organizations with the opportunity "to discuss how to strengthen scientific and technological cooperation" in one of the world's most troubled regions as part of a larger effort to promote regional stabilization and economic growth.

Minister Spanta, who followed Minister Frattini to the podium, readily acknowledged Afghanistan's daunting challenges. Over the past three decades, he noted, millions of Afghans have left their country, most seeking refuge in neighbouring Pakistan and Iran, where Afghan refugees now exceed 3 million. Among

those who have fled, he went on to say, are "a great many technocrats and professionals, including doctors, lawyers, engineers, teachers, scholars, artists and scientists." The continual outward migration of the country's most educated and skilled citizens, he observed, has led to a "severe brain drain" of the country's most prized citizens – people that Afghanistan can least afford to lose.

Afghanistan, the Minister said, has sought to address the critical economic and social challenges it faces by placing "additional emphasis" on education. The goal is "to ensure future generations of knowledgeable and engaged citizens, as well as competent leaders", who are well versed in the issues of the day. To this end, more than 7 million Afghan students and teachers have returned to school this year, which is six million more than in 2002. Student enrolment in Afghanistan's universities, led by the reopening of Kabul University in 2001 and the American University of Afghanistan in 2006, has also increased dramatically, from 4,000 students in 2002 to 37,000 in 2007. Next year, enrolment could reach 100,000.

Yet the Minister readily acknowledged that both the level of instruction (many Afghan teachers do not have university degrees) and the physical condition of the schools (only 40% of classroom instruction in Afghanistan takes place inside buildings) remained far below the standards found in other countries. As a result, financial and technical assistance from other nations will be necessary for many years to come if progress is to be achieved.

Minister Qureshi of Pakistan noted that his country also faces enormous economic challenges that require significant investments in science and technology. He observed that Pakistan, which enjoys strong historical, cultural and trade ties with Afghanistan, stands ready to forge even stronger partnerships with its neighbour in such areas as commerce, water management, border controls and, yes, scientific and cultural exchange.

"No nation", he said, "stands to gain more than ours if Afghanistan becomes a peaceful and prosperous nation." Minister Qureshi added that regional connectivity, focusing on promoting people-to-people interaction, represents "one of the best ways forward" to achieve these goals. "Economic development requires building adequate capacity in science and technology", he emphasized, "and efforts to build this capacity can benefit greatly from regional cooperation."

Afghanistan can trace its roots to the most ancient civilizations.

Abdul Bari Rasheed, president of the Afghanistan Academy of Sciences, who spoke at the conference's first plenary session, reiterated Minister Spanta's observations that Afghanistan faced daunting challenges in its efforts to stabilize its economy and to provide security to its citizens. Nevertheless, Rasheed noted Afghanistan's science academy was in much better shape than it was just three or four years ago when "the institution's future existence was very much in question." Rasheed told the participants that the Afghan government had recently signed an official decree recognizing the academy. More importantly, the government had provided funding for a new building, now nearing completion in the capital city of Kabul, "that would provide the academy with secure and ample space to conduct its activities."

Although Afghanistan still lacks a critical mass of researchers in most fields of scientific study, Rasheed maintained that the situation has markedly improved since the fall of the Taliban regime. Signs of progress, he said, suggest that "now may be an appropriate time to develop a comprehensive plan of action for building a sound foundation for science in Afghanistan." Such an effort, he stated, "would require the help of such organizations as TWAS."

The public and media have rightfully focused on the cost of the war in Afghanistan both in lives and money. Some 110,000 troops are currently deployed in Afghanistan – 65,000 from the United States and 45,000 from more than 40 other, largely NATO, countries. Troop causalities total more than 1,500 for US and coalition forces. There is no official number of Afghan casualties, but estimates range from 12,000 to 32,000 deaths. Since 2001, the United States alone has spent more than USD180 billion on the war. All of these figures will rise in light of President Obama's decision to send an additional 30,000 troops to Afghanistan.

While paling in comparison to military funding, the money spent on economic development – estimated to total USD2-3 billion a year – has also been substantial. A portion of this assistance has been invested to preserve and promote Afghanistan's scientific and technical capacity. Funds have been used, for example, to provide technical assistance to farmers, build veterinary field units to aid in animal husbandry, train university professors and administrators, and not least, construct 650 schools.

At the conference, Minister Frattini noted that the Italian government has allocated EUR400 million to aid Afghanistan in its efforts to regain its footing and to take its first hesitant steps towards peace and sustained economic growth. He stated that Italy's archaeological research and fieldwork in the region (in Barikut, Ghanzi, Kabul and Udegram, for example), dating back to the 1950s, not only reflect his government's desire to aid Afghanistan and its neighbours but are also a sign of Italy's "affection for the region's traditions, cultures and the extraordinary works of art." Italy "knows and respects the region", he observed. As a result, he believed that his country, in concert with other G8 countries, could contribute a great deal "to fostering peace and stabilization" there.




But Minister Frattini also acknowledged – as did many of the other speakers – that the efforts of G8 countries, however generous, would not be sufficient to ensure success. Both Afghanistan and its neighbours would also have to play a central role in the country's reconstruction.

Marcio Barbosa, UNESCO's Deputy Director-General, declared that Afghanistan has experienced "tremendous social and political upheaval in recent decades that has resulted in incredible damage and neglect to the very institutions that should be at the centre of the nation's efforts to promote stability and peace." Scientific and cultural institutions, he added, have been among the institutions that have suffered the most damage.

Consequently, Barbosa noted that a major "challenge for the international community today is to develop a regional network of cultural and scientific cooperation" to help reconstruct Afghanistan's institutions.

"As in the days when caravans travelled the Silk Road", he observed, "we need to create a 'scientific caravan' of institutions to help the people of the region and, in particular of Afghanistan, to rebuild societies in which human well-being may be achieved through peaceful and productive work, rather than undermined by violence."

Barbosa went on to say that UNESCO, as an "honest broker that promotes international cooperation in education, science and culture aimed at human and institutional capacity building, is uniquely positioned to play this role." He cited UNESCO's support to protect Afghanistan's cultural heritage – pointing to the placement of the minaret and archaeological remains of Jam in Hari Valley (home to the world's second-tallest ancient minaret) on UNESCO's World Heritage List – as one example of his organization's efforts. Such measures have also included the creation of an International Coordination Committee for the Safeguarding of Afghanistan's Cultural Heritage and technical assistance for the rehabilitation of the National Museum of Afghanistan in Kabul and the Museum of Islamic Art in Ghazni.

Representatives of science academies and research centres in Italy also voiced their support for efforts to assist in the building of scientific capacity in Afghanistan.

Picking up a suggestion made earlier by the president of the Afghanistan Academy of Sciences, Mohamed H.A. Hassan, executive director of TWAS, suggested that both his organization and the InterAcademy Panel (IAP), a global network of science academies headquartered in Trieste, should undertake a fact-finding mission to Afghanistan. Working closely with the Afghanistan Academy of Sciences and other scientific institutions, under such a mandate, TWAS and IAP would seek to develop a comprehensive agenda to help rebuild the nation's long-neglected scientific infrastructure. "The key to moving this effort forward", noted Hassan, "lies in devising a credible strategy, with direct input from the Afghan scientific community, and then securing adequate funding from donors to ensure that the plan is executed in a timely and effective fashion."




K.R. Sreenivasan, director of the Trieste-based Abdus Salam International Centre for Theoretical Physics (ICTP), stated that ICTP stood ready to invite eligible scientists to the Centre's broad-ranging research and training programmes in mathematics and physics. ICTP, he said, which sponsors more than 50 activities each year that attract some 6,000 scientists from around the world, could prove to be a valuable source of training for Afghan scientists, a role it has played for scientists in other developing countries for more than four decades. Franciso E. Baralle, the director of the International Centre for Genetic Engineering and Biotechnology (ICGEB) added that his institution would also be interested in aiding scientists from Afghanistan.

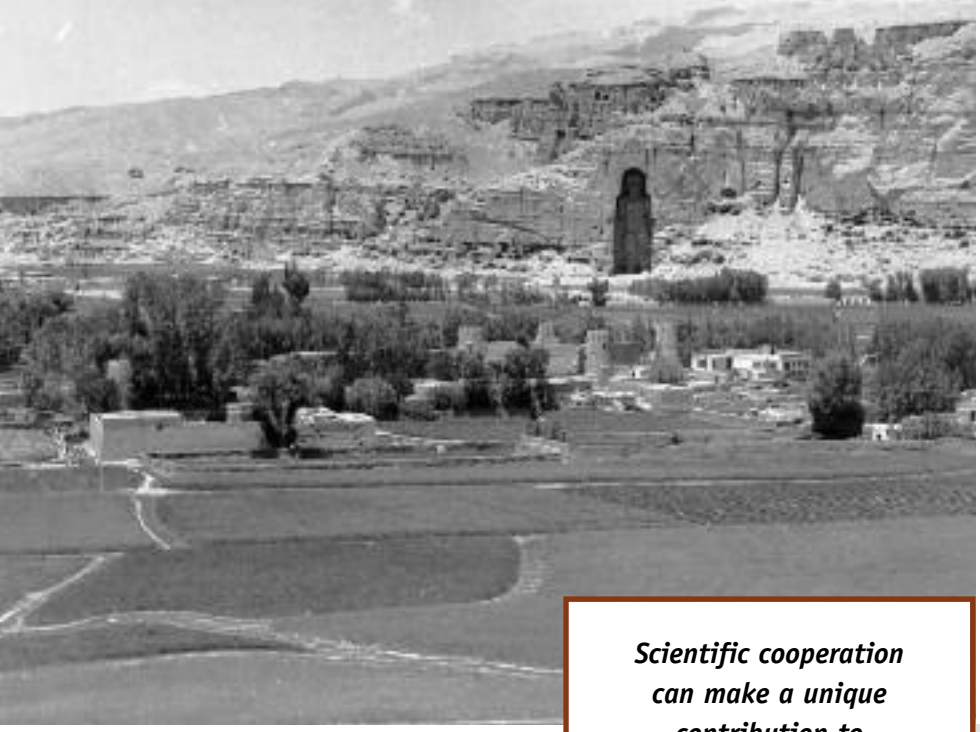
Yet, both Sreenivasan and Baralle readily acknowledged that interaction with Afghan scientists had been extremely limited to date. Sreenivasan, for example, stated that between 1991 and 2004, not a single Afghan scientist visited the ICTP. In contrast, during the same period, 663 Pakistani scientists participated in ICTP activities. The Centre also has collaborative agreements in place with several of Pakistan's preeminent scientific institutions, including the National Centre for Physics.

