ISSN 222-7369

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YEAR 2011
VOL.23 NO.3

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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

NOW MORE THAN EVER, ASPIRING YOUNG SCIENTISTS IN THE DEVELOPING WORLD NEED OPPORTUNITIES TO LEARN AND WORK, SAYS ROMAIN MURENZI, EXECUTIVE DIRECTOR OF TWAS.

Making Opportunity Happen Now

In 1982, I was a 23 year-old high school teacher who had recently graduated with a bachelor's degree from the National University of Burundi, where I had majored in mathematics. I was born in Rwanda but my family had moved to Burundi when I was three. I came from a modest background but I harboured big dreams. For the sake of job security, I had obtained a teaching certificate during my undergraduate studies. But what I really wanted to do was to earn a PhD in mathematics and physics and to become a professor and researcher at a major university.

So, I applied for "une bourse du tiers monde" *from the Catholic University of Louvain in Belgium. The application, which took more than two months to reach its destination, was rejected. The comments were as revealing as they were disappointing. As one reviewer noted in a comment that was unabashedly passed on to me: "Mr. Murenzi is best placed as a high school mathematics teacher. He is a refugee. If he comes to Europe for a PhD he will never return to Africa, which will lose an excellent high school teacher."*

I was undoubtedly proud of my accomplishments as a teacher. Students at Collège du St Esprit *and* Athénée de Bujumbura*, the two best high schools in Burundi's capital Bujumbura, had shown excellent progress under my tutelage, and I had received substantial recognition for my efforts. In retrospect, the three years that I taught high school had an enduring impact on my career, giving me a first-hand look at the enormous challenges in education faced by Africa and requiring me to think hard about the measures that needed to be taken to improve both teaching and learning across the continent.*

But all of that was beside the point when it came to the application that I had filled out for "une bourse du tiers monde" *– and the personal aspirations that this application repre-*

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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

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PRINTING
Stella Arti Grafiche, Trieste

Cover image:
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sented. The response from the reviewer was at once complimentary and inadvertently dismissive of my abilities, suggesting that both I and Africa would be better off if I stayed where I was – which was not what I was aspiring to. That, I thought, was the key point: Why should I accept what others said was in my best interests?

So I applied again the following year, and this time I was fortunate enough to be selected.

My high school teaching helped to shape my values and priorities. But it was the fellowship from the Catholic University of Louvain that set the foundation for my career. Since then, I have held a variety of university and research posts in both Europe and the United States, and from 2001 to 2009 I had the distinct honour of serving as the minister of education, science and technology of Rwanda.

I have been thinking about my personal journey a great deal since I became the executive director of TWAS in April.

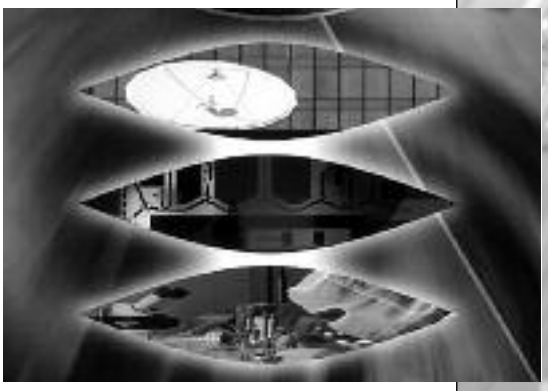
I have always been hesitant to speak about personal experience in general terms. Each person's experience could well be instructive and often is. But each person's journey is also unique. Consequently, I believe that you should always be careful about drawing broad lessons from the life's journey of a single individual.

Yet, TWAS's wide range of activities – several of which are dedicated to addressing the needs of young scientists – open the door for a number of comparisons between my own experience (and those of my colleagues a generation ago) and the "thirty something" scientists of today.

First, the good news. It is highly unlikely that any reviewers of fellowship applications would suggest that it would be best for a promising applicant to stay where he or she is. "Brain drain" remains a serious problem, but it is a challenge that all observers now agree must be addressed without compromising an individual's aspirations to reach his or her full potential.

Attitudes have thus changed for the better. But equally important, so too have circumstances. TWAS, for example, oversees a large and growing fellowship programme for postgraduate and postdoctoral students jointly sponsored by governments and research institutes in Brazil, China, India, Kenya, Malaysia, Mexico, Pakistan and Thailand.

More than 300 fellowships are currently made available each year, making the initiative one of the world's largest South-South fellowship programmes. Yet, through a broader lens, this is also a North-South-South fellowship programme. That's because TWAS receives its core administrative and programmatic funding from the Italian government.



Regardless of where the funding is coming from, this much we know: Opportunities to receive post-graduate and postdoctoral training are growing in the developing world, and these opportunities are increasingly taking place through initiatives based on South-South cooperation.

But we cannot close our eyes to some of the less positive trends as well – or perhaps, more accurately, aspects of science in the South that have not changed fast enough.

First, there is the challenge posed by a growing gap between developing countries that are rapidly strengthening their scientific capacity – for example, Brazil, China, India, Turkey, to name just a few – and developing countries that continue to lag behind in scientific capacity. The latter are located primarily in sub-Saharan Africa and countries with predominantly Muslim populations.

Research by TWAS shows that just six developing countries account for three quarters of the scientific articles published in international peer-reviewed journals by scientists from the South. China alone accounts for 30% of all publications authored by scientists in the developing world. Clearly, such imbalances have serious implications for scientists – and especially young scientists – in countries that are failing to keep pace in a world of rapid scientific advances.

And, second, even in most countries in which scientific capacity is growing, there remains a gap between science and innovation. This also carries serious implications, especially for poor developing countries where sustained investments in science will likely depend on science's ability to aid in reducing poverty and increasing wealth.

The truth is that nearly 30 years ago, when TWAS was established, the words "science and technology" and "development" were rarely found in the same sentence, except to note that immediate needs of poor countries were so great that science had to wait. Now, partly due to TWAS's efforts, it is well recognized that science, technology and innovation can help developing countries overcome such critical challenges as access to safe drinking water, food and energy security, mitigating and adapting to the impacts of climate change and improving public health.

Yet, TWAS estimates that there are some 80 countries that continue to lag far behind in scientific and technological capacity. The capacity gap is glaring in terms of all the major indicators, including the number of researchers, publications and patents. Equally disturbing, by many measures, the distance between these 80 scientifically lagging countries and the rest of world seems to be growing, not narrowing.

Three major steps will have to be taken over the next several decades for countries currently stymied by lagging scientific and economic capacity to join both the international scientific community and global economy.

First, there is an urgent need to provide adequate training – in terms of both quality and numbers – for the next generation of scientists seeking doctorate degrees. Without the presence of a critical mass of professors with PhDs, and in the absence of doctorate-level research, there is no way that scientific capacity can be built – let alone flourish – in poor countries.

Second, steps must be taken to expand opportunities for scientific exchange with colleagues in scientifically and technologically advanced countries. There are a growing number of fellowship opportunities available through both bilateral and multilateral frameworks. Yet the total number of openings remains small. As a result, too many eager and able young scientists in developing countries continue to be denied opportunities to obtain advanced degrees.

And, third, scientists (particularly young scientists) from developing countries must have broader opportunities to obtain merit-based research funds to continue their studies. Again, levels of funding are increasing but not rapidly enough to meet the growing demand. Part of this funding can be derived from foreign donors but part must come from the countries themselves.

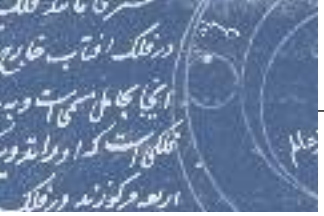
Doctorate and postdoctorate training, scientific exchange and research grants serve as the cornerstones of TWAS programmes. Today, more than ever, it is imperative that young university graduates in scientifically lagging countries be given opportunities to gain the education and training that they need to pursue careers in science. As global demographics continue to shift southward and as a majority of the world's young people come from the developing world, the future of not just poor countries but the entire world will depend on adequately meeting the needs of young scientists in the South.

So, yes, as I think back to my early career and the persistence and good fortune that it took to succeed, I do indeed see many positive changes for young scientists that I hope will ease their journey and make it more likely for larger numbers of them to enjoy productive careers without having to emigrate to other countries.

But, at the same time, I also see "capacity divides" among countries and disconnects between scientific pursuits and societal impacts that will require greater attention and focus if we are to make science a truly global enterprise characterized by contributions from scientists in all countries – North and South, rich and poor. ■

Romain Murenzi
Executive Director
TWAS, the academy of sciences for the developing world
Trieste, Italy
e-mail: rmurenzi@twas.org

An earlier version of this article was published in Nature *magazine, July 2011*
see www.nature.com/news/2011/110629/full/474543a.html



WILL SCIENCE BLOSSOM IN THE ARAB SPRING?

SCIENCE COULD BE BOTH A SOURCE AND BENEFICIARY OF THE DRAMATIC CHANGES TAKING PLACE IN THE ARAB REGION BUT ONLY IF THE MOVEMENT STAYS TRUE TO ITS ABIDING PRINCIPLES OF DEMOCRACY AND TRANSPARENCY.

The Arab region is comprised of 22 countries and is home to 350 million people. Some 30% of the population is less than 15 years old. East to west, the region stretches from the Indian to the Atlantic oceans; north to south, from the Mediterranean to the Arabian seas. People in the region share a common language, religion and history. Yet there are also significant differences in governance, socio-economic systems and wealth.

When it comes to science, technology and innovation, the prevailing notion has been that Arab countries continue to lag substantially behind other regions, not only in the developed world but increasingly in the developing world as well. Yet, there is also a sense that the region's scientific and technological capacity has grown in recent years, although not as fast as proponents would like and more rapidly in some countries than in others.

Even more importantly, the advances in science and technology that have taken place have not always translated into improved living conditions for the people in the region. Social conditions are difficult and good paying and rewarding jobs are hard to find, even for those who are well educated. Unemployment in the region exceeds 10%. For people under 25, it is estimated to be 30%.

The 'Arab Spring', which began last December, has upended many of the conventional assumptions about the region and has made it virtually impossible to predict what the future will hold for science and

society. Indeed the Arab Spring has exposed just how tenuous discussions about the future of the region can be in light of the unforeseen events that are now taking place virtually everyday.

The events that have followed the Arab Spring have also revealed how difficult it is to view the region as one – despite its shared heritage

and the common set of challenges that it faces. In fact, it is distinctly possible that the sweeping changes currently unfolding across the region will play out in different ways in different countries – again for both science and society.

This much we know: Prior to the Arab Spring, a growing number of countries in the region were taking significant steps to improve their scientific capacity. We witnessed this trend in such dramatic, high-profile initiatives as the launching of the King Abdul-Aziz University for Science and Technology (KAUST) in Saudi Arabia, Education City in Qatar, and Masdar City in Abu Dhabi. Each is a multibillion, multi-year project carrying lofty ambitions that correspond to the projects' price tags.

We also witnessed this trend in the extensive investments that the Qatar Foundation, the Mohammed bin Rashid Al Maktoum Foundation and others have made in science and technology, and in the partnerships they forged with other scientific institutions, including prominent universities in the United States and Europe. And we witnessed this trend in the commitments that governments have made to increasing the percentage of their national gross domestic products (GDP) devoted to research and development (R&D).

Many Arab countries spoke of putting science and technology to work to solve the region's pressing problems in agriculture, water and energy. For example, in 2010 Morocco pledged to increase the share of energy produced from renewable sources from 4% to 12% by 2012, and the Moroccan National Electricity Office announced plans to invest more than USD3 million on projects designed to meet this target. Countries throughout the region have emphasized the importance of investing in such cutting-edge technologies as information and communications technology, nanotechnology and biotechnology. Egypt, for example, opened up a nanotechnology research centre in 2009 in the government-sponsored "Smart City" just outside of Cairo.