The embargo imposed by the United Nations during the reign of the Taliban in the 1990s helps to explain the absence of Afghan scientists participating in ICTP activities. But, as Sreeenivasan lamented, many Afghan scientists simply do not have sufficient training to benefit from ICTP workshops and seminars. As a result, he said that it was essential for Afghanistan to improve its educational system at all levels.

In a statement issued at the close of the G8 Foreign Ministers' Meeting on 27 June, the ministers noted that "regional cooperation will undoubtedly serve as a prerequisite for stabilizing Afghanistan and the region as a whole." The TWAS conference, which had taken place two days earlier, spoke directly to the prospects of achieving this goal through scientific collaboration. Even more importantly, the conference outlined a series of steps that could be taken both now and in the future, drawing on the experience of Trieste's international science organizations and the global networks that these institutions have created.

As many of those present at the conference noted, science will undoubtedly play a key role in meeting

Science will play a key role in meeting some of Afghanistan's most critical challenges.



Scientific cooperation can make a unique contribution to stabilization in the region.

many of Afghanistan's most critical challenges, including food and energy security, environmental protection, water management and public health. Science could even provide a helping hand in efforts to strengthen border controls and impede illicit drug trafficking. Most importantly, science could serve as one of the cornerstones of Afghanistan's efforts to nurture a well-educated citizenry capable of addressing the country's problems in an effective manner.

Both Afghanistan and the world at large would, of course, welcome science-based progress on all fronts. As Minister Frattini observed in his speech in the opening session: "Scientists around the world share common goals – to improve the lives of people on Earth, regardless of race, creed or political persuasion. That is why scientific cooperation can make a unique contribution to stabilization in the region."

As a country with a rich and storied history, Afghanistan can trace its roots to the most ancient civilizations. Archaeologists conducting research and field studies in Afghanistan have found evidence of human habitation that dates back 50,000 years and have uncovered artefacts belonging to 10,000-year-old farming communities that are among the oldest in the world. But as a nation that has been at the crossroads of trade for thousands of years, it has too often found itself trapped in the crosshairs of competing powers. Alexander the Great and Genghis Kahn, in times past, and the English, Russian and US intruders, more recently, have been among those who have occupied its territory.

Today, Afghanistan is struggling to regain its identity and, at the same time, to establish a firm foundation for sustainable economic growth in ways that will allow its people to live with dignity and in peace. Plagued by decades of impoverishment and violence, it cannot accomplish this goal alone. Compelling security concerns, a flourishing drug trade and tribal rifts tearing at Afghanistan's social

fabric, mean that reforms directed by faraway countries, however well intended, will fail to solve the country's deep-seated problems unless they are accompanied by efforts to promote strong regional cooperation in culture and science.

Discussions at the conference on "Afghanistan and its geographical context: the development of a regional network of cultural and scientific cooperation" provided a valuable forum for outlining how the countries of the region might move forward together to achieve a better future for a part of the world where isolation, conflict and hopelessness have been the order of the day for far too long. It won't be easy, but it can be done, and regional cooperation in science will undoubtedly play a significant part in this effort. ■

MIGRATION AND SCIENCE

ADVANCES IN SCIENCE DEPEND ON THE OPEN MIGRATION OF SCIENTISTS. WHILE SUCH FREE MOVEMENT BENEFITS BOTH SCIENCE AND SCIENTISTS, SCIENCE-POOR COUNTRIES CONTINUE TO BE HAMPERED BY THE 'BRAIN DRAIN' PHENOMENON. NEVERTHELESS, COUNTRIES SUCH AS CHINA AND INDIA HAVE BEGUN TO REAP THE BENEFITS OF 'BRAIN CIRCULATION', AS HIGHLY SKILLED MIGRANTS RETURN HOME AND DIASPORA NETWORKS CREATE VALUABLE OPPORTUNITIES FOR THE DEVELOPMENT OF SCIENCE AND THE ECONOMY.

The annual meeting of the G8+5 countries' science academies, hosted last spring in Rome, Italy, by the Accademia dei Lincei*, and attended by representatives of TWAS and the InterAcademy Panel (IAP), discussed trends in international migration as they affect scientists and medical doctors. Participants agreed on two important points. First, migration of knowledge workers cannot be stopped: individuals with ambition will continue to aggressively pursue their career opportunities. Second, the best way for scientifically lagging countries to retain (or lure back) highly skilled workers is to provide them with opportunities at home.*

COMPLEX ISSUE

Knowledge workers represent only a very small percentage of global migration flows. They are the elite and are not driven by desperation but by ambition – the desire to succeed in their chosen fields. The migration of low-skilled workers can be a thorny political issue: native populations often resent the competition for jobs and the burdens imposed on welfare systems. Scientists and health-care professionals, on the other hand, are more welcome because they bring valuable skills, provide much needed services, and can make important contributions to their fields and society.

Attendees of the G8+5 science academies meeting agreed that the free migration of knowledge workers is crucial for science and must not be discouraged. But they also acknowledged that protections should be sought for poor countries whose well-being is threatened by brain drain, which can seriously undermine development.

The attendees stressed two points in particular. First, highly skilled migration cannot and should not be halted. And, second, while various schemes to encourage migrants to return may help in the short term, the best way for developing countries to ensure that their 'best and brightest' come home (or, better, not leave in the first place) is through socio-economic development and capacity building in the sciences.

INTERNATIONAL ENDEAVOUR

Science is universal. The truth value of a scientific proposition knows no borders, and scientific discoveries do not get lost in translation in the way that, say, literature does. Throughout history, science has been characterized by an international 'cross-pollination' of ideas. The foundations of modern science were laid by a truly international team – Copernicus from Poland, Kepler from Germany, Galileo from Italy, Newton from England and Maxwell from Scotland – with each 'great man' building upon the work of his predecessors, often from other countries.

Yet, historians of science are increasingly recognizing, the Copernican revolution owed much to Indian mathematics, Arabic astronomy and Chinese science. An example of how fruitful cultural exchange can be for the advancement of knowledge is offered by the case of the 12th-century Muslim astronomer and metaphysician Ibn Rushd (known in the West as Averroes), who was instrumental in the Christian West's rediscovery of Aristotle, when his work on the great Greek philosopher was translated into Latin.

ON THE PLUS SIDE

The United States remains the greatest draw for knowledge workers – thanks to the size of its economy, the level of R&D investment, the quality of its universities, and policies (at least until recently) that encouraged the immigration of highly skilled workers. Yet, the UK, Canada, Australia and Japan all depend upon immigration to provide them with highly skilled knowledge workers.

The impact of immigration on science in the US should not be underestimated. Indeed, it could be argued that the country largely owes its pre-eminence in science and technology to a steady influx of scientists over the past century. An interesting fact highlights this point: more than one-third of US Nobel laureates in the sciences since 1990 were born abroad.

Migration of knowledge workers cannot be stopped.

Foreign-born workers, moreover, make up a surprisingly large proportion of the US science and technology labour force. In 2002, nearly one-quarter of scientists and engineers aged 25–44 were foreign born (up from 17% in 1996), while those with doctoral or professional degrees represented fully 43% (up from 38% in 1996).

The foreign-born are also a significant presence in academia in the US, particularly in the sciences. Roughly one-fifth of science and engineering faculty at US universities today were born abroad. In 2003, nearly 150,000 foreign students enrolled in science and engineering graduate programmes at US universities.

Moreover, the country's 'brain gain' is a gift that keeps on giving. A recent research report by the non-profit Virginia-based organization National Foundation for American Policy, based on the awarding of high school research prizes, revealed that 60–65% of the US's top science and mathematics students are chil-

dren of recent immigrants. These children will grow up to make their own contributions to their adopted country.

BRAIN DRAIN MATH

Yet, where receiving countries benefit, sending countries often lose. Even developed countries such as the UK have been experiencing 'brain drain' in recent years. Indeed, according to a recent study done by the Organisation for Economic Co-operation and Development (OECD), the UK is losing more skilled workers than any other country, with more than 1.1 million highly skilled university graduates living abroad.

But it is the developing world, of course, that bears the brunt of brain drain. That's because when developed countries like the UK lose native-born workers to the US, Canada and Australia, they are replaced by migrants from the South, whereas for developing countries (with the exception of South Africa), the flow is all in one direction.

Brain drain remains a major problem for Africa, in particular. Although reliable data are hard to come by, what statistics there are tell a woeful story. According to the World Bank, the continent sees some 80,000 highly skilled people a year migrate to work overseas.