Many of these initiatives will undoubtedly continue in the aftermath of the dramatic events that have taken place this year. Indeed such initiatives might even be expanded.

Saudi Arabia, Qatar and the UAE, for example, have continued to move ahead with their plans to build world-class educational and research facilities on a grand scale. Equally important, the provisional post-Mubarak government in Egypt announced that it would increase spending on science and technology by one-third from USD66.5 million in 2010 to USD90 million in 2011. It also announced that it would spearhead a drive to build a USD2 billion science city named after the Egyptian-born Nobel Laureate Ahmed Zewail (TWAS Fellow 1989).

Yet, we also know that these efforts are set against a backdrop of significant shortcomings and challenges.

For example, the region on average spends just 0.38% of its GDP on R&D compared to a global average of 1.7%. Similarly, the

region has just 407 researchers per one million population, compared to a global average of 1,544.

With the uncertainties and disruptions caused by the political and social changes now taking place, it is not at all clear that countries within the region will be able to maintain the investments in R&D that they have made. This is especially true in Syria, Yemen and other countries where widespread political unrest, government suppression and violence persist.

The prospects for continuing – and indeed increasing – investments in science and technology are not the only challenge. In 2008, scientists in the region published 13,574 articles in peer-reviewed international journals. That represented nearly twice as many articles as in 2000. Yet, in terms of scientific articles per million population, the Arab region publishes 41 scientific articles compared to a global average of 147. Only one Arab scientist, Boudjema Samraoui, a biologist at the University of Annaba in Algeria, is included in the list of the world's most cited scientists compiled by Thomas Reuters (formerly ISI) *Web of Knowledge*.

In 2008, the number of patents that technologists and entrepreneurs in the region filed in international patent offices totalled just 71, compared to a remarkable 84,110 in South Korea, a country whose scientific capacity was comparable to Egypt's in the 1960s. In a similar vein, only Cairo University makes the list of the 500 top universities published by Shanghai Jiao Tong University in China. And only seven of the 22 countries in the Arab region host national science academies.

In short, the progress that the Arab region has made in strengthening its scientific and technological capacity rests on a weak foundation and, given the tumultuous events that have taken place within the region over the past six months, there is no guarantee that these advances will continue.

Yet, there is reason for hope. Science, after all, depends not just on the level of financial investments but also on the health of the social and political environment in which it is taking place.

Evidence-based inquiry, transparency and excellence are the hallmarks of international science. Moreover, science itself seems to function best in countries that embrace these principles in spheres of concern other than science, most notably governance.

That is why the Arab Spring holds such great promise for both science and society. If the democratic impulses that drove the protests in the first place can guide the principles of reform that are now taking shape, science will surely benefit. Successful societies built upon abiding respect for evidence and excellence are also societies in which science flourishes. Indeed societal and scientific progress seems to go hand-in-hand in a virtuous cycle of success.

The challenges for the Arab region are two-fold. First, countries throughout the region must devise effective strategies for getting from

here to there, and must do so as quickly as possible. Calling on people to be patient in the face of the dramatic changes that are taking place is one thing. Expecting them to be patient is quite another, especially if the economy stalls and conditions do not improve – or, even more troubling, deteriorate.

The history of the Arab region since the late 1940s has been one of disappointment and disillusion-

ment. The material well-being of citizens throughout the region has often been neglected and their very identity as a people placed under assault – both by outside forces and the policies of their own governments. The inability to settle the Palestinian-Israeli conflict has served as a flashpoint of anger and resentment. The stalemate has had grave repercussions for the Arab region and the entire world.

Not surprisingly, scientific communities throughout the region have not been shielded from the consequences. The failure to achieve peace in Palestine is undoubtedly a major reason for Arab frustration today. The sense of hopelessness prompted by this never-ending conflict has evolved into chronic public discontent and spasms of violence. The conflict must be resolved if the Arab Spring is to succeed.

Such a resolution would have a positive impact on both science and society.

Here's why. The Palestinian-Israeli conflict led governments throughout the Arab region to define security in the narrowest of terms, not only because of the threat posed by Israel but also because of the uneasiness fuelled by the discontent of their own people.

Given a choice between national security and democracy, governments opted for security, which in their minds also meant not only protecting their borders from external risks but also ensuring social order within the borders.

For the scientific community, such governance meant that their activities would be funded to a degree but only within an environment of oversight and control that would stymie the scope and impact of national research agendas.

This sentiment was shared by the region's outside benefactors, most notably the United States and Europe, which continued to assist the governments of Arab countries in the name of social order even if it meant turning a blind eye to government-led violations of freedom and human rights.

As a result, Arab governments have spent an inordinate percentage of their budgets on security. Over the past quarter century, the percentage of government expenditures devoted to national defence averaged 4% throughout the region, and this does not include the amount of money devoted to internal security.

Money spent on national defence and internal security cannot be spent on other critical issues. And that is why it is critical for governments to broaden the scope of security to include such matters as water, food and energy security.

Indeed, it would be wise for the governments throughout the region

to embrace the five key areas for sustainable development first outlined by former UN Secretary General Kofi Annan at the World Summit for Sustainable Development (WSSD) in Johannesburg in 2002: water, energy, health, agriculture and biodiversity, which have since been referred to under the acronym WEHAB.

Security, in short, is not simply matter of protecting the population from enemies, however vital to national well-being this is. It also includes protecting the population from material want and ensuring that people have access to the basic building blocks needed to construct a life defined by well-being and opportunity.

Second, it is important for Arab countries to provide not just token, make-work jobs but to create clear pathways to rewarding and fulfilling careers for their increasingly educated populations. It was not just material deprivation that led to the Arab Spring. Rather, it was a gnawing sense of hope unfulfilled – and never to be fulfilled – that prompted the people to confront their governments and not back down.

Just as the region's rapid population growth over the past several decades has placed the region's ecosystems at risk, it has also created an expanding pool of a frustrated young workers unable to find jobs that match their levels of education or their desires for success.

For example, both Egypt and Tunisia have increased enrolment in universities by 35% over the past 20 years. However, neither country was able to provide job opportunities commensurate with their youthful population's education and skills. This created a huge reserve of unemployed young people who joined – indeed led – the uprisings that marked the Arab Spring.

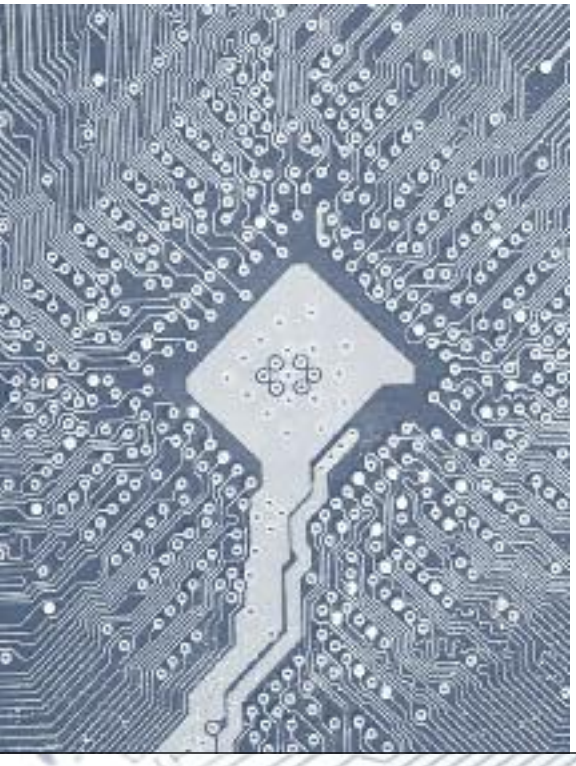
Yet, providing increasing numbers of young Arabs with educational opportunities, however noteworthy and valuable, will simply not be sufficient to ensure that they are satisfied with the changes that are taking place. Events over the past six months suggest that the opposite may be true: that well-educated citizens denied opportunities pose a greater threat to the existing social order than do marginalized and poorly educated citizens harbouring scant hope for change. For the government, this reality means that they must devise strategies that are attuned to the demands of the global economy, which has become the hallmark of the 21st century.

Key goals for the government must not only include providing a good education but also helping to generate a sufficient number of good jobs for all citizens and especially college-educated citizens whose expectations have been raised by the education they have received.

For the scientific community – and more generally universities and research centres – a key goal must be to provide training that helps to make students "worker-ready". Such a strategy will require

universities and research centres to collaborate more closely with both government and the private sector and to provide training for their students that conforms to the knowledge and skills that employers desire.

History dating back more than 1,000 years shows that scientists from the Islamic world first measured the circumference of the Earth, first mapped the constellations of the stars, and first laid out the basic tenets of the scientific method based on observation, measurement and verifiable proof.



The Golden Age of Islamic science spanned more than 1,000 years from 7th to the late 16th centuries, when the ruling sultan closed the Istanbul observatory. It drew its strength from such centres of learning as the Library of Alexandria and al-Ma'mun's House of Wisdom in Baghdad, and its inspiration from such science luminaries as al-Khawarizmi and Abu Ali ibn Sina. It went on to produce an outpouring of knowledge unmatched in world history to that point. It is a past worthy of praise and celebration.

But the only way to return to the glories of the past is to successfully chart a path to the future that accepts the world as it is in the 21st century and not like it was in the 11th century.

The Arab Spring has given the region the opportunity to do just that. Whether the region takes full advantage of this opportunity will be determined by decisions made by the people and their governments both now and in the years ahead.

The scientific community has a key role to play in this effort. Few other sectors of society will benefit more from reforms dedicated to transparency and excellence, and few other sectors will be able to contribute more to efforts to build more peaceful and prosperous nations.

There is no question that science can benefit from the Arab Spring. But that will only be the case if the Arab Spring fulfils its promise to transform society in ways that past regimes did not. ■

Moneef R. Zou'bi
Director General
The Islamic World Academy of Sciences (IAS)
Amman, Jordan
ias@go.com.jo

Daniel Schaffer
Public Information Officer
TWAS
Trieste, Italy
schaffer@twas.org

IN BRIEF

Recent news from the TWAS Public Information Office based on research and capacity-building activities that are being pursued by TWAS members and partners.

GAS HYDRATES IN OUR ENERGY FUTURE

Gas hydrates are water-based crystalline solids containing gas molecules trapped inside lattice-like organic frameworks. Found in abundance beneath the ocean floor and in permafrost regions, they could play a key role in meeting the world's future energy needs.

Harsh K. Gupta (TWAS Fellow 1995), director of the National Geophysical Research Institute, Hyderabad, and former Secretary of the Department of Ocean Development in India, has been conducting research on gas hydrates for the past two decades, earning an international reputation in the field. In addition to his efforts to investigate the location of gas hydrate deposits, he has helped convince policymakers and energy executives that conventional methods of oil exploration, which rely on drilling originating at the ocean surface, may not be the best way to explore for gas hydrates.

Instead, he has encouraged the development of a remotely operated underwater vehicle (ROV) to roam – and sample – the ocean bottom for signs of gas hydrates. Once an ROV identifies a promising location, a drilling outfit could be lowered to the ocean floor. "This," Gupta says, "would be a more economical way to conduct the search." India's National Institute of Ocean Technology in Chennai has taken the lead in developing such a device.

"India is the fourth major consumer of fossil fuels in the Asia-Pacific region," says Gupta. "Only China, Japan, and South Korea use more." And the country's consumption levels are on pace to more than double over the next 20 years due to population growth and increased wealth. "To meet the growing demand for fossil fuels," he says, "India must aggressively pursue a mix of energy policies that both promote efficiency and increase supplies."