It is estimated that one-third of all African scientists live and work in developed countries. Because most African countries finance students' higher education, brain drain represents a double loss: not only is the continent losing many of its 'best and brightest', but the money spent on their education is lost as well (or rather is effectively transferred to the North).

According to the International Organization for Migration (IOM), some 3.8 million Africans live in Europe, North America and Australia, including several hundred thousand high-level professionals. The United Nations Conference on Trade and Development (UNCTAD) estimates that 30–50% of the developing world's population trained in science and technology currently live in the developed world.

The migration of skilled workers from South Africa since 1997 is estimated to have cost the country nearly USD8 billion in lost human capital, hindering economic growth, according to the OECD.

THE DOCTOR IS AWAY

The brain drain of health professionals from developing countries is a particular cause of concern. The worsening health statistics in many sub-Saharan African countries, while largely attributable to diseases

NASAC STATEMENT ON BRAIN DRAIN

At the conclusion of the G8+5 Summit in Italy in July, members of the Network of African Science Academies (NASAC) issued a statement on "Brain Drain in Africa", from which the following excerpt is taken:

We believe that past experience calls for a new, more sophisticated approach to the brain drain challenge. This approach would recognize not just the obstacles but also the opportunities for S&T capacity building in Africa afforded by the migration to developed countries of well-educated, productive scientists with great drive and ambition.

Such an approach would acknowledge that global progress in S&T depends on international exchange and the ability of scientists and technologists to move freely across borders.

It would also recognize that even the poorest nations need a critical mass of talented scientists and technologists. Such well-educated citizens must not only possess a deep understanding of the science-based challenges that their nations face, but must also be able to participate fully and freely in global scientific initiatives as valued partners.

To read the complete text, see: www.lincei.it/files/dichiarazioni/NASAC_statement_brain_drain_Africa.pdf

such as HIV/AIDS, are no doubt also partly a consequence of the continuing exodus of doctors and nurses to the US and Europe. According to the World Health Organization (WHO), more than 13,000 doctors trained in sub-Saharan Africa are practising in the UK, Australia, Canada and the US.

Doctors and nurses represent only a small proportion of the highly skilled workers who migrate, but the loss for developing countries can mean a significantly compromised capacity to deliver health care. WHO has established that there is a direct relationship between the ratio of health workers to population and the survival of women during childbirth and children in early infancy. That means, as the number of health workers declines, survival declines proportionately.

Sub-Saharan Africa faces the greatest shortage of health workers. According to WHO, although the region has 11% of the world's population and 24% of the global burden of disease, it has only 3% of the world's health workers. In comparison, the statistics for the Americas are: 14% of the world's population, 10% of the global burden of disease and 42% of the world's health workers.

Indeed, WHO has identified 10 sub-Saharan countries (including the Democratic Republic of Congo,

Ethiopia, Madagascar, Tanzania and Uganda) in which the density of physicians, nurses and midwives is lower than the WHO minimum standard of 100 per 100,000 population.

According to the IOM's *World Migration Report 2008*, sub-Saharan Africa suffers the most severe shortage of health workers, yet doctors trained in this region make up nearly one-quarter (23%) of the current foreign-trained doctor workforce in OECD countries. Fully a quarter of all doctors working in Canada, New Zealand, the UK and the US have migrated from other countries, enticed by better pay and working conditions. Moreover, their prospective employers provide assistance with obtaining visas and even pay their moving expenses.

30–50% of the developing world's S&T-trained population live in the developed world.

Some countries, such as Ghana, have been particularly hard hit. According to WHO, some 30% of Ghana's physicians are practicing abroad. Ghana has about 13 physicians per 100,000 population (as compared with 256 in the US). Yet there are more than 500 Ghanaian doctors practicing in the US. That represents nearly 20% of the 2,600 physicians in Ghana. An additional 259 Ghanaian physicians are in the UK and Canada. According to some estimates, since 2000 Ghana has lost more than 1,000 nurses to the UK alone.

A similar story can be told for other sub-Saharan countries. The OECD estimates that there are more than 20,000 Nigerian doctors practicing in the US and Canada. Between 1998 and 2008, the number of medical doctors practising in Zambia declined from 1,600 to 400. In Kenya, 9 out of 10 health workers migrate to Europe and the US each year, while 60% of Liberia's physicians are practising in the US or UK. There are more Malawian doctors in Manchester, UK, than in Malawi, and more Ethiopian doctors in Chicago than in Ethiopia.

A 2008 WHO bulletin advocated that international aid to Africa be targeted to boost physicians' salaries and the recruitment and training of medical staff. The report concluded that Africa is likely to be short of some 167,000 doctors in 2015, hampering the UN Millennium Development Goals.

POSITIVE EFFECTS SOMETIMES

Yet the effects of migration for sending countries are not all bad. Indeed, there is an increasing emphasis on the positive effects of migration for developing countries, with many suggesting that brain drain is being replaced by 'brain circulation'.

The former United Nations Under Secretary General José Ocampo declared, in 2006, that "international migration is a positive force for development, both in countries of origin and countries of destination." Migration can compel a country to undertake productive restructuring and investment. Countries benefit when migrants (who might have been unemployed at home) send money to their families in the form of remittances. Migrants who return bring with them enhanced skills, thus contributing to capacity development. Finally, diaspora networks can provide opportunities for the transfer of knowledge and technology.

Migration generates billions of dollars in remittances to developing countries, contributing to poverty reduction. Remittances to developing countries more than quadrupled between 1990 and 2005, from slightly less than USD40 billion to more than USD160 billion.

Indeed, studies have shown that remittances constitute an important contribution to many developing countries' economies. For example, according to the World Bank, between 1980 and 1999, remittances accounted for 4.5% of GDP for Benin, 5.8% for Burkina Faso, and 13.5% for Cape Verde. Officially recorded

global remittances registered double-digit annual growth in the past few years to reach an estimated USD305 billion in 2008. According to a United Nations report, yearly remittance flows into China in recent years have been around USD20 billion. There are clear signs that the global economic downturn has adversely impacted the flow of remittances. Nevertheless they remain an important source of income for many poor countries.

Yet migrants' remittances have negative consequences as well. They tend to result in dependency, both within households and on a national level. Additionally, remittances can vary widely from year to year, meaning that smaller countries can suddenly be deprived of a significant portion of their GDP.

More importantly, remittances cannot undo the harm sustained by science-poor countries when the educated elite are lost to other countries. Africa can no more depend upon remittances than it can upon foreign aid to build the scientific capacity necessary for sustainable development. Help, in whatever form, can only go so far. What is more, it is low-skilled migrants – and not scientists and doctors – who typically contribute most to reducing poverty in their home countries through remittances, both because they come from lower-income groups (and so even a small income is an improvement) and also tend to remit more per person (since the primary reason for migrating was to provide support for their families back home).

BRAIN CIRCULATION

Scientists who do return to their home countries bring with them enhanced skills and can thus make a contribution to development. Because of the experience of South Korea and Taiwan, in the 1990s, and China and India today – where economic growth and demand for high-tech workers has resulted in a reverse flow of migrants – there has been a trend lately to see brain drain being replaced by 'brain circulation'.

Another potential positive impact for sending countries is the creation of a well-connected scientific diaspora, which may foster the creation of migrant entrepreneur networks. Migrants' skills and networks can generate important opportunities for their countries of origin and provide them with access to new research.

In her book *The New Argonauts*, the University of California's AnnaLee Saxenian argued that the migration of workers in the high-tech sector, mostly from India and China, to Silicon Valley, ultimately benefited both the US economy and migrants' home countries when migrants returned home with valuable skills, starting new businesses while also maintaining valuable links to the US.

China is now reaping big benefits from the 'open door' policy instituted by Deng Xiaoping.

Yet, such instances seem restricted to China and India. We have yet to see the same trend for sub-Saharan Africa. And the successes of a few countries – although important and worthy of consideration – should not be allowed to obscure the continuing problems which migration continues to cause for others.

CURIOUS CASE OF CHINA

The case in China offers hope, however, that brain drain can in time be turned around, and eventually lead to brain gain.

In 1978, Chinese leader Deng Xiaoping, in the wake of the disastrous 'Cultural Revolution', decided the country should send 3,000 students and scholars to study overseas every year, reasoning that even if 5% did not return, the country would still benefit. Yet the percentage that stayed abroad was closer to 75%.

Recently, the Chinese Academy of Sciences revealed

that, of the 1 million students who had gone overseas since 1978, only 275,000 had returned. The result was a significant brain drain for the country, which had already lost one generation of scientists to the Cultural Revolution.

Yet, since the 1990s a number of factors – including globalization, market liberalization and increasing privatization – have begun to reverse the flow. While large numbers of Chinese enrolled in foreign universities continue to remain abroad (a recent estimate put the figure at 70%), there are irrefutable signs that China is now reaping big benefits from the 'open door' policy instituted by Deng Xiaoping.

Today, the government recognizes that letting its scholars and students go abroad can be an economical way of training them. Talented scientists can receive excellent education and training in the West, then bring those talents and skills back home.

The numbers involved are significant. In the United States alone, there are some 130,000 Chinese students, with 50,000 holding permanent residence. China is hoping that if significant percentages return, the country can reap the rewards of their enhanced skills and education.

The government also knows that highly skilled migrants who decide to stay abroad can help China too. In 1987, Zhao Ziyang, then general secretary of the Chinese Communist Party, argued that the country should "store brain power overseas". This idea has gained currency, and today the government encourages overseas students to "serve their country from abroad" – by setting up firms, engaging in financial and technological transfer, and joining pro-Chinese business organizations.