India's Exclusive Economic Zone (EEZ), which according to the Law of the Sea extends 370 kilometres from the ocean shoreline, has yet to be comprehensively examined for the extent of its natural resources, including gas hydrates. Despite a lack of new data, Gupta notes that investigations conducted by him and his colleagues, based on existing data, indicate that large quantities of gas hydrates reside within India's EEZ.

"At standard temperatures and pressures," Gupta cautions, "gas hydrates become unstable and cannot be used as fuel." Consequently, simply extracting gas hydrates with existing technologies will serve no purpose.

"We need to develop new technologies that will retain the integrity of the resource in ways that will allow it to be exploited," says Gupta. "This will require additional research, as well as investments in technologies with the potential to reach the marketplace." ■

WORKSHOP ON LIFE SCIENCES

Ways to improve faculty research and training on issues related to biosecurity and biosafety were at the centre of discussions at a workshop in Trieste sponsored by the US National Academies of Sciences (NAS) and hosted by TWAS.

The workshop, 'Developing a Framework for an International Faculty Development Project on Education about Research in the Life Sciences with Dual Use Potential', is part of a two-year project sponsored by the US State Department and directed by a committee of researchers, policy experts, and science educators appointed by the US National Research Council (NRC).

Some 30 participants – from Egypt, Italy, Poland, South Africa, Switzerland, South Africa, the United Kingdom and the United States – shared a broad range of experiences on the subject. The goal was to draft a global framework for researchers and science educators on how to conduct and teach life sciences research responsibly.

As Rita Colwell, the project's committee chairperson, stressed in her introductory remarks, a "set of global guidelines for responsible life sciences research is essential today because research is occurring so rapidly and unevenly around the world." Colwell, who directed the US National Science Foundation from 1998 to 2004, is currently a distinguished professor at the University of Maryland at College Park and Johns Hopkins University Bloomberg School of Public Health.

While participants acknowledged that the quality of research and training in the life sciences had improved significantly over the past few decades, they also agreed that a host of challenges remained. This, they emphasized, was especially true for developing countries, many of which were experiencing historic political and social change.

Recent events in Egypt, taking place during the "Arab Spring," were instructive and proved to be a particularly lively aspect of the discussions at the workshop. Participants, including Ismail Serageldin (TWAS Fellow 2001), director of the Bibliotheca Alexandrina (BA), Mohamed El-Faham, director of the Center for Special Studies and Programs at BA, and Alaa Ibrahim, assistant professor of space astrophysics at the American University in Cairo, noted how students across Egypt had lent their voice to the urgent need for new frameworks not only for research but, more generally, for society.

Institutions of higher education such as Alexandria University and Cairo University, both of which have student populations that exceed 150,000, have suffered from a host of constraints, including inadequate funding, outdated equipment, and poor faculty and staff salaries. Meeting these challenges will likely be a prerequisite for building a strong foundation for safe and responsible life sciences research and training.

Egyptian researchers also face institutional obstacles, including lengthy delays for the approval of courses, which can take up to two years, and security-based restrictions on collaborative projects. Such barriers hinder international partnerships at a time when collaborative transnational research projects are increasingly important for the global advancement of science. ■

A CELEBRATION OF CHEMISTRY

The International Year of Chemistry (IYC), a year-long celebration of chemistry's contributions to society, is taking place this year. IYC is designed to draw attention to the important role that chemistry plays in our lives.

Renowned chemist Henry N.C. Wong (TWAS Fellow 2005) has highlighted this role in his cutting-edge research on furans. These five-atom chemical compounds help scientists obtain large numbers of molecules that can be analysed to determine if they have therapeutic value in combating disease.

Wong, currently a professor at the Chinese University of Hong Kong, displayed a keen interest in chemistry at a young age. "I carried out my first experiments in secondary school," he recalls. "Unaware of the potential danger, my classmates and I tried to produce gases like hydrogen and hydrogen sulphide."

From these early adventures, Wong's interest in chemistry, nurtured by inspiring teachers, grew.

After earning a bachelor's degree from the Chinese University of Hong Kong in 1973 and a doctorate degree from the University College London, under the supervision of Franz Sondheimer in 1976, Wong was awarded a postdoctorate fellowship at Harvard University.

"Those years remain unforgettable," says Wong. "I was able to meet some of the world's best chemists — Bob Woodward, who served as my mentor, Dieter Hoppe, Masakatsu Shibasaki, Masaaki Suzuki, Bill Roush, Stuart Schreiber and Tohru Fukuyama".

It is Wong's research on furans that have earned him an international reputation in the world of chemistry.

Furan, first described by scientists in the late 1700s, is a compound consisting of four carbon atoms and one oxygen atom. It is prepared in large quantities through the acid treatment of vegetable residues derived from the production of oats and cornflakes.

"Furans" he explains, "allow researchers to synthesize other compounds – for example, palllavicinin, which is identified in the Taiwanese liverwort *Pallavicinia subciliata*."

"Pallavicinin's biological activity," Wong notes, "has not been studied in much detail. But by using organic synthesis, based on the framework of furans, we can produce enough material for extensive biological studies. As a result, the potential to uncover therapeutic properties becomes much more likely."

Wong cites another compound that has been isolated from the sponge *Plakortis halichondriodes*. He notes that "his research group recently synthesized four possible alternative configurations of the same molecule – the so-called plakortone B." The molecule, he says, is known for its "calcium-pumping effects" inside muscle cells. Such effects could have wider health implications as well – for example, in easing cardiac muscle contraction.

That's the kind of social impact that IYC, which is organized around the theme of "Chemistry – our life, our future", is intended to showcase. The celebration, an initiative of the International Union of Pure and Applied Chemistry and UNESCO, will continue through the end of this year. ■

NUTRITIONAL VALUES

The lead authors of 40% of the peer-reviewed articles devoted to issues related to nutrition in Africa are from the United States or Europe, not Africa. That is one of the key findings of a recent survey conducted as part of European Union project "Sunray: Sustainable Nutrition Research for Africa in the Years to Come." The survey identified some 11,000 articles on nutrition in Africa published between 2000 and 2011.

A series of interviews conducted as part of the same project showed that the vast majority of African researchers currently examining nutritional issues – nearly 95% – do not believe their studies address issues of critical concern to their societies.

"These findings, if reaffirmed by additional surveys and interviews, suggest that nutritional research begs for significant reforms," says Patrick Kolsteren, who is the head of the nutrition and child health unit of the Institute of Tropical Medicine in Antwerp, Belgium, and coordinator of the Sunray project. The project consists of a consortium of four African and five European institutions. TWAS was asked to participate in the Sunray steering group meeting to explore potential avenues of collaboration.

The research agenda for nutrition in Africa has been largely driven by outside donors. "As a result," Kolsteren says, "African researchers have largely pursued research questions that are not of their own making."

Research on nutrition in Africa, he also notes, is dominated by "descriptive" studies. The majority of scientific articles – some 60% according to surveys conducted by Sunray – focus exclusively on the nature of the problem, answering such questions as how many people are affected, the demographic profile of those who are, and the cost of the problem to society. The research framework has been largely the same whether the issue is malnutrition, vitamin A deficiency or rising levels of obesity.

"Such information is undoubtedly important," Kolsteren notes. "But the findings often shed light on questions to which we already know the answer. "It's no secret, for example, that children living in single-family, low-income households and low-education households are more susceptible to

malnutrition and other health-related problems. We don't need additional studies to tell us that."

The more important issue, according to Kolsteren, is which interventions work and which don't. "These are the kind of studies," he says, "that we don't have enough of." In fact, the initial survey conduced by Sunray shows that only 5% of the research articles published in peer-reviewed journals have been designed to assess the impact of interventions.

"Policymakers need evidence-based information to enact effective policies," says Kolsteren. By concentrating on descriptive studies and devoting so little time and effort to assessing the impact of interventions, "researchers have shed important light on the nature of the problems we face, but they have done little to help us determine what should be done."

The Sunray project, which began this spring and will continue through 2012, will seek to lay the groundwork for reforming the nutritional research agenda in Africa. "The goal," says Kolsteren, "is to develop a new research agenda that we hope will help guide decisionmakers in Africa as they devise strategies for addressing the critical nutritional needs of their citizens." ■

NUCLEAR POWER IN THE ARAB REGION

At first glance, it may seem improbable, but oil-rich Gulf States are turning to nuclear power to meet at least a portion of their future energy needs, says Adnan Shihab-Eldin, director general of the Kuwait Foundation for the Advancement of Sciences (KFAS).

Shihab-Eldin made his remarks at the 44th session of the Erice International Seminars on Planetary Emergencies held in Erice, Italy, on 19-24 August 2011. TWAS attended the event at the invitation of Antonio Zichichi (TWAS Associate Fellow 1986), founder and chair of the seminar series.

Shihab-Eldin cites three reasons for the Arab region's recent interest in nuclear power.

First, he states that the region's growing population has prompted additional demand for electricity and other forms of energy.

Second, he notes that not all Arab countries are rich in gas and that "only two Arab countries have substantial 'isolated' supplies of natural gas not associated with oil production – Libya and Qatar." As a result, he observes, many Arab states will need to "import natural gas to meet their non-transportation energy needs as an alternative to burning valuable export-earning oil."

And, third, he says, oil-rich Arab countries "have been increasingly reluctant to divert a high-value export commodity such as oil to the domestic market." Oil in Saudi Arabia, for example, accounts for more than 70% of government revenues and, in Kuwait, it represents more than 80% of export revenues. As a matter of national economic policy, governments have decided that it is wiser to sell the oil abroad than to consume it at home – if they can find cheaper energy alternatives.

According to Shihab-Eldin, "the key factor driving interest in nuclear power in the Arab region is the price of natural gas on the international energy market. "If the price of natural gas remains above USD7 per million BTU, nuclear power becomes economically viable as an alternative to gas."

Today, for example, the price of imported natural gas averages USD13 per million BTU in Kuwait. Energy experts project that the price will remain at that level or climb even higher in the years ahead.

In 2007, the United Arab Emirates announced plans to build 14 nuclear units. The first would go online in 2017. In 2009, Kuwait established the Kuwait National Nuclear Energy Committee and announced that it is exploring strategies for building four reactors with electricity generation beginning in 2020. Saudi Arabia launched a project to build a City for Atomic and Renewable Energy in 2009 and earlier this year announced its intention to build 16 nuclear units.

Less than a year ago, the Arab region was on track to build some 20 nuclear reactors over the next two decades. But two dramatic events, Shihab-Eldin says, have since slowed the advance towards nuclear energy. The Arab Spring has upended the political environment across the region and raised the need to gain public consensus on nuclear issues. And the nuclear accident at Fukushima Dai-ichi in Japan has led countries throughout the world, including in the Arab region, to re-examine their commitments to nuclear power.

Shihab-Eldin maintains that what has happened this year will delay but not reverse the Arab region's efforts to build nuclear power units. He projects that by 2030 the region will have 10, not 20, nuclear units online. ■

INDIA: WHERE VISION COUNTS

IT OWES ITS EXISTENCE TO AN UNUSUAL ALLIANCE BETWEEN AN INTERNATIONALLY RENOWNED OPHTHALMOLOGIST, WHO HAS SPECIALIZED IN MICROSURGERY AND CORNEAL DISEASES, AND A FAMOUS INDIAN FILM PRODUCER, WHO HAS FOUND FAME AND FORTUNE IN THE "DREAM WORLD" OF BOLLYWOOD. THIRTY YEARS ON, THE LV PRASAD EYE INSTITUTE HAS BECOME ONE OF THE DEVELOPING WORLD'S LEADING CENTRES FOR EYE RESEARCH AND CARE.