A number of initiatives to attract scientists back to China have been introduced recently, both by the government and the private sector.

In 1994, the Chinese Academy of Sciences (CAS) launched 'The Hundred Talents Programme', awarding four-year research grants of 1 million Yuan (USD120,000) to young Chinese scientists living abroad. In 2005, the National Natural Science Foundation of China (NSFC) began offering grants of 1 million Yuan annually for up to four years to Chinese researchers with foreign citizenship.

The government is also encouraging entrepreneurs in science and technology who have established successful careers abroad to start up high-tech firms in their home country. Incentives include higher salaries,

science parks offering tax incentives and possibilities of 'clustering' with other firms and institutions, long-term residence permits for holders of foreign passports and expedited paperwork.

Science and technology parks such as Beijing's Zhongguancun Science Park (sometimes referred to as China's Silicon Valley) – home to some 8,000 high-tech firms – are providing growing opportunities for returnees. In Shanghai, there are now more than 1,700 firms run by return migrants, up 80% since 2001. To attract scientists at the top level, relocation allowances of up to USD100,000, in addition to high salaries, are offered.

SOUTH AFRICA'S REVOLVING DOOR

The experience of South Africa, which has found itself in a unique position in respect to migration flows, is also instructive. Regionally, it is a receiving country – a magnet for knowledge workers from less developed countries on the continent. Globally, however, it is a sending country.

Essentially, for many Africans who come to South Africa, the country is a stepping stone to greener pastures in the North. While neighbouring countries complain that South Africa is taking in all their highly skilled workers, the country still suffers from serious brain drain as the highly skilled – both native born and those who have come from other African countries to earn advanced degrees or begin their careers – very often move on to developed countries such as the US, UK, Australia or Canada.

In addition, since the country ended apartheid and established democracy in 1994, emigration has grown considerably, due to white flight, higher pay abroad and escalating crime rates at home. Between 1989 and 1992, 70,000 South Africans emigrated; from 1999 to 2001, the figure jumped to 166,000. South Africa must expand oportunities and improve security if it is to staunch the flow of its elite to the North. In the meantime, it is depending on the temporary replacement afforded by immigrants from neighbouring countries.

South Africa is thus an illustration of how – as water seeks its own level – highly skilled workers will follow their opportunities. Just as less developed African countries have not been able to discourage ambitious scientists from going to South Africa to improve their education and opportunities, so South Africa has not been able to stop knowledge workers from emigrating to more developed countries. In both

cases, the solution lies in creating comparable opportunities at home.

GO WITH THE FLOW

Proposed strategies for solving the problem of brain drain include flexible visa schemes, the taxing of companies in the North who hire migrants from the South, and various schemes (such as being undertaken now in China) to encourage return migration.

Any solution to 'brain drain' must directly address its primary causes.

Receiving countries, for example, could issue 'permanent visas' to scientists and medical doctors, which would allow a voluntary 'recirculation'. A 1998 French law grants foreign workers who retire after a minimum of 15 years in the country the right to a 'retirement card', permitting them to move freely between their home country and France. Such a scheme could be extended to scientists on shorter-term visas.

Similarly, the proposed European Union 'Blue Card' would allow circular migration, by permitting migrants to return to their home countries (or any third country) for up to 12 consecutive months without losing their residency rights in Europe. The idea is to avoid discouraging skilled migrants from ever returning home.

In the 1970s, Jagdish Bhagwati, an Indian-born American economist, famously proposed "taxing the brain drain." His idea was to allow developing countries to receive revenue from global funds derived from a relatively low tax (perhaps 5% of salary) levied on firms employing highly skilled immigrants. Numerous variations on this plan have since been proposed, but the idea is generally considered a political non-starter.

A more promising, and forward-looking, idea is represented by the Joint African-EU Strategy to allow participation in international research endeavours while staying at home. Such a scheme would depend upon the establishment of an inclusive global policy that would broaden access to the internet by increasing connectivity in developing countries.

HAPPY RETURNS

While solutions such as return incentive schemes may help in the short term, in the end it is only through socio-economic development and capacity building that countries can hope to offer the kind of opportunities that will lure back those who have left and keep others from leaving.

In other words, to be truly effective, any solution to brain drain must directly address its primary causes. The main 'push factors' motivating scientists to go abroad are lack of career opportunities and low wages; relative weakness of higher education institutions; insufficient infrastructure and funding for science and research; poor job prospects; and political instability and corruption. If developing countries are to discourage their best and brightest from emigrating, these fundamental problems will need to be addressed.

Since its inception a quarter century ago, TWAS has been dedicated to advancing just this goal – building the scientific capacity needed in the South to allow sustainable development to become a reality.

The Academy is justifiably proud of the progress that has been made in this area. But, for the brain drain challenge to be squarely met, each and every country must commit itself to establishing both the infrastructure and the working conditions necessary for their scientists to find their futures at home.

In the final analysis, the loss of a country's scientists to other countries is a societal problem that every country must solve in its own way. Others – including organizations like TWAS – can certainly help, but effective national programmes are the key to success. ■

CLEARING THE AIR IN DELHI

DELHI, COVERING A SPRAWLING METROPOLITAN AREA OF SOME 17 MILLION PEOPLE, IS ONE OF INDIA'S PRIMARY ENGINES OF GROWTH. BUT THE CITY'S GROWTH HAS COME AT A COST. SARATH GUTTIKUNDA, A RESEARCHER AT URBAN EMISSIONS.INFO IN DELHI, EXPLAINS WHAT DELHI IS DOING TO IMPROVE ITS AIR QUALITY.

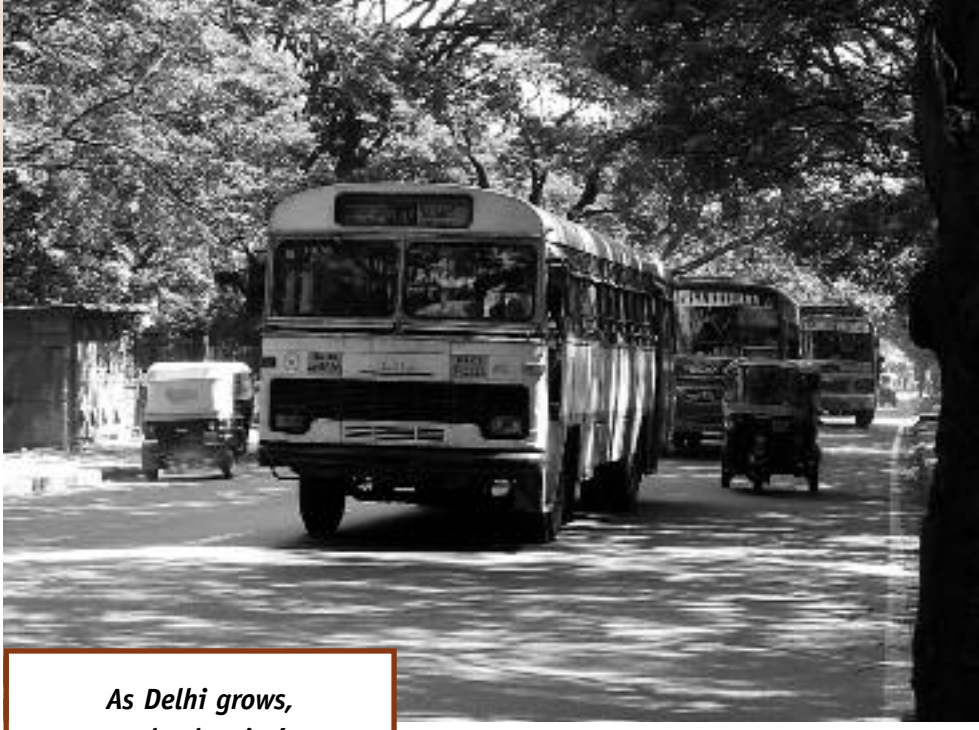
"India's Asthma Capital". That's the dubious honour the Indian Central Pollution Board (CPCB) gave to Delhi, the nation's capital city and second largest city (only Mumbai is larger), in March 2009.

Such rankings aside, Delhi is emerging as a world class city. But its growth has been accompanied by a relentless expansion of roads, industry, commerce and housing that has spurred a dangerous increase in the levels of air pollution. That, in turn, has led to rising health risks, reflected most notably by an increase in respiratory ailments.

In 1985, the National Capital Region (NCR) of Delhi covered just over 30,000 square kilometres. Today, the region covers more than 33,500 square kilometers and includes the neighbouring states of Haryana, Uttar Pradesh and Rajasthan.

Geographic expansion, of course, has been driven by population growth. In 1990, the population of Delhi's metropolitan area stood at 8.6 million. Today, it exceeds 17 million, and by 2025 it is expected to climb to 22.5 million. Yet, you don't need to be a mathematician to realize that the 10% increase in city size has failed to keep pace with a 50% increase in population.

Over the past decade, India's governments – at the city, regional and national levels – have introduced a number of 'green' initiatives to address the city's air pollution problems. While these measures deserve support, they have nevertheless fallen short in addressing the daunting challenges posed by air pollution. As a result, there is still a tremendous amount of work that needs to be done to provide clean air for the city's growing number of residents.



As Delhi grows, so do the city's transportation needs.

SEASONS AND SOURCES

No single sector – neither housing nor industry nor transportation – is solely responsible for Delhi's air pollution problems. Rather, a combination of factors, including outdated power plants, inefficient industries, widespread household burning of coal and biomass for cooking and heating, rising levels of vehicle emissions and road dust, all contribute to the city's dirty air.