G.N. Rao, who was born in the Krishna district of Andhra Pradesh on the southeastern coast of India, had already earned an international reputation for his work as an ophthalmologist and cornea specialist in the United States when he decided to come back home in the early 1980s. His goal was to lend his expertise to improving eye care in India, especially for its poorest citizens. Upon his return to India, he came in contact with Ramesh Prasad, the son of the famed "Bollywood" film producer, LV Prasad, who was searching for worthy philanthropic causes to invest in and who had heard about Rao's desire to build an eye clinic and hospital.

In subsequent conversations, Rao convinced both the son and LV Prasad that the creation of an institute for high-quality eye care and world-class research would be a worthy investment. In 1987, the institute that bears LV Prasad's name opened its doors in Hyderabad, Andhra Pradesh's capital city, funded in large measure by the Prasad Trust.

Today, the LV Prasad Eye Institute (LVPEI) employs 400 people, including 25 ophthalmologists and 10 medical researchers. It focuses its efforts on combatting eye diseases for people living in Hyderabad and the state of Andhra Pradesh and conducts research that can effectively treat these diseases. The institute also oversees an expansive network of regional and community vision centres that reaches into 13 of the state's 23 districts and caters to more than 50 million people.

LVPEI's broad mission includes the provision of high-quality eye care services, the pursuit of world-class basic and clinical research on eye diseases, the training of researchers, clinicians and technicians, the development of products and services for improved eye

care, and the effective rehabilitation of patients suffering from incurable vision impairment. The institute pays special attention to providing eye care to poor, underserved populations. Indeed the Jasti V Ramanamma Children's Eye Care Centre, launched soon after the creation of the institute, was one of the first centres dedicated solely to children's ophthalmology built outside of the United States.

LVPEI consists of six components: a hospital, a rehabilitation centre, research laboratories, educational facilities, a community eye centre and a non-profit product development centre. It is administered by two non-profit trusts: the Hyderabad Eye Institute, which focuses on service delivery, and the Hyderabad Eye Research Foundation, which oversees the institute's research programmes.

LVPEI's broad mission includes the provision of high-quality eye care services.

Patient care leads the list of responsibilities at the institute. Indeed ophthalmologists attend to a remarkable 800 patients each day. Half of the patients do not pay for the services they receive. More well-to-do patients pay from 250 to 750 Indian rupees (USD5 to USD15) for a consultation visit.

"Rich and poor receive the same care," says Shaik Yousuf Arfath, administrator of the institute's education centre. Those who pay receive better amenities – a less crowded waiting room or more private quarters if they need to stay overnight at the hospital or rehabilitation centre. "But we never compromise on the clinical services regardless of a patient's ability to pay," Arfath notes. "In fact, our stair-stepped payment system allows those who can afford to pay to subsidize those who cannot."

The institute also houses nine operating theatres where doctors perform, on average, 100 surgeries each day. Operations range from laser-based cataract removals to cornea transplants. Indeed, according to Arfath, the institute carries out the largest number of cornea transplants in the world. In 2009, the total number of transplants reached nearly 1,600. Half of all surgeries, including the cornea transplants, are done cost-free and half are done on a sliding price scale based on the patient's ability to pay. LVPEI's price-shifting strategy enables it to serve people in need regardless of their ability to pay.

The institute's 25 ophthalmologists work six days a week: two days in the outpatient facilities, two days in the operating theatre and two days in the research facilities. Each ophthalmologist sees on average eight patients an hour. All told, the institute caters to more than 800 outpatients and performs more than 80 surgeries each day.

The ophthalmologists are able to attend to such a large number of patients because of the efficient system of patient care that has been developed.

Some 80% of the patients have appointments. Only 20% are walk-ins. As a result, a strict appointment schedule is set each day. At the time of the appointment, patients are brought to one of 50 examination rooms (grouped into five corridors each containing 10 rooms). There, they are met by an optometrist, a technician skilled in testing for vision defects who does the initial examination that consists of documenting the condition of the patient and performing a vision test using a conventional eye chart.

An ophthalmologist then arrives to do a more comprehensive follow-up examination that usually takes 10 minutes. The ophthalmologist uses a biomicroscope that provides a highly magnified view of the structure of the eye to assess the health of the eye and determine whether infection or disease is present. Once the follow-up examination is complete, the ophthalmologist prescribes the treatment and then moves to the next room where another optometrist has already performed the initial examination.

There are five optometrists for each ophthalmologist. Each optometrist is assigned to a single room, while each ophthalmologist moves from one room to the next among five rooms.

The ability of the ophthalmologist to rotate from one room to the next and to leave the initial examination to an optometrist largely accounts for the system's efficient method of care. It allows for a coordinated team of health practitioners to see a continuous stream of patients without compromising the quality of the care.

The institute has gained an international reputation for its cornea transplants.

CARE PLUS

The institute has gained an international reputation for its cornea transplants. In fact, it performs the largest number of cornea transplants in the world – nearly 1,600 in 2009, compared to less than 100 in 1989. As is the case for the clinical care unit, the efficiency of the cornea replacement procedure is based on a dedicated staff, skilful planning and a reputation for excellence that helps to foster support and cooperation from the larger community.

The institute relies on a large contingent of voluntary "grief" counsellors who travel to major hospitals throughout the region to advise families on the possibility of donating the corneas of a deceased relative as a benevolent gesture to allow others to gain sight.

A six-hour window exists between the time a person dies and the time a cornea can be safely removed for transplant. Discussions with the family take place at a time of profound grief and often shock. Therefore the most important consideration for a counsellor is to

recognize the fragile emotional state of the family. Sensitivity to the situation is paramount.

If the family agrees to donate the corneas, a technician comes to the hospital to remove them. The procedure is skilfully performed to ensure that no disfigurement occurs.

In 1989, the institute created the Ramayamma International Eye Bank for the purpose of storing corneas for replacement and research. The bank, which helps to ensure that there is no waiting time for those in need of a transplant, currently serves as the "nodal" eye bank for southeast Asia. In addition to harvesting and distributing corneas, it also oversees training programmes for eye bank technicians and grief counsellors.

EYE RESEARCH

LVPEI has an active research programme that employs some 10 full-time scientists. For example, the institute's stem cell research laboratory has successfully used limbal stem cells to reconstruct the damaged corneas of burn victims to restore their vision. Currently, the laboratory is seeking to induce pluripotent stem cells to develop into ocular cells for possible use in genetic therapies to treat diseases of the retina. In addition, it is investigating cellular properties that spur the development of cancerous tumours to learn more about the processes responsible for the growth of abnormal cells that strengthen the body's resistance to chemotherapy.

There is also a molecular genetics laboratory where researchers study mutant genes that might be responsible for glaucoma, macular degeneration and congenital hereditary endothelial dystrophy. The laboratory is investigating pluripotent stem cells in hopes of developing ocular cells for retina and cornea regeneration.

Researchers in the institute's biochemistry laboratory are focusing their studies on the genetic makeup of crystallins, the proteins responsible for the transparency of the eye. Hardening of the crystallins is a major cause of cataracts.

"The success of the institute," says Dorairajan Balasubramanian (TWAS Fellow 1997), director of research and TWAS Secretary General, "is living proof that clinical medicine and medical research work best when they work together – and that strong synergies develop when you serve people in need and pursue scientific excellence at the same time."

Indeed the success of the institute lies in its ability to integrate the complementary goals of clinical care and medical research under one roof. Clinical practice draws on the knowledge gained from applied and basic research. Experience gained through patient care, in turn, helps to refine and shape the future research agenda.

PYRAMID OF HEALTH

As an international centre of excellence, LVPEI resides at the centre of an intricate network of eye care facilities that reach across the entire state of Andhra Pradesh. Staff at LVPEI prefer to view the system as an "eye health pyramid" that helps to provide "vision care for all."

LVPEI, which serves a population of 50 million, functions as an advanced tertiary care centre that not only offers services ranging from comprehensive eye check-ups to intricate surgeries, but also conducts state-of-the-art clinical research and oversees an exten-



sive training for eye care professionals that relies on the latest advances in information and communication technologies (ICT).

The healthcare pyramid also consists of three tertiary care centres at the GMR Varalakshmi campus in Visakhapatnam, the Kode Venkatadri Chowdhry campus at Vijayawada and the LVPEI-Bhubaneswar campus, which function as mini-LVPEIs offering a full range of eye care services, including surgical procedures. Each of the tertiary centres provides care for a population of about 5 million people. Staff see between 400 and 500 patients and perform 50 to 60 surgeries each day, about half the number of the LVPEI.

There are also 16 secondary care centres across the region, including Kuchakulla Ramachandra Reddy Eye Centre in Thoodukurthy. The secondary centres provide care for a population of 500,000 people living in rural and peri-urban areas.

In addition, there are 72 vision centres, each serving a population of 50,000 people. These facilities, which are rapidly increasing in number (10 were launched just last year), offer vision tests and basic eye examinations for the clientele they serve. They also provide eye glasses – free-of-charge for those who cannot afford to pay for them and for prices ranging from 60 (USD1.30) to 950 rupees (USD21) for those with adequate incomes. In 2010, these vision centres cared for more than 100,000 outpatients.

Then there are a host of voluntary "vision guardians", caring and committed people hailing from the villages, who conduct door-to-door visits in the villages to inform residents of the services that are available to them. The purpose of the visits is to determine who needs eye care and to encourage them to seek help at the centre.

In effect, the vision guardians seek to generate demand for the primary care centres among people who could benefit from the services that the centres provide. Or, as LVPEI staff like to say, the vision guardians "keep an eye on the eye health of their neighbours."

Like the LV Prasad Eye Institute, the other smaller centres are proud of the fact that no one is turned away regardless of his or her financial circumstances. Poverty does not stand in the way of care. As stated earlier, paying customers enjoy some ancillary "creature comforts" when they come to the clinic. But the level of care for everyone remains the same regardless of a patient's ability to pay.

Some 90% of those suffering from blindness and severe vision loss live in poor countries.

The true strength of the pyramid lies at its base. As LVPEI's founder, GN Rao, has noted: One of the primary goals of the institute has been "to train people from rural areas to take care of the diagnosis of the eye problems and provide primary eye care like issuing spectacles. If a surgical intervention is required, they refer the patient to a secondary centre or a tertiary hospital." Since only 20% of all eye care problems require advanced complicated care, most people can receive the help they need from primary care centres located near their homes. The estimated cost of each visit is USD1.



ENVISIONING THE FUTURE

Vision impairment is a health issue of global dimensions, affecting more than 300 million people worldwide. Some 90% of those suffering from blindness and severe vision loss live in the world's poorest countries. India alone has an estimated 20 million people who are visually impaired. Three of every 10,000 Indians are blind at birth. All told, the country has the largest number of blind children in the world.

While blindness and severe eye disease is unavoidable in many cases, excellent eye care can make a huge difference for the lives of millions of people. Interventions, in fact, can prevent many eye diseases, mitigate the impact of others and provide a pathway for rehabilitation and reintegration into the community for those suffering from irreparable vision loss. Extensive training of patients with permanent vision impairment can help them to adapt to their loss of sight, and the use of low-vision aids can help improve the quality of their lives. "The engagement with patients is often long and difficult," says Balasubramanian. "But the outcomes are often inspiring."

Since its inception, LVPEI has conducted more than 6 million outpatient visits, performed 600,000 surgeries, published more than 800 research articles and trained more than 12,500 personnel. It has paid particular attention to the needs of underserved populations – most notably, women and children. In 2010, some 46% of the patients that the institute cared for were children and some 49% of the outpatients were women.

LVPEI has also forged strong ties with other eye research institutes and clinical research centres both in India and across the globe, including the Universities of Sydney and Melbourne in Australia, Harvard University's Massachusetts Eye and Ear Infirmary, the University of Rochester and the University of California in Los Angeles (UCLA) in the US, and the International Centre for Eye Health in the UK. It serves as a World Health Organization (WHO) Collaborating Centre for the Prevention of Blindness.

Two statistics highlight the full spectrum of activities in which the institute has engaged: LVPEI researchers have published more than 800 articles in peer-reviewed international scientific journals and LVPEI clinicians have helped to rehabilitate more than 25,000 visually challenged individuals, enabling them to live more satisfying and productive lives.

Excellence and equity have been the hallmark of the LV Prasad Eye Institute since GN Rao and LV Prasad first envisioned the institute a quarter a century ago," says Balasubramanian. "And excellence and equity will continue to guide the institute in the years ahead." ■

For additional information about the LV Prasad Eye Institute, see www.lvpei.org

QUANTUM STEPS

THE NEXT BIG STEP IN QUANTUM PHYSICS COULD WELL COME FROM A DEVELOPING COUNTRY, SAYS LUIZ DAVIDOVICH (TWAS FELLOW 2002), PROFESSOR OF PHYSICS, AT THE FEDERAL UNIVERSITY OF RIO DI JANEIRO IN BRAZIL.

In the conventional (and, for physicists, classical) world we live in, people and things can be in only one place at one time. Those who think or say otherwise are, to say the least, thought to be a bit out of touch with reality.

But in the world of quantum physics, subatomic particles such as electrons theoretically exist in different places at the same time.

This aspect of quantum physics is called superposition.

Indeed superposition and other counterintuitive elements of quantum theory have been found to conform closely to both mathematical calculations and experimental evidence. This has made quantum physics both elegant and potentially applicable.

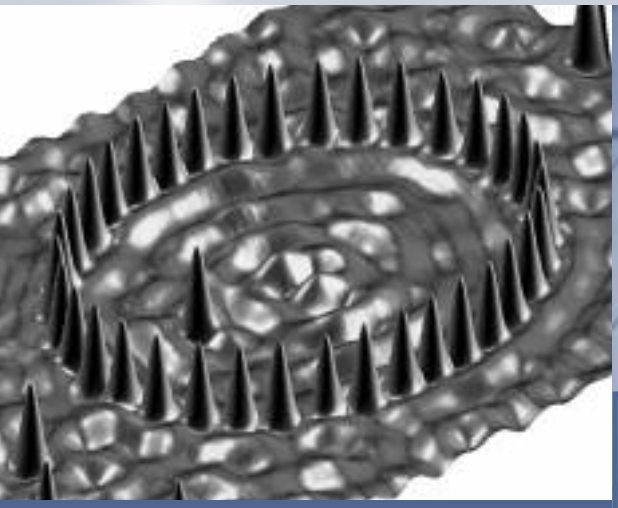
But such insights have posed gnarly questions for physicists, not the least of which is: How does this mysterious subatomic world translate into the world of macroscopic objects that we can see and touch?

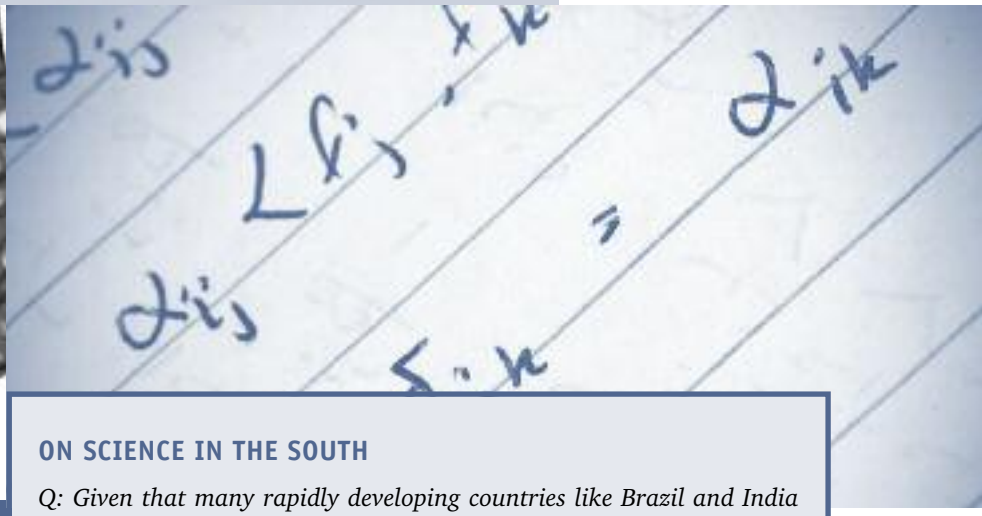
If all of this sounds mind-bendingly complex and confusing, don't fret. Quantum theory is notoriously difficult to grasp, let alone comprehend, even for physicists and mathematicians. As Richard Feynman, one of the field's superstars, is reported to have said in 'The Character of Physical Law', a series of lectures published in print by the BBC in 1965, "I think I can safely say that nobody understands it."

Luiz Davidovich, one of Brazil's most prominent quantum physicists and a TWAS member since 2002, has dedicated his professional life to investigating the weird (at least weird for non-physicists) world of quantum physics. One of the things he has been interested in is how the environment – that is, everything surrounding the particle – influences quantum phenomena. "It is the largely invisible neighbourhoods in which subatomic particles reside that likely hold the key to understanding the subtle transitions between the classical and the quantum world," he explains.

Davidovich's personal background is typical of the patchwork of nationalities and cultures that characterize the Americas' multi-ethnic and multi-cultural societies.

His grandparents came from Russia to Brazil in the beginning of the 20th century, escaping the turmoil of





ON SCIENCE IN THE SOUTH

Q: Given that many rapidly developing countries like Brazil and India are making such rapid advances in science and technology, how can TWAS continue to stay relevant to them?

Davidovich: "I believe the continued relevance of TWAS depends on two things. First, that it promotes the exchange of students and scientists, thus helping to foster understanding between different cultures and reducing the scientific gap between countries. Second, that it promotes the exchange of successful experiences in developing countries. This would include, for instance, strategic technologies, models for the development of science, technology and innovation, approaches to science education, and the structure of higher education. All of this is important for all developing countries, including Brazil, which, despite its growth in science capacity and excellence, still faces big challenges regarding capacity building and the promotion of innovation.

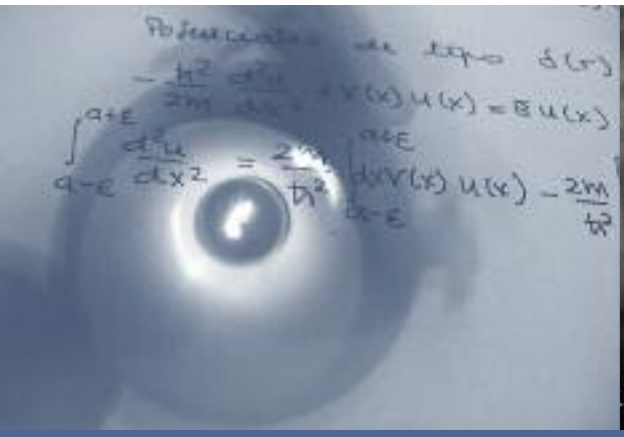
"All developing countries also confront challenges stemming from their late start. For this reason, they could all learn a great deal from the successes and failures of more scientifically advanced countries as well as from the experiences of countries that are in comparable stages of scientific capacity building and economic development. TWAS can help in this pursuit by fostering dialogue and collaboration."

the Russian revolution, as did many of their fellow citizens. He says that at the time, people from the Old World didn't really know the difference between North and South America. For many, the New World was as mysterious as the quantum world is for many of us today. In fact, it was simply chance that landed his family far south of the Rio Grande. They could have just as easily wound up on the east side of Manhattan or the north side of Chicago.

Not that Davidovich ever saw working in a developing country as a drawback – especially now in such a rapidly developing country as Brazil.

In recent years, Brazil's science and technology budget has risen sharply. When former president Luiz Inácio Lula da Silva took office in 2003, total funding for science and technology stood at 21.4 billion reals (USD11.4 billion). By the time he stepped down last year after serving two terms, it had soared to 43.1 billion Brazilian reals (USD22.9 billion). Publications by Brazilian scientists in international peer-reviewed science journals leapt from 14,237 to 30,415 in the same period, according to data from Thomson Reuters.

"Physics in Brazil has certainly benefited from the strong push for science in general," he explains. Among other things, President Lula made sure that a portion of the taxes levied on Brazilian industries, such as the country's oil company Petrobras, were channeled back into the research community to stimulate additional growth. There was also more money for "blue-skies" research, including public funds for a National Institute of Science and Technology for Quantum Information that engages about 70 researchers in more than 10 institutions.



A great deal has been said about Brazil's rapid rise in international science and technology. But Davidovich reckons the best is yet to come.

"There are many projects that have not yet produced findings. For instance, Brazilian universities and research centres across the country have recently received money to launch laboratories in a broad range of fields. I think that we will see these laboratories generating significant results over the next few years," he says.

SYSTEMS QUANTUM

Davidovich's network spans the globe. He received his PhD in 1975 from Rochester University in New York, USA. He has worked at the *Seminar für Theoretische Physik* in Zürich, Switzerland, and visited universities and research centres in France, Germany, the USA, and the UK, to name just a few places, to pursue a broad range of collaborative research projects.

One of the seminal experiments he was involved in was with colleagues at *Ecole Normale Supérieure* in France. The initiative had to do with understanding how quantum systems turn into classical ones – that is, how systems that behave in strange counterintuitive ways begin to behave in ways that we are familiar with and that conform to our perceived notions of space and time.

It turns out that the environment around the system plays a crucial role. The larger the system, the faster it loses its quantum characteristics. This explains why an electron can be observed in a superposed state, while a human cell cannot.

From there, it was not a big step for Davidovich to work on understanding what might arguably be called the holy grail of quantum theory applications – the quantum computer.

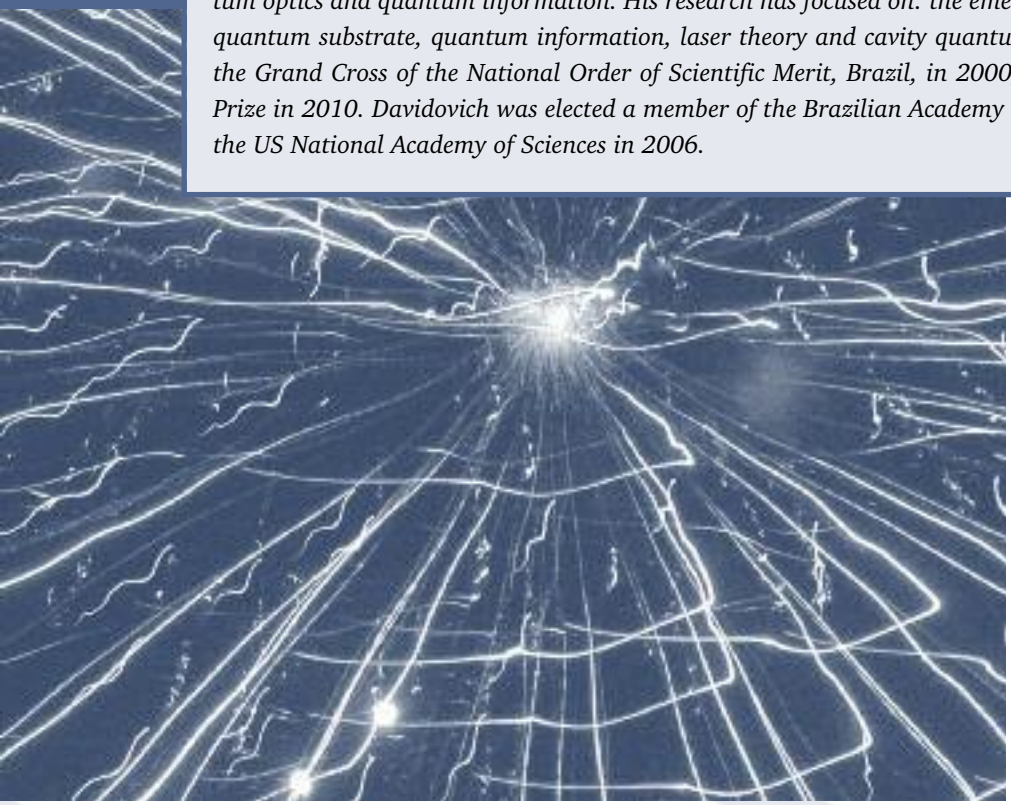
A quantum computer uses the quantum superposition of particles to carry out calculations much faster than classical computers. Such a computer would not only gain its creator fame but could also earn him or her a great deal of money by enhancing the accuracy and efficiency of a wide range of pursuits – some which would be legal and productive, but some others that could prove to be illegal and risky. For example, a quantum computer could be used to create more precise behavioural models of global climate. But it could also be used to crack high security encryption schemes that banks and the military rely on to keep information safe.