Moreover, seasonal fluctuations in demand for fuel and such natural phenomenon as temperature inversions and dust storms create wide month-to-month variations in pollution sources and levels. All of this complexity must be taken into account when trying to maximize the effectiveness of pollution-mitigation initiatives.

In summer, dust storms that originate in the Thar Desert, southwest of Delhi, add to the levels of air-borne particulate matter and dust in the city. Scorching summer temperatures, moreover, cook the air and reduce its moisture content, causing high levels of dust to kick-up from the roadbed and waft into the air. Indeed some 40% of the particulate air pollution in summer is due to road dust, compared to less than 5% in winter. By way of contrast, in winter up to 30% of the particulate air pollution is due to the burning of biomass to heat homes and other structures. In summer, biomass accounts for less than 10% of particulate pollution as the burning of biomass is used solely for cooking.

Agricultural clearing is another factor that contributes to Delhi's rising air pollution levels. Again, this is a seasonal phenomenon that occurs in late fall and early winter as farmers in the not-so-distant agricultural districts that surround the city burn post-harvest plant residue – stems, leaves and upended roots – in preparation for next year's planting. The slithering smoke eventually sweeps over Delhi causing smog levels to rise.

STOP AND GO

As New Delhi grows, so do the city's transportation needs, fuelling a dramatic increase in scooters and motorcycles, automobiles and trucks, buses and taxis, and even auto-rickshaws. In 1991, New Delhi had an estimated 2 million registered vehicles plying its roads. Today, that figure stands at 4.5 million. Traffic speeds have slowed and idling times have increased, causing air pollution levels to skyrocket.

Efforts to unclog the traffic have prompted major road construction projects throughout the city. But the new highways, flyovers and bypasses have failed to yield the desired results. The reason, as most transportation experts will tell you, is that road construction only addresses the supply side of the transportation equation and thus fails to reign in the demand for vehicles. Indeed most experts agree that such efforts spur demand.

In fact, Delhi's experience with road construction has been replicated in cities throughout the world: More roads have led to more vehicles. This, in turn, has reversed the hoped-for improvements in traffic flow that the road construction projects were designed to achieve. In 2005, the number of car registrations rose to 1,000 a day in Delhi, marking a doubling of daily registrations in just five years. No amount of road construction can keep pace with such a dramatic increase in the number of drivers.

Industry, the other major source, accounts for about one-fifth of air pollution. Major culprits include the city's three major coal-fired electric power plants at Indraprastha, Badarpur and Raj Ghat, and about 200 brick kilns that also use coal to power much of the city's industry.

WHAT WORKS

In 1998, India's Supreme Court ruled that Delhi should take a number of concrete steps to combat air pollution in the transportation and industrial sectors. Most notably, it issued an order mandating the conversion of all diesel-powered buses in Delhi to compressed natural gas (CNG).

AIR BEIJING

Air pollution problems in Beijing, China, received a great deal of attention in 2008, primarily because the city served as the host of the summer Olympics. While stationary sources (industrial facilities and electric power plants) have historically been the main contributors to the city's pollution, Beijing's transportation sector – personal, public, and freight – has become an increasingly important factor.

The growing number of automobiles and trucks is not only exacerbating the city's air pollution problems, but it is also generating unprecedented levels of traffic. In 2009, according to the Beijing Traffic Management Bureau, the city registered nearly 1,500 motor vehicles a day, compared to 1,350 a day in 2008, a 10% increase in one year.

In 2003, the World Bank estimated that air pollution costs the Chinese economy some 520 billion Yuan (USD76 billion) per year, which represents about 3.2% of the nation's total gross domestic product (GDP).

During the 2008 Olympic Games, a series of measures were introduced to improve the number of "blue sky" (low pollution) days in Beijing (and the other participating cities in China). Two measures with the greatest impact were: shutting down the industries not only within the city limits, but also in cities within 100 kilometres of the centre of Beijing; and prohibiting 50% of the city's passenger vehicles from operating each day by instituting an even-odd permission system based on the vehicles' license numbers.

According to a report by the United Nations Environment Programme (UNEP), these measures led to a 50% decline in nitrogen dioxide levels and a 20% decline in carbon dioxide and particulate matter. The full impact of these initiatives, both for the environment and economy, have yet to be completely quantified. Meanwhile, government officials recently decided to reinstitute a less stringent version of the driving restrictions, requiring most cars to stay off the road at least one day every week. Clearly, shutting down the factories was only a temporary measure, designed to clear the air for the Olympics, and could not be continued beyond the closing ceremonies.

In addition to improvements in Beijing's air quality, these short-term measures also helped to enhance our understanding of the 'footprint' of various sectors and the potential that 'command and control' measures can have on efforts to reduce air pollution levels. We can only hope that Beijing (and other cities in China) do not need the incentives of Olympic games to make things happen in the future.



The compressed natural gas ruling marked the high point of Delhi's strategy.

In the transportation sector, this ruling led to more than 100,000 vehicles, including buses, taxis and auto-rickshaws, being converted to run on compressed natural gas (CNG).

The change-over, which occurred over a five-year period beginning in 1998, marked the world's largest switch to CNG for publicly owned and operated gas-driven vehicles to date. More importantly, it resulted in a dramatic reduction in the level of air pollution, with the greatest improvement coming from the conversion of some 3,000 diesel buses to CNG. As a result, Delhi has been able to enforce Euro II emission standards since 2000 – five years ahead of schedule. And since 2005, the city has been able to enforce Euro III for all passenger vehicles.

The court ruling also had a welcomed impact on mitigating industrial air pollution. About 500 heavy industries were shuttered and moved to areas beyond the city's administrative boundaries. This not only stirred a significant drop in air pollution within the city, but also prompted significant energy efficiency measures to be put in place as industries took advantage of the opportunity afforded by the relocation to upgrade their energy systems.

In 2003, the Indian Supreme Court issued another rule that required India's 14 fastest growing cities to conduct comprehensive analyses of their air pollution problems and then to submit an air pollution control action plan, based on their analyses, to effectively address the challenges.

As one of the 14 cities subject to this rule, Delhi's pollution control board is currently conducting the required comprehensive analysis, which includes a top-down monitoring of data and a bottom-up assessment of city-wide energy consumption and emission levels. The assessment, in addition to being a legal requirement, will also serve as the basis for the allocation of funds from the government-sponsored Jawaharlal Nehru National Urban Renewal Mission (JNNURM) for cities, which provides financial support for such urban development projects as the purchase of clean and efficient buses and road improvements for better traffic management.

DELHI ON THE GO

The CNG ruling marked the high point of the city's strategy to address rising air pollution problems. Early results following the conversion to CNG, especially for buses, were so dramatic that citizens could easily observe the improvement in air quality.

However, in the decade since the CNG conversion, air pollution levels in the city have edged back up. Some pollutants, including respirable particulate matter (RSPM) and nitrogen oxides, have climbed 40%.

The reasons are many. First, there is the sheer number of new vehicles on the road. As noted earlier, in 2000, some 500 vehicles were registered each day; in 2005, this figure doubled to 1,000. Consequently, the total number of vehicles in Delhi increased from 3.6 million in 2001 to 4.8 million in 2006. A survey conducted in February 2009 indicated that about 7% of vehicle exhaust emissions in Delhi are due to the idling of gas-driven vehicles stuck in traffic.

In 1998, India's Supreme Court ruled that Delhi should take steps to combat air pollution.

Then there is a lack of proper care and maintenance of gas-driven vehicles – both private and public. Here's one example. Buses operated by the publicly owned Delhi Transport Corporation were retrofitted to burn CNG in 2000. Over the past 8 years, maintenance has been spotty at best. As a result, many of these same buses have become less fuel efficient.

There is an urgent need to update Delhi's bus fleet. But efforts to purchase new buses have been hampered with delays. India's two largest bus manufacturers – Tata and Ashok Leyland – manufacture nearly 90% of the country's buses. At the current rate of production, only about 100 buses a month roll off the assembly line – a rate of supply that falls far short of the demand. The JNNURM fund alone has enough money to purchase 70,000 buses. It would take nearly 60 years to expend these funds at the current rate of bus production.

Exhaust fumes from poorly maintained trucks are also a problem. Emission controls are weak. Moreover, adulteration of diesel fuel, in which the fuel is contaminated by various products such as kerosene, is a chronic problem that only adds to the pollution that these trucks produce. In 2001, the city passed legislation prohibiting heavy duty trucks from entering the city during the day and enforced bypass regulations for trucks not destined for business locations in Delhi. Nevertheless, nighttime truck deliveries have an adverse environmental impact that is as perceptible as visibility-reducing smog during the day. This is especially true during the morning hours.

TAKE THE BUS

Delhi will host the 2010 Commonwealth Games. The government is using this high-profile event to enact measures that are designed to improve the quality of the city's air by easing traffic flows and increasing access to mass transport. Steps taken include expanding the public transportation network and streamlining traffic flows.

Among the most significant measures is an initiative to develop a Bus Rapid Transit (BRT) system characterized by dedicated bus lanes, train-like bus stations and wider bus doors.

In 2006, the TransMilenio BRT system in Bogotà, Colombia, became the world's first mass transport project approved for participation in the Kyoto Protocol's Clean Development Mechanism (CDM). TransMilenio has inspired other countries, including India, to institute the same system in their cities.

But results in Delhi have been mixed. After a two-year planning effort, only a five-kilometre 'pilot' lane has been built. The lane has been labeled the "corridor of chaos". While the road has yet to prove its mettle, it remains too early to declare the initiative a failure.