Physics in Brazil has benefited from the strong push for science in general.

A popular way of encrypting secret data makes use of the fact that it is much easier to multiply large prime numbers with each other to calculate their product than it is to divide a given large number into its prime factors. Multiply large enough numbers together and you soon run out of time in the universe to factor it into primes. Banks and governments rely on this to protect sensitive information. It is part of the mathe-

LUIZ DAVIDOVICH: A PROFILE

Davidovich (TWAS Fellow 2002 in physics), was born in Rio de Janeiro, Brazil, on 25 June 1946, and was educated at the Pontificia Universidade Catolica do Rio de Janeiro *and the University of Rochester, USA, where he obtained a PhD in 1975. He is full professor of physics at the* Universidade Federal do Rio de Janeiro. *He has held a number of visiting scientist positions in France, Germany, the USA and the UK. His interests cover quantum optics and quantum information. His research has focused on: the emergence of the classical world from the quantum substrate, quantum information, laser theory and cavity quantum electrodynamics. He was awarded the Grand Cross of the National Order of Scientific Merit, Brazil, in 2000, and the Brazilian National Science Prize in 2010. Davidovich was elected a member of the Brazilian Academy of Sciences in 1996 and a member of the US National Academy of Sciences in 2006.*



matical puzzle pieced together to protect the sensitive credit card information that customers give out when buying goods from reputable sites on the internet. However, a quantum computer would drastically reduce the time it would take to factor primes, allowing its owners to break the code and turn the world – not to mention your wallet – upside down overnight.

The issue caused such a worry after it was discovered in the 1990s, says Davidovich, that the US military would issue calls for research proposals on the topic from anywhere in the world, on the condition that the results from the research were published at workshops held in the US. "In other words, if somebody came up with a way of building a quantum computer, the US military wanted to know about it," says Davidovich.

However, a quantum computer is easier to envision in theory than it is to build in practice. And, when all is said and done, a chalkboard computer is no computer at all.

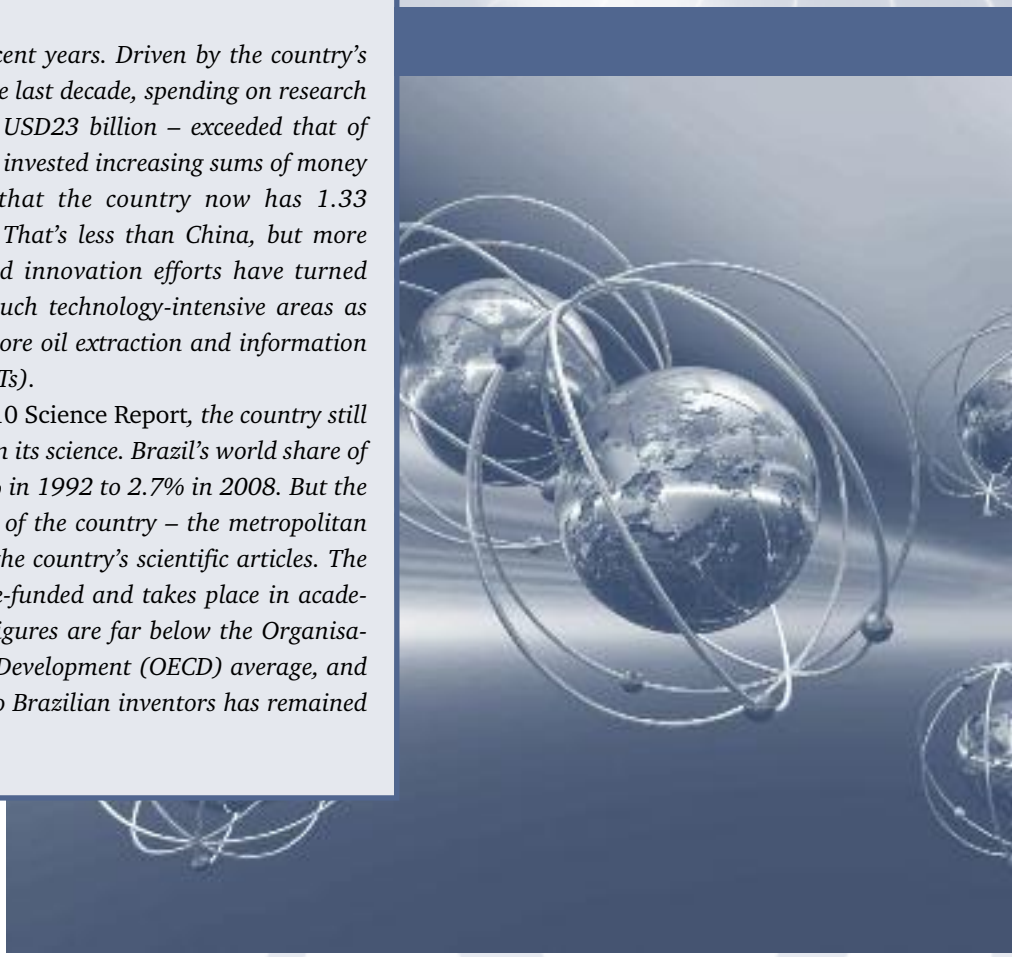
To break modern cryptography, you would need a computer made up of a system of 1,000 particles, says Davidovich. But such large collections of particles easily deteriorate into classical states. In an article published in 2007 in the journal *Science*, Davidovich and his colleagues in Brazil showed how something called 'entanglement' between particles – crucial to the concept of quantum computing – was frightfully easy to destroy.

"Physicists call that the sudden death of entanglement," he says. Entangled particles are special. That's

SCIENCE IN BRAZIL

Brazilian science has exploded in recent years. Driven by the country's extraordinary economic growth in the last decade, spending on research and development (R&D) in 2008 – USD23 billion – exceeded that of Spain and Italy. The government has invested increasing sums of money into PhD training. The result is that the country now has 1.33 researchers per 1,000 labour force. That's less than China, but more than Mexico. National research and innovation efforts have turned Brazil into a prominent player in such technology-intensive areas as biofuels, agricultural research, off-shore oil extraction and information and communication technologies (ICTs).

However, according to UNESCO's 2010 Science Report*, the country still lags behind in terms of capitalising on its science. Brazil's world share of articles may have climbed from 0.8% in 1992 to 2.7% in 2008. But the growth comes mainly from one part of the country – the metropolitan area of São Paolo produces 60% of the country's scientific articles. The lion's share of R&D in Brazil is state-funded and takes place in academia. The country's industrial R&D figures are far below the Organisation for Economic Co-operation and Development (OECD) average, and the number of US patents awarded to Brazilian inventors has remained stagnant.*

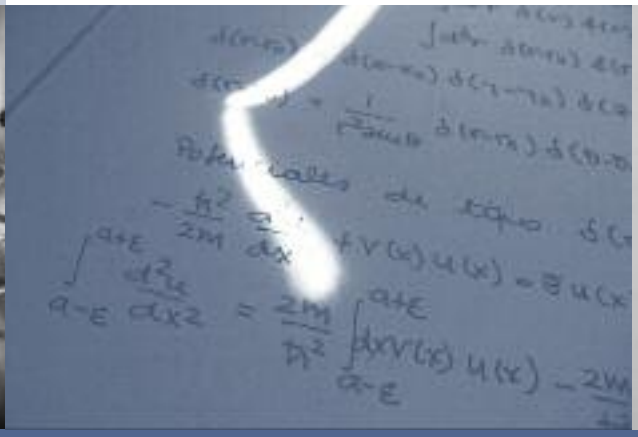


because, while an observer can measure the global state of an entangled pair of particles – their relative position to one another – you cannot know the individual positions of the two particles.

"You don't know, not because you haven't looked, but because the positions are in an "entangled state."

Stated another way, once you measure the position of one of the particles, you can infer the corresponding property of the other, since you know its relative position with respect to the measured particle. But this measurement leads to a change of the state of the two particles, so it is still impossible to assign a specific property to each particle before the measurement was made."

In this sense, quantum physics is a lot like real estate. The key to the value of both lies in location,


location, location. But since you are never certain of the location of quantum particle, you can never know its value.

QUANTUM DIFFICULTIES

The experiment outlined in *Science* found that quantum entanglement was less resistant to the environment than other properties of the particles, such as their energies.

The findings were bad news for quantum computing, but good news for banks and defence ministries. "This implies that there are many deeply embedded difficulties to building quantum computers," says Davidovich.

In fact, Davidovich is sceptical that anyone will gain the knowledge and insights they need to build a quantum computer of the kind that can crack security encryptions with the technologies that are currently available.

"Many people have tried to build systems of many entangled atoms. The latest system, constructed in Innsbruck, Austria, in 2010, entangled 14 atoms. But the "entangled" state that was produced was far from the ideal state that scientists would need to construct an encryption-breaking quantum computer. Moreover, as the system grows in complexity, so do the imperfections. "If you want to have 1,000 entangled atoms as part of the system to ensure its effectiveness, the current intellectual building blocks that can be used to construct the system are not likely to allow you to do this," Davidovich says.

However, he is more upbeat about the possibilities of building quantum computers for the purpose of simulating quantum systems. This would enable researchers to do the kind of modelling that is currently impossible with classical computing speeds. "I think here we have good prospects for success," he says.

So, the current state of research should build public confidence that, in fact, this research can have a positive impact on society. For example, quantum computers that can aid in understanding complex processes in nature could well be on their way, according to Davidovich. However, quantum computers that could prove effective in breaking computer codes and, in the wrong hands, that could be used to access sensitive personal information and critical military data won't be available any time soon and may never become a reality.

You can't buy technology from abroad at the cutting edge of knowledge.

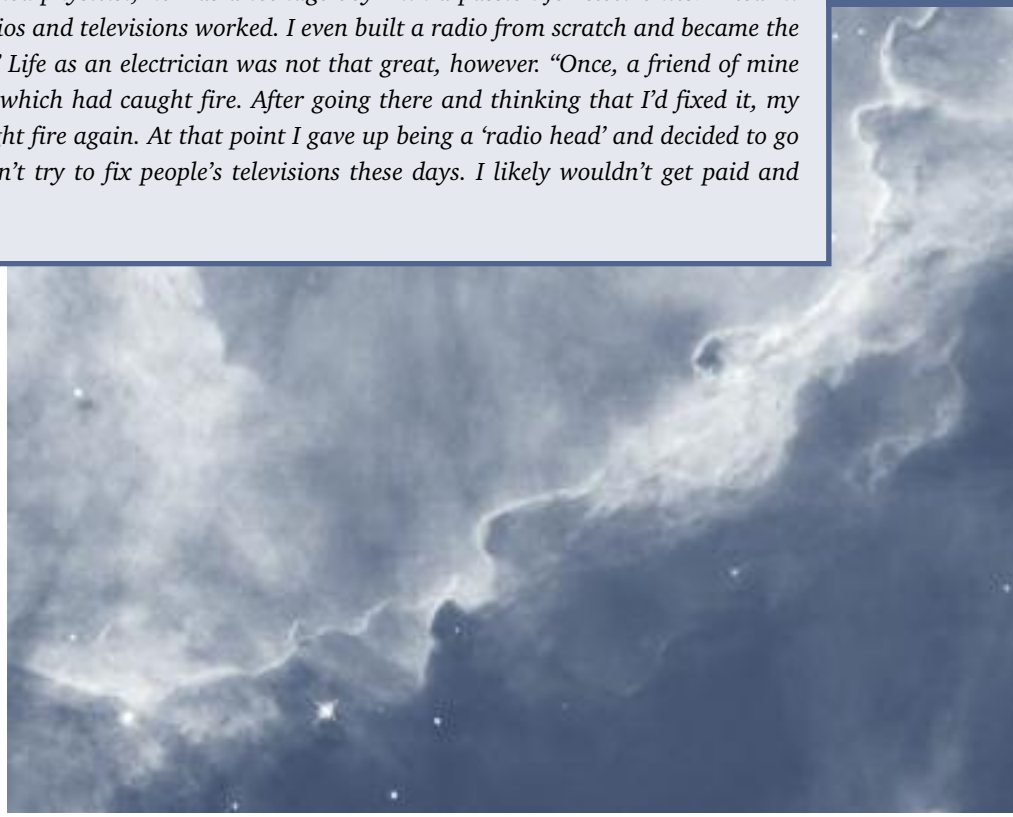
LEVELLING THE FIELD

What is more, Davidovich believes developing country scientists will play a leading role in the next steps in quantum theory.

"To build a quantum computer that could do something like find the prime factors of a large number, you need new ideas," he says, "and new ideas can come from anywhere. What is required is an inviting ambience that encourages creativity and bright young peo-

THE RELUCTANT ELECTRICIAN

Before Luiz Davidovich was a renowned physicist, he was a teenage boy with a passion for electronics. "I learnt via a correspondence course how radios and televisions worked. I even built a radio from scratch and became the go-to person for when radios broke." Life as an electrician was not that great, however. "Once, a friend of mine wanted me to fix his family's radio, which had caught fire. After going there and thinking that I'd fixed it, my friend called me and said it had caught fire again. At that point I gave up being a 'radio head' and decided to go into more theoretical work. I wouldn't try to fix people's televisions these days. I likely wouldn't get paid and might get sued."



ple to turn their minds to these problems. Obviously, you don't need to be in the United States or Europe for this to happen."

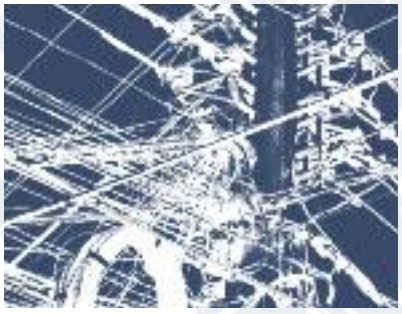
He hopes that other developed countries will follow Brazil's lead and think seriously about building their capacity for conducting research and encouraging innovation within their borders.

"The idea that research and innovation can be bought is flawed," he says. "Some years ago influential people in Brazil said that we didn't need to develop high technology because we could buy it from other countries. But you can't buy technology from abroad at the cutting edge of knowledge. It's not for sale. And technology changes so fast that by the time you get to use it, it's no longer new. That means you are always behind the curve. When the Brazilian government started to put money into research, it was based, in part, on the notion that it's always better for a country to be ahead of the curve than behind it."

That, Davidovich might have added, is not just true for countries but also true for both the classical and quantum worlds. Then again, as research conducted by Davidovich and other physicists has shown, when it comes to the world of quantum physics, it's theoretically possible to be both ahead of and behind the curve at the same time. ■

LIGHTS ON IN AFRICA

A RECENTLY PUBLISHED REPORT BY THE AFRICAN SCIENCE ACCADEMY DEVELOPMENT INITIATIVE, "TURNING SCIENCE ON: IMPROVING ACCESS TO ENERGY IN SUB-SAHARAN AFRICA", OUTLINES WHAT IT WILL TAKE TO BRING ELECTRICITY TO ALL AFRICANS.



There's a famous image spliced together by scientists at the US National Aeronautics and Space Administration (NASA) showing planet Earth as it appears at night looking down from space. Silhouetted against continents drawn in shades of midnight blue, the eastern United States, Western Europe and Japan shine brightly. Clustered dots of light also spread across Asia and South America. But Africa is almost entirely in the dark.

This darkness is the result of a paradox. Africa's energy reserves, in the shape of its vast forests, mighty rivers, and oil, coal and gas reserves, are among the world's richest. Yet approximately 70% of sub-Saharan Africans do not have access to electricity.

At a time when electrification is speeding across formerly poor regions of the world, sub-Saharan Africa's power supply is stagnant. The subcontinent's entire power-supply is comparable to that of Spain, or equivalent to 10% of that of Latin America. Moreover, access is concentrated around the cities. More than 70% of urban Africans has electricity, compared to just 13% of rural dwellers.

The continent's scientists have tackled this paradox head-on in a recent report. "Turning science on: improving access to energy in sub-Saharan Africa" presents an overview of access to energy services in sub-Saharan Africa and makes suggestions for expanding the generation and distribution of electrical power.

The report was presented at the sixth annual meeting of the African Science Academy Development Initiative (see sidebar) in Somerset West outside Cape Town, South Africa, from 7-10 November 2010. The publication is the second of a series of documents prepared by ASADI to illustrate science-based solutions to Africa's myriad challenges. The first report, published in 2008, examined maternal and child health.

Bringing clean, affordable and reliable energy to all Africans is a crucial step in fighting poverty, according to South Africa's minister of science and technology, Naledi Pandor. "Without access to energy, individuals and communities are unable to lift themselves out of poverty. It is a primary determinant of access to social and economic development," she told attendees to the ASADI conference.

As the report notes, access to energy is vital if African countries are to meet the Millennium Development Goals (MDGs). It matters to food security as it powers the farm machinery designed to increase productivity and fuels the refrigerated trucks that speed deliveries and reduce spoilage. It matters to education as it provides light for children to read by. It matters for gender equality as women generally carry out the dangerous, tedious and backbreaking work of gathering firewood. And it matters to health as many Africans die from exposure to smoke from open cooking fires.

BLEAK OUTLOOK

The report paints a bleak picture of electricity access in Africa. Not only is access the lowest in the world, but the numbers of Africans without access is likely to rise due to rapid population growth. For instance, today around 15 million Angolans do not have access to electricity. By 2030, this number could rise to 18 million.

Moreover, sub-Saharan Africa's power grids are notoriously unreliable. Maintenance is poor, and outages common. Many consumers resort to polluting, noisy and expensive diesel generators as a back up. And widespread electricity pillaging and haphazard revenue collection has contributed to the continent's high electricity prices.

Although the continent's situation is dreary, there are home-grown solutions, the report says. These include ingenious applications of renewable energy and off-grid schemes designed to light up poor and remote parts of the continent.

For instance, more than 2,000 homes in Khayelitsha, a poor township outside Cape Town, South Africa, have been provided with solar water heaters, insulating ceiling boards, upgraded electrical wiring and energy-efficient light bulbs. The project has reduced expenditures on electricity, not only cutting the township's power consumption but also saving residents money. The initiative, which is funded by the South African government, is the first African project registered under the global Clean Development Mechanism. That means the project qualifies for trade emission reductions on the international carbon market.

It's important to note that funding to increase Africa's energy services need not rely on other regions of the world. For example, the Kenya Electricity Generating Company (KENGEN) has secured more than USD110 million through a public offer of its shares on the Nairobi Stock Exchange. This money is being invested in improving and extending services.

> ***"Without access to energy, individuals and communities are unable to lift themselves out of poverty."***

"Local funding is an untapped funding source in many African countries," the report says. To take advantage of this potential source of money, "policy makers must ensure that the energy sector has the leadership and capacity to plan and attract investment-worthy projects."

MIXED BAG

The ASADI report does not promote a one-size-fits-all solution to sub-Saharan Africa's energy shortcomings and bottlenecks. Such a solution, however attractive for its simplicity, would not be suitable because each

LAKE KIVU NATURAL GAS PROJECT

The Lake Kivu natural gas extraction project in Rwanda is an example of innovative energy investments in Africa. The African Development Bank is lending USD25 million to the KivuWatt project, which will use a floating barge to extract methane gas from under the lake.

Power will be produced by integrated sets of methane-fuelled reciprocating generators that produce a combined total of 25 megawatts (MW) of electricity. Phase II will produce an additional 75 MW of power. The project will create 250 jobs during construction. Some 200 workers are expected to come from the local community.

"The KivuWatt project creates a low cost energy solution, which will help Rwanda meet its domestic energy requirements while reducing reliance on expensive imports from neighbouring countries or high cost emergency diesel generation," the Bank notes.

country has different energy resources within its borders. Indeed there are significant differences in the 'energy mix' of various African countries.

For instance, figures from the International Energy Agency (IEA) show that while biomass (charcoal, wood, and waste burning) provides most of the energy in Africa, each country's access to 'modern' energy sources is not the same. In Nigeria, the main formal energy sources are oil and natural gas. Ethiopia, meanwhile, relies on hydroelectric dams. In South Africa, coal dominates the energy mix.

Local funding is an untapped funding source in many African countries.

Countries should build on their natural resources to promote modern and clean energy generation, the ASADI report says. Countries should pursue regional efforts for energy distribution so that one country's surplus can overcome another's deficit. Regional collaboration would have the added benefit of helping to enhance the continent's resilience by bringing together a wider array of energy sources.

Many African energy sources are wasted, or not used locally. For instance, Mozambique exports natural gas to other countries while its people continue to rely on wood-fired stoves. Meanwhile, natural gas is flared off in Nigeria because of limited demand and the desire to speed the production of oil for export. In central Africa, hydropower derived from the mighty Congo River could play a key role in sating the basin's thirst for electricity by serving as a source of hydropower. In short, a diverse set of resources provides African governments with a wealth of opportunities for exploitation.

Africa's equatorial sun and brisk winds make solar and wind power an obvious candidate for electrifying remote African villages. Kenya's government is investing in geothermal power in the geologically active Rift Valley region, which could hold as much as 9,000 megawatts – equivalent to nine nuclear power stations.

ASADI IN A NUTSHELL

The African Science Academy Development Initiative (ASADI) is a 10-year effort to strengthen the capability of African science academies to provide advice to African governments. Launched in 2004 by the U.S. National Academies and funded by the Bill & Melinda Gates Foundation, it aims to encourage a culture of evidence-based policy making in Africa. The grant supports capacity-building efforts with the science academies of Uganda, South Africa, and Nigeria. It also provides modest support to the academies of Ghana, Cameroon, Senegal, Kenya, and the regional African Academy of Sciences for strategic planning efforts.
For additional information, see www.nationalacademies.org/asadi/about.html

Then there is the lure of nuclear power itself. A number of African countries (Sudan, Nigeria, Senegal, Uganda, Ghana and Niger to mention a few) have expressed a desire to acquire nuclear technology. But so far, in sub-Saharan Africa, only South Africa operates a nuclear power plant. In fact, nuclear power will likely remain beyond the grasp of most African nations for many decades to come. The recent catastrophic meltdown at the Fukushima nuclear plant in Japan, moreover, might push the prospects for nuclear power in Africa even farther into the future.