As experience elsewhere shows, a rapid bus transportation system can only succeed if it is built at a large enough scale to take people to where they need and want to go. Clearly, a bus lane that is less than 5 kilometres is inadequate to prompt significant changes in bus usage.

Despite the limited scale of this project, the start-up problems it experienced during the early months of operation and unfavorable media coverage, Delhi's BRT

system has recently elicited more positive approval, reflected not only in surveys but increased ridership.

The government should continue its efforts to improve the BRT by purchasing additional buses, upgrading the system's information centres and signage, and rigorously enforcing the restrictions placed on BRT lanes.

Without proper lane monitoring and enforcement, the BRT will not meet its objectives. For example, special lanes were set aside for pedestrians and other non-motorized transport in the initial plan. However, at one major junction, the lane that had been dedicated to cycling and walking has been converted to a 'left-turn only' lane for automobiles. Meanwhile,

AIR ULAANBAATAR

Ulaanbaatar, the capital city of Mongolia, is facing deteriorating urban air quality due to increased and inefficient combustion of coal, the primary source of energy. Also, efforts to curb air pollution in Ulaanbaatar have been thwarted by a number of natural constraints, including the fact that the city is encircled by mountains, which often trap the air, and it experiences very low temperatures during the winter months that cause the pollutants to mix and remain at low heights in the atmosphere. This increases the pollutants' ambient concentrations.

An analysis prepared for the World Bank in 2007 concluded that for particulate pollution, the largest emitters are power plants, domestic stoves and industrial boilers. The transport sector, which comprises fewer than 100,000 vehicles (including public transport), is small. But that doesn't mean Ulaanbaatar is free of traffic. Indeed limited infrastructure and inadequate planning causes traffic tie-ups despite the limited number of vehicles.

Gers *(traditional Mongolian dwellings comprised of wooden frames draped with several layers of wool felt), as well as the numerous food kiosks that line the city streets, burn coal during the winter months for heating and fuel wood all year round for cooking. The city's three combined heating and power plants and nearly 900 heat-only boilers generate heat for the apartments and commercial buildings.*

Although the power plants are responsible for most of the emissions, cooking stoves and small boilers in winter, and road dust in summer, add to the city's air pollution levels.

Local authorities have implemented a multi-pronged approach to control air pollution. Key programmes include improving monitoring capacity (through the efforts of a variety of government agencies), the introduction of innovative stove designs (aided by funds from the World Bank/Global Environment Fund), insulation of the gers *(with assistance from the Asian Development Bank), improving energy efficiency among small-scale industries and the power plants (again with funds from the World Bank), utilization of the fly-ash to reduce fugitive emissions (supported by the Xia Bank), the use of clean coal briquettes (which has been supported by the European Bank for Reconstruction and Development), and increasing the capacity of public transport (largely undertaken by government agencies in Mongolia).*



AIR DHAKA

Dhaka, Bangladesh's capital city and home to 12 million people, is the world's most densely populated city. Air pollution problems are on the rise due to the relentless increase in population and rising demand for energy. A 2008 study conducted by the Bangladesh Department of Energy attributed 15,000 premature deaths and several million cases of pulmonary, respiratory and neurological illnesses to poor air quality.

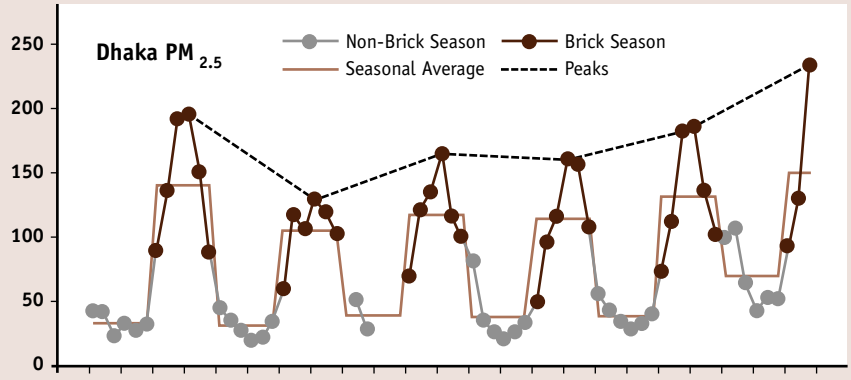
Transport emissions – direct exhaust from the vehicles and dust due to re-suspension – are the primary sources of Dhaka's air pollution. In the industrial sector, brick kilns are the major culprit, especially during periods of heavy manufacturing, which generally run from October to March depending on the behaviour of the monsoons. Seasonal averages have shifted over the years, but during peak brick manufacturing, pollution peaks measure 230 microgrammes per cubic metre ($\mu g/m^3$), compared to 100 $\mu g/m^3$ during off-peak manufacturing periods.

Growing construction activity has increased demand for brick, and that, in turn, is increasing the city's air pollution levels. A study by the Bangladesh University of Engineering and Technology of some 700 brick kilns shows that some 40% of the pollution in Dhaka originates from brick kilns burning biomass and low-quality coal. An additional 40 $\mu g/m^3$ during peak brick manufacturing periods leads to an estimated 5,000 premature deaths annually.

Pollution control measures for the transport sector range from better emission standards for passenger cars and cleaner buses to banning two-stroke vehicles and restricting bicycle rickshaws in central Dhaka to ease traffic.

Major efforts are now underway to mitigate pollution caused by the brick kiln industry. These measures, which include the use of advanced combustion technologies and filtering systems as well as public education to increase public awareness of the cost-savings derived from increased energy efficiency, are expected to quickly improve the city's air quality.

Monthly average $PM_{2.5}$ measurements in Dhaka City



Rapid bus transport and urban rail systems can help alleviate traffic congestion.

lanes that had been designated for non-motorized transport lanes are now dominated by motorcycles.

In 2002, Delhi opened a much awaited (and much delayed) 65-kilometre metro rail system. Construction on the next phase of the system – running 128 kilometres and reaching into a large number of Delhi's neighbourhoods – is underway.

The metro rail system has proven popular with the public. Indeed, it currently carries about 650,000 passengers a day. Air pollution experts project that when the second phase of the rail system is completed, it could help reduce emissions of RSPM and nitrogen oxides by nearly 10%.

The rapid bus transport and urban rail systems can help alleviate traffic congestion and encourage people to shift from private to public transportation. Yet, two completely 'zero emission' sources of transportation – bicycling and walking – should not be overlooked. Both help promote personal health, nurture a sense of community and enhance the quality of urban life.

BREATHING EASY

Delhi faces daunting air pollution challenges. Continuous growth, moreover, means that these challenges are likely to become even more daunting in the future. Yet, as the experience of other cities (for example, London, New York and, more recently, Beijing) shows, air pollution is an environmental problem that can be mitigated. The technology for providing cleaner air is already in place. What is most needed are innovative regulations, planning and incentives that allow growth to continue – but not at the expense of the air we breathe. ■

BIOVISION IN LYON AND ALEXANDRIA

This article is based, in part, on a presentation given by the author at the BioVision, The World Life Science Forum*, held in Lyon, France in March 2009 (see www.biovision.org). The conference session, organized by TWAS, also included presentations by Claudia Sheinbaum, researcher at the Institute of Engineering,* Universidad Nacional Autónoma de México *and former environment minister of Mexico City, and Robert Vaugard, director,* Laboratoire des Sciences du Climat et de l'Environnement*, France. It was moderated by Peter Wrobel, editorial director of Science Business Publishing, UK, and former managing editor of* Nature.

BioVision *is an international platform for dialogue, debates and proposals concerning major issues in the life sciences. The signature event is a conference held in alternating years in Lyon, France, and Alexandria, Egypt. The Lyon meeting is organized by the* Fondation Scientifique de Lyon *in collaboration with the French Academy of Sciences.* BioVison Alexandria *is held at the* Bibliotheca Alexandrina *(see www.bibalex.org). The next meeting of* BioVision Alexandrina *will take place on 11–14 April 2010.*

BUILDING CAPACITY FOR CLIMATE CHANGE

AS A PRELUDE TO THE POST-KYOTO CLIMATE CHANGE NEGOTIATIONS SCHEDULED TO TAKE PLACE IN COPENHAGEN IN DECEMBER, TWAS AND ITS PARTNERS ORGANIZED A SERIES OF WORKSHOPS EARLIER THIS YEAR TO PROVIDE THE LATEST SCIENTIFIC INFORMATION TO NEGOTIATORS FROM DEVELOPING COUNTRIES.

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty that seeks to stabilize greenhouse gas (GHG) concentrations in the atmosphere "at a level that would prevent dangerous anthropogenic interference with the climate system". Under the protocol, which was adopted in December 1997 in Kyoto, Japan, and entered into force in February 2005, industrialized countries agreed to reduce their collective GHG emissions by 5% from 1990 levels by 2012.

Long-standing efforts to develop a 'post-Kyoto treaty' will culminate in a conference to be held in Copenhagen, Denmark, in December. The goal is to work out a 'Copenhagen protocol' that will effectively address the global climate challenge. Representatives from 170 countries are expected to attend.

The climate change challenges that we are currently experiencing, and which we will continue to experience for decades to come, have been caused in large part by the historic emissions of the industrialized countries. However, no consensus has been reached on how to deal with the current and future emissions of such rapidly industrializing countries as India and, especially, China. China, for example, is now the world's leading producer of GHGs, although its per capita production is still significantly lower than the United States and other developed countries.

Against this backdrop, there are a large number of developing nations that are responsible for very little




of the world's GHG emissions. The 50 least developed countries (LDCs), for instance, contribute only 1% to global carbon emissions. Yet, it is the world's poorest people, often relying on subsistence agriculture to survive, who are most at risk due to the increased prevalence of flooding, drought, and intermittent and unreliable rainy seasons.

In a 2009 report, *Anatomy of a Silent Crisis*, the Global Humanitarian Forum, based in Geneva, Switzerland, states that climate change causes some 300,000 deaths each year and adversely affects the lives of 325 million people. Furthermore, the report estimates that economic losses due to climate change total USD125 billion each year. Such impacts, it adds, are not felt evenly across the globe. Indeed, developing countries bear 99% of deaths and more than 90% of the economic losses linked to climate change.

A key challenge that needs to be addressed in Copenhagen is this: while developing countries are likely to be the most affected by climate change, their negotiating capacity is often weak and their policy-makers often lack a sufficient understanding of the science behind the issue.

THREE WORKSHOPS

To address such capacity-deficit issues – and, more specifically, to brief Copenhagen climate treaty negotiators from developing countries on the current state of knowledge on climate change and adaptation strategies, TWAS entered into an agreement with the European Climate Foundation (ECF) and the Inter-Academy Panel on International Issues (IAP) to organize three regional workshops in collaboration with local partners:

- for Asia: in Kuala Lumpur, Thailand, on 2–3 July, in association with the Thailand Academy of Sciences and Technology (TAST);

EUROPEAN CLIMATE FOUNDATION

The European Climate Foundation (ECF) aims to promote climate and energy policies to reduce Europe's greenhouse gas emissions and to help Europe play an even stronger international leadership role in mitigating climate change globally.

According to ECF, key elements of a sustainable energy future include:

- *a substantial increase in energy efficiency;*
- *a successful transition from conventional to renewable energy;*
- *maintenance of the Earth's ecological systems and their life-supporting services; and*
- *equitable distribution of energy services both internationally and within nations.*

To achieve these, ECF has identified four major areas for immediate intervention within Europe:

- *energy efficiency in buildings and industry;*
- *low-carbon power generation;*
- *transportation; and*
- *EU climate policies and diplomacy.*

ECF is based at The Hague in the Netherlands. It receives funding from a number of national and international foundations.

For additional information, see www.europeanclimate.org.

- for sub-Saharan Africa: in Nairobi, Kenya, on 6–7 July, in association with the African Academy of Sciences (AAS); and
- for Latin America and the Caribbean: in Itaipava, Brazil, on 10–11 July in association with the TWAS Regional Office for Latin America and the Caribbean (TWAS-ROLAC).

Some 80 people, about half of whom were national climate change negotiators, participated. The organizers also invited national and international climate change experts to present the latest scientific information on this complex issue. Large developing countries such as China, India and Mexico, which already have large teams of negotiators, were not invited to the workshops in order to give smaller countries more time to discuss climate change issues relevant to their nations.

Developing countries bear 99% of deaths and more than 90% of the economic losses linked to climate change.




Each workshop, which focused on the overarching issue of 'climate-resilient, low-carbon development', was divided into four sub-themes: current understanding of climate change, mitigation, adaptation and costs. Presentations by local experts were made on both the primary and sub-themes. In Brazil, for example, Carlos Nobre (TWAS Fellow 2006) gave an introductory talk on 'climate change and its impacts'.

Nobre highlighted the increasing scientific certainty driving the analysis of the reports prepared by the Intergovernmental Panel on Climate Change (IPCC). He observed that models in the 2001 report did not even consider the potential impact of melting ice in the Arctic. In contrast, models in the 2007 report placed this issue front and centre. He added that a 'tipping point' had already been reached and that it will be almost impossible to reverse the effects of melting ice on future climate change.

We are approaching other tipping points, too, Nobre cautioned. The 2007 IPCC report does not consider acidification of the oceans, but the seas are already approaching the limits of the carbon they can safely absorb – a point underscored in a IAP statement on ocean acidification released in June 2009 (see box on facing page).

"The acidity of the sea will increase to levels not seen for tens of millions of years", Nobre says, "and that means that 40% of shelled marine organisms will not survive". The marine ecosystem could collapse, he warned.

And then there is the melting of permafrost – a newly identified tipping point not accounted for in current climate models. Recent studies show that permafrost stores twice the level of carbon than previously thought. If these frozen soils melt and the trapped carbon is released into the atmosphere, another "potential major instability will need to be added to the climate models", observed Nobre.

WAY FORWARD

The workshops highlighted several issues of critical importance, including the need to:

- Integrate climate-resilient, low-carbon development

IAP STATEMENT ON OCEAN ACIDIFICATION

Ocean acidification, one of the world's most important climate change challenges, may be left off the agenda at the Copenhagen conference. Yet, ocean acidification is expected to cause massive corrosion of our coral reefs and dramatic changes in the make-up of the biodiversity of our oceans and to have significant implications for food production and the livelihoods of millions of people.

The gravity of the situation was made in a joint statement published by the InterAcademy Panel on International Issues (IAP), signed by 70 national science academies.

The statement calls for world leaders to explicitly recognize the direct threats posed by increasing atmospheric CO_2 emissions to the oceans and its profound impact on the environment and society. It emphasizes that ocean acidification is irreversible and suggests that, on current emission trajectories, all coral reefs and polar ecosystems will be severely affected by 2050 or even earlier.

Unless we cut our global CO_2 emissions by at least 50% by 2050, the statement warns fundamental and immutable changes in the make-up of our marine biodiversity could threaten food security and irreparable damage to coastal areas.

The IAP statement was issued during the United Nations Framework Convention on Climate Change (UNFCCC) conference in Bonn, Germany, in June 2009, which has helped shape the Copenhagen negotiations.

For the complete text of the statement, see: www.interacademies.net.

into overall national development plans (leading to climate-compatible growth plans) and make such strategies compatible with poverty reduction efforts in the poorest countries.

- Meld adaptation measures into overall national development plans, examining how effective these measures would be and how much they would cost.
- Better understand the potential impact of climate-change induced changes in forestry, agriculture and land use, and how this could be measured accurately, especially with regard to Reducing Emissions from Deforestation and Forest Degradation (REDD), which will be a key issue in the Copenhagen negotiations.

- Examine the full range of options related to technology transfer, including intellectual property rights and the extent to which a lack of appropriate technology limits effective responses to climate change.
- Build capacity for dealing with mitigation and adaptation.
- Increase public awareness and education in matters related to climate change.
- Improve collaboration among developing countries for the purposes of devising effective strategies for mitigation and adaptation to climate change.

Many participants, especially those from the LDCs, cited the promotion of capacity building in science, technology, management and policy-making as crucial. They also emphasized the importance of South-South collaboration in advancing these goals.

ONE VOICE

One positive sign of South-South collaboration to emerge after the workshops is the agreement of African Union (AU) member states to speak with one voice at the negotiations in Copenhagen. Following their August meeting in Tripoli, Libya, the AU announced that Ethiopia's Prime Minister Meles Zenawi had been selected as the continent's climate change spokesperson and that he would lead the negotiations in Copenhagen on behalf of African countries.

Likewise, the world's small island developing states (SIDS) have a common negotiating position. They believe that stabilizing global temperatures at 2°C above current or recent levels, as agreed by the G8 in L'Aquila, Italy, in July, is too high and that subsequent sea-level rises will devastate their nations. "During the meetings it became clear that the urgent adaptation needs of developing countries considered most vulnerable to climate change, including some small island states, do not get the attention and support they deserve", says the ECF's Jos van Renswoude.

"The positions taken by developing countries in the negotiation process vary widely, even though most of these countries demand that industrialized countries take adequate measures to ensure that the 2ºC pathway is followed", continues van Renswoude. "This implies that CO_2 emissions by industrialized countries should be 80% lower in 2050 compared to 1990 and

that emission cuts should start immediately and proceed progressively."

Such an approach, the so-called 'top-down' approach, prescribes what needs to be done based on the best available science. The alternative, the so-called 'bottom-up' approach – favoured by many industrialized countries – involves reducing emissions depending on what is thought to be economically feasible.

TWAS and its partners would prefer to see the top-down approach be given due weight in any post-Kyoto treaty. In addition, it is clear that most developing countries require appropriate financial assistance from industrialized countries to tackle climate change and its impacts.

Networks such as TWAS should be empowered to promote dissemination of knowledge on climate change.

Many developing countries lack or cannot afford the analytical expertise necessary for charting the intricacies of the climate-change related problems, and they also lack the capacity for devising adequate action plans.

Nevertheless, there are examples of successful experiences in developing countries that could easily be adapted and replicated in other developing countries. The Assessments of Impacts and Adaptation to Climate Change (AIACC) initiative, which was coordinated by the Global Change System for Analysis, Research and Training (START) in partnership with TWAS and the United Nations Environment Programme, and funded by the Global Enivronmental Facility (GEF), could serve as a model for such endeavours. Efforts to identify and replicate cases as these would significantly reduce the time-scale and costs of adaptation and mitigation efforts (see *TWAS Newsletter* 14, Apr–Sept 2002).

RECOMMENDATIONS

Based on such outcomes from the three workshops, the ECF has proposed two main recommendations:

- Existing networks such as TWAS should be empowered to promote dissemination of knowledge on climate change and take additional steps to foster South-South collaboration. Equally important, existing globally operating organizations like the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP) should reinforce their efforts to disseminate climate change policy-related best practices in developing countries.
- An international workshop for smaller developing countries should be organized focusing on the relationship (both in terms of mitigation and adaptation) between climate change and agriculture, forestry and land use change. The workshop should aim to develop potential solutions and policies.

Both these issues fall within the remit of TWAS. As a result, the Academy looks forward to developing a fruitful and lasting relationship with ECF as both organizations attempt to highlight the plight of developing nations in responding to the changing climatic conditions the Earth is already experiencing – changes that are predicted to increase in frequency and intensity in the coming years unless a strong and equitable agreement can be reached in Copenhagen this winter. ■

NEW ICTP DIRECTOR

• **Fernando Quevedo**, a particle physicist from Cambridge, has been appointed the new director of ICTP, succeeding K.R. Sreenivasan (TWAS Associate Fellow 1998), who had served in the position since 2003. Quevedo was born in Costa Rica and educated in Guatemala. He obtained his PhD from the University of Texas at

Fernando Quevedo

Austin, USA, and has held several research appointments in Switzerland, Canada, USA and Mexico. Quevedo joined the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge, UK, in 1998, where he was professor of theoretical physics and fellow of Gonville and Caius College. He has wide-ranging interests in string theory, phenomenology and cosmology, and was awarded the 1998 ICTP Prize for his contributions to superstring theory. In assuming the directorship, Quevedo stated, "As a scientist from a developing country, I look forward to following Professor Salam and my predecessors' footsteps to lead and further advance ICTP through these exciting times in which science is of greatest importance for the world's culture, development and survival."

US SCIENCE ENVOYS

• **Bruce Alberts** (TWAS Associate Fellow 2001), editor-in-chief of *Science* and former head of the US National Academy of Sciences, and Ahmed Zewail (Nobel laureate 1999, TWAS Fellow 1989), Linus Pauling chair professor of chemistry and physics at the California Institute of Technology, were named as two of the first three US Science and Technology Envoys by US Secretary of State Hilary Clinton. Elias Zerhouni, past director of the National Institutes of Health, was the third nominee. The US Science Envoy programme is part of President Obama's "New Beginning" initiative with Muslim majority countries, which is designed to promote scientific and technological collaboration and exchange.

Bruce Alberts

DEPUTY PERMANENT OBSERVER

• **Maurizio Iaccarino** (TWAS Associate Fellow 1997) has been appointed UNESCO Deputy Permanent Observer. He obtained his MD at the University of Naples in 1962 and Honoris Causa in biology at Univesity of Tuscia in 1999. After working at Stanford University, USA, and the University of Sussex, UK, he was appointed director of the International Institute of Genetics and Biophysics, Naples (1985-

Maurizio Iaccarino

1993), and director of the Institute of Molecular Genetics, Alghero (1994). He also served as Assistant Director-General for natural sciences at UNESCO (1996-2000), where he helped organize the World Conference on Science (Hungary, 1999).

NIGERIAN ORDER OF MERIT

• **Aderemi Kuku** (TWAS Fellow 1989) has been awarded the Nigerian National Order of Merit (NNOM), the highest honour given by the government to Nigerian academics. Kuku is professor of mathematics at Grambling State University in Louisiana, USA. He has held a number of previous positions, including president of the African Mathematical Union; member of the Institute for Advanced Study, Princeton, New Jersey, USA; and visiting professor at the *Max-Planck-Institut für Mathematik* in

Aderemi Kuku

Bonn, Germany. He is the recipient of the African Mathematical Union (AMU) Medal and the Officer of the Order of the Niger, Government of Nigeria.

GM MODI AWARD

• **Padmanabhan Balaram** (TWAS Fellow 1996) has been given the Gujar Mal Modi Innovative Science and Technology Award for his outstanding contributions to the field of molecular biophysics. Balaram directs the Indian Institute of Science's Molecular Biophysics Unit

Padmanabhan Balaram

in Bangalore, India. He has also won the Shanti Swarup Bhatnagar Prize of the Council for Scientific and Indutrial Research (CSIR), TWAS Award in Chemistry, GD Birla Award for Scientific Research, Distinguished Alumnus Award of IIT Kanpur and Padma Shri by the Government of India.

SRINIVASA RAMANUJAN PRIZE

• **Swadesh Mitter Mahajan** (TWAS Fellow 1991) was awarded the 2005 Srnivasa Ramanujan Prize funded by the Neils Henrik Abel Memorial Fund in Norway, in collaboration with the International Mathematical Union (IMU), and administered by the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The

Swadesh Mitter Mahajan

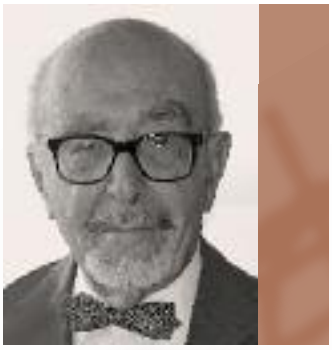
award honours young mathematicians (less than 45 years old) from developing countries and carries a cash prize of USD10,000. Mahajan is senior research scientist and research professor at the Institute of Fusion Studies, University of Texas at Austin, USA. iraqi

NIGERIAN NATIONAL MEETING

• The '**Nigerian National Meeting on Global Navigation Satellite Systems** (GNSS) Science and Application', which took place at the National Universities Commission in Abuja, Nigeria, on 16-19 November, is the first jointly sponsored international meeting between TWAS and the ICTP. Other sponsors were Boston College, USA, the Nigerian National Universities Commission and the Nigerian Meteorological Agency. Topics discussed included an overview of GNSS science and applications; a review of research work on Global Positioning System (GPS) derived data carried out in Nigeria; an examination of techniques for ionospheric Total Electron Content (TEC) data retrieval from GPS information; and ionospheric research projects oriented towards a GPS Augmentation System for Nigeria. For a complete review after the meeting, please see www.oosa.unvienna.org/oosa/en/new.html

IN MEMORIAM

• **Luigi Stasi**, a close associate of Abdus Salam and Paolo Budinich who helped transform the lofty ideals behind the International Centre for Theoretical Physics (ICTP) and TWAS into concrete realities, died on 5 August 2009. He was 87 years old. A lawyer by training, Stasi was instrumental in the establishment of ICTP, TWAS, the InterAcademy Panel (IAP), the InterAcademy Medical Panel (IAMP) and the Consortium on Science, Technology and Innovation for the South (COSTIS). He played a key role in the drafting of the legal documents and in finalizing arrangements for the acquisition of land and the construction of buildings for virtually all of the international scientific institutions that are now part of the Trieste System. He also served as the long-time secretary of the *Fondazione Internazionale Trieste per il progresso e la libertà*



Luigi Stasi

delle scienze, which was actively involved in the creation of TWAS, the International Centre for Genetic Engineering (ICGEB), the International Centre for Sciences and High Technology (ICS), the International School for Advanced Studies (SISSA-ISAS), the Elettra Synchrotron Laboratory and the science centre *Immaginario Scientifico*.

WHAT'S TWAS?

TWAS, the Academy of Sciences for the developing world, 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 900 members from 90 countries, 73 of which are developing countries. A 13-member Council is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a secretariat, headed by an Executive Director and located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Italian government.

The main objectives of TWAS are to:

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

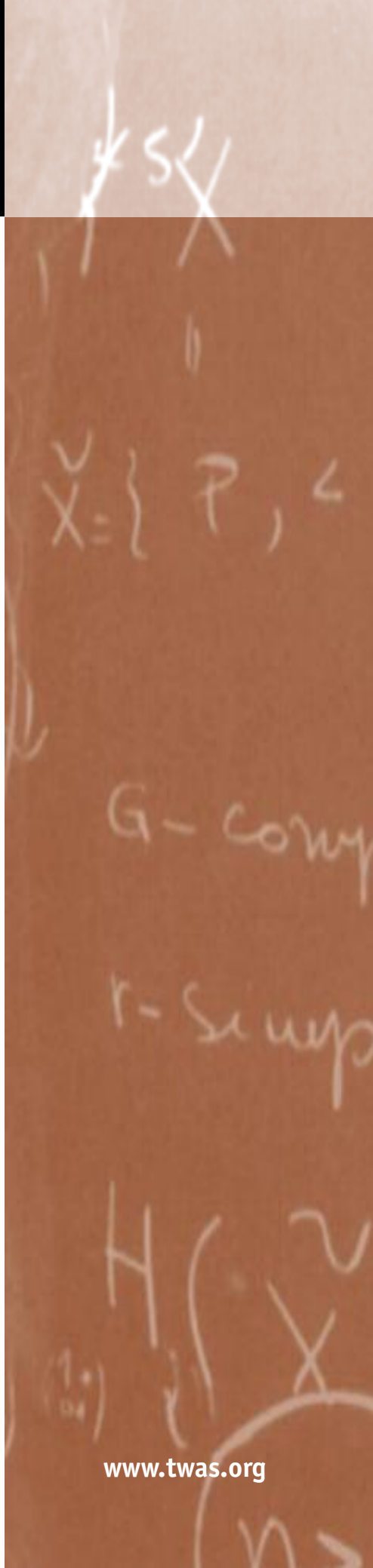
In 1988, TWAS facilitated the establishment of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of some 150 scientific organizations in the South. In September 2006, the foreign ministers of the Group of 77 and China endorsed the transformation of TWNSO into the Consortium on Science, Technology and Innovation for the South (COSTIS). COSTIS's goals are to help build political and scientific leadership in the South and to promote sustainable development through broad-based South-South and South-North partnerships in science and technology. **costis.g77.org**

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

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 100 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), a global network of 65 medical academies and medical divisions within science and engineering academies, relocated to Trieste in May 2004 from Washington, DC, USA. IAMP and its member academies are committed to improving health worldwide, especially in developing countries.

www.iamp-online.org



www.twas.org