MAKING BIOMASS SUSTAINABLE

While the African continent is awash with energy-generation potential, the continent's politicians should not expect to wean its population off biomass for cooking and heating any time soon.

"Logging may have a bad name among environmentalists due to its role in deforestation, but it plays a vital role in Africa," says Gisela Prasad from the University of Cape Town's Energy Research Centre, one of the main authors of the ASADI report. Buying and selling charcoal and fuel wood is how many Africans earn their living, she says. For example, it accounts for 2% of the gross domestic product (GDP) in Malawi and Rwanda.

But biomass production and harvesting must become more sustainable to protect the continent's forests, she adds. This is usually best done by the communities with residents who largely live on the land and draw on the land's bounty both for their sustenance and livelihood. "There used to be a culture dedicated to looking after the forest. This culture has gradually disappeared. We need to take steps to regain the level of sensitivity for the forests that once existed among the people," Prasad says.

The London-based International Institute for Environment and Development (IIED) made the same point in March 2011. According to the IIED report, "Bundles of energy: The case for renewable biomass energy", global reliance on biomass fuels is set to triple from 10% to 30% of global energy consumption by 2050.

"Many governments in developing nations dissuade people from burning wood or charcoal as fuel. They

think it represents a backward form of behaviour. But this mentality just penalizes poor people for their energy needs and does little to limit deforestation. Instead government should embrace and legalise biomass fuels as a source of energy and enact policies that make supply chains sustainable," noted Duncan Macqueen, a senior researcher in IIED's natural resources group, in a statement issued by the institute last spring.

'TASTES OF THE SUN'

Another challenge lies with social acceptance of new technologies.

LIGHTING UP AFRICA

A number of African organisations conduct research aimed to help the continent's policymakers expand energy access.

- *The Energy Research Centre at the University of Cape Town, South Africa, is one of Africa's leading academic centres focusing on energy. It studies energy efficiency, climate change, energy systems planning and poverty, and also plays a key role in forming the continent's stance in international climate change negotiations (www.erc.uct.ac.za/).*
- *AFREPREN, a nongovernmental organization (NGO) based in Nairobi, Kenya, brings together over 300 African energy researchers and has initiated energy policy research studies in 19 African countries. AFREPREN focuses its efforts on energy-sector reform, extending clean energy services to the urban poor, broader use of renewable energy in rural areas and issues related energy use and gender (www.erc.uct.ac.za/)*
- *The Environment and Development Action in the Third World (ENDA-TM) is a nongovernmental organization based in Dakar, Senegal, comprised of a network of research centres dedicated to the study of energy use and sustainable development in Africa. More specifically, ENDA-TM focuses on continent-wide issues that lie at the interface of energy and the environment. Such issues include biodiversity conservation and desertification (www.enda.sn/).*
- *KITE, a non-profit organization based in Ghana, aims to influence policy in the country's energy sector. It has published studies on development and the environmental and social impacts of Ghana's emerging oil and gas industry (www.kiteonline.net/).*
- *The Association of Mediterranean Energy Regulators (MEDREG) brings together electricity and gas regulators in countries bordering the Mediterranean Sea. Financed in part by the European Union (EU), MEDREG seeks to promote stable and harmonised legal and regulatory frameworks within the region. Strategies designed to facilitate technology transfer, especially for clean energy technologies, are a key aspect of its work (www.medreg.ipi.it/).*

In South Africa, the roll-out of solar heaters for poor households has had caused many South Africans to turn their backs on this renewable-energy device because they now associate solar power with being poor. "Electricity from the grid is seen as superior to off-grid technologies," says Prasad. This has resulted in calls for wealthy South Africans to put solar heaters on their roofs to remove the negative associations.

People have also been reluctant to adopt cutting-edge cookers that use solar energy, complaining that 'the food tastes of the sun'.

"Social acceptance is a problem in South Africa," says Prasad. But the situation is not the same across the continent, she adds. For instance, solar power is accepted in Kenya.

ADVICE TO GOVERNMENTS

Ultimately, the ASADI report calls on Africa's governments to draw on the full range of energy expertise dotted around Africa to influence their roll-out of energy services (see sidebar, p. 34). To advance this goal, the ASADI report itself needs to be aggressively promoted among African governments.

Science academies can assist governments in their efforts to address energy access issues in several ways, the report says: They can convene expert groups to brainstorm on scientific and policy challenges, they can inform policymakers of the role of science, they can highlight examples of best practices, they can identify gaps in knowledge, and they can track government investments.

South Africa's ASSAF is already doing this by giving input on the country's "Integrated Resource Plan". The plan, which has been widely criticised for not focusing sufficient attention on renewable energy sources, nevertheless presents a vision for the country to invest in electricity generation and distribution. The primary goal is to extend electricity access to those who currently do not have it.

It's time to turn on the lights in Africa.

The South African government's request to the academy to offer its views on the plan represents a step in the right direction for evidence-based policymaking. However, science can only play a part in the solution. Political will and effective policies and regulations will be vital to the process of extending energy services in Africa and creating a brighter future for the continent and its people.

Only when such initiatives have been launched and sustained will NASA's night-time portrait of the Earth from space cease to show a broad area of darkness as a distinguishing characteristic of sub-Saharan Africa, where economic distress and electricity shortages have gone hand-in-hand for too long. It's time to turn on the lights in Africa. ■

SCIENCE FOR PEOPLE IN BOTSWANA

AS AFRICA'S ECONOMY CONTINUES TO GROW AND THE CONTINENT SHOWS PROMISING SIGNS OF PROGRESS, SCIENTIFIC CENTRES OF EXCELLENCE HAVE BECOME EVEN MORE CRITICAL FOR ENSURING THAT THESE TRENDS CAN BE SUSTAINED. THE OKAVANGO RESEARCH INSTITUTE (ORI) OFFERS HOPE THAT AFRICA'S DEMAND FOR SCIENTIFIC KNOWLEDGE, FOCUSED ON SOCIETY'S MOST CRITICAL PROBLEMS, CAN BE MET.

The Okavango Research Institute (ORI) is a unit of the University of Botswana (UB). The institute, which is dedicated to the study and conservation of one the world's largest inland wetland ecosystems, is located on the fringe of the Kalahari Desert, some 550 kilometres northwest of the university's main campus in the capital city of Gaborone.

In 2010, ORI expanded its area of concern to include the entire Okavango Basin in which the delta resides, an area adjoining Zimbabwe to the east, Zambia and Angola to the north, as well as a sliver of Namibia along the northern frontier.

ORI was not fully staffed until the mid-1990s and it has grown rapidly in the past several years. Additional growth is anticipated with the opening of a second UB campus adjacent to the site of ORI, which is scheduled to take place no later than 2015. This entire complex is about 15 kilometres up the Thamalakane River from the sprawling, dusty town of Maun, the destination for most of the country's tourists, who travel from around the world to see the Okavango's rich wildlife.

ORI is comprised of just one main building for offices and laboratories, plus a handful of outlying, mostly temporary structures for graduate students, visitors and staff. There is also a tented camp for



visiting students and researchers, a refurbished library, a new herbarium and a modern geographic information systems (GIS) laboratory, which produces maps and charts and maintains geospatial data on the Okavango Basin.

With 33 academic staff and 45 support staff, ORI is involved in more than 50 research projects, many in collaboration with international partners. Its mandate extends beyond hydrology and natural resource management to issues related to ecosystems, tourism, livelihoods and governance.

The first graduate students arrived in 2009. Today, 15 are enrolled, five of whom are supported by the Regional Initiative in Science and Education (RISE) of the Carnegie Corporation of New York. A master's programme in development practice will begin this year to train students from around the world to establish businesses in developing countries. This programme receives funding from the MacArthur Foundation and grants from Columbia University and the University of Florida in the US. For the near future, however, ORI's main focus will be research that is funded by grants that provide much of the institute's income.

ORI is a unit of the University of Botswana located on the fringe of the Kalahari Desert.

REACHING OUT

BioKavango, which combines scientific research with public outreach, has been one of ORI's most successful programmes. The five-year programme, which ended in December 2010, had four components: tourism, fisheries, water and 'biodiversity mainstreaming' (that is, teaching people about the value of biodiversity for tourism and other aspects of economic development).

Each of these issues has sparked community conflict that was often ignited by an insufficient knowledge of the factors that determine long-term health and sustainability. A primary goal of *BioKavango* has been to try to minimize community conflict to allow for more effective decision-making.

"One way we hoped to do this", says Lapo Magole, an ORI social scientist, "was to dispel some misperceptions, including the one that fishers were overfishing certain areas. We showed this wasn't true – that, in fact, the scale of the fishing industry in the region was simply too small to overfish the stocks. The real source of discontent turned out to be that tourists simply did not want to see local people fishing in front of their lodge. The problem, in short, was one of perception, not reality."

Another misperception Magole cites was that an invasive plant from Brazil, *Salvinium molesta*, would permanently choke off the waterways and kill the fish. "We worked with the Uganda Department of Water Affairs," she says, "importing a tiny weevil that is helping to control this plant."

A third misperception, Magole points to, was that

SUZANNE RINGROSE, ORI DIRECTOR

Susan Ringrose, director of ORI, began working and teaching at the Main Campus of the University of Botswana in 1983. She came to Botswana with a PhD degree in remote sensing, soil science and Quaternary geology, and was tasked with helping the country combat drought and desertification. After serving as a project leader in the National Institute of Research in Gaborone, she was transferred to Maun in 2000 and in 2003 became head of the newly formed Land and Water Unit of ORI. During her decade in Maun, she has been a productive researcher specializing in geomorphology and biogeography – how landscapes form and change – and has pioneered the application of remote sensing techniques to vegetation mapping in semi-arid countries. One of her interests involves the formation of soils and, in particular, duricrusts – thin, hard layers of minerals deposited at the soil surface in arid settings that experience rapid evaporation. Another aspect of her work is to examine landscape change, focusing on areas subject to broad-scale wetting and drying – basically considering the effects of floods and droughts on landscape and in particular soil processes. A native of the UK, she has acquired broad knowledge and expertise in these areas since moving to southern Africa, and has published more than 80 papers in peer-reviewed publications. While Ringrose continues her research with many colleagues, her duties have grown with the rapid evolution of the ORI. As director, she is responsible for ORI's overall management, and especially for co-ordinating and implementing the strategic plan emphasizing community interactions, which has become a central focus for ORI as it moves to full institute status with expanded research and teaching responsibilities. "We receive very good support from the university," she said. "It pays for 90% of staff salaries, and for most of our vehicles, utilities and instrumentation. But there is less public money coming into the university overall, so we are being urged to be more self-sufficient." She is also tasked with helping to organize the University of Botswana's new Maun campus, scheduled to begin activities in 2015. She expresses pride in having achieved Botswana citizenship in 2009, which strengthens her own relationship to the community. She is also proud of the fact that most of her young faculty are Botswanans who are active researchers and can communicate easily with the delta people living nearby.

cattle were grazing on land that had been reserved for tourists, interfering with the wildlife that tourists had come to see. "We showed that this was seldom the case. In addition, we illustrated that when such trespassing did occur, it was because the cattle herders believed the land belonged to them."

Addressing the issue involved conducting research to help ensure that the discussions would be based on facts, not feelings, and on bringing the parties together to make it possible for them to work out their differences.

Specifically, ORI staff arranged for community leaders, government officials, fishers and tourism operators to meet and discuss issues of common concern over which conflicts had flared. Tourism operators balked at first, but they soon realized they had to

participate if they were to have any chance of resolving the critical problems that they faced. The discussion, in fact, led several community leaders to join together in setting up their own Tubu Village Tourism Company.

The goal was to build a cultural village featuring ancient rock paintings and to operate a campground to accommodate tourists. The company worked with government officials to require both cattle herders and tourism operators to file environmental management plans when leasing land.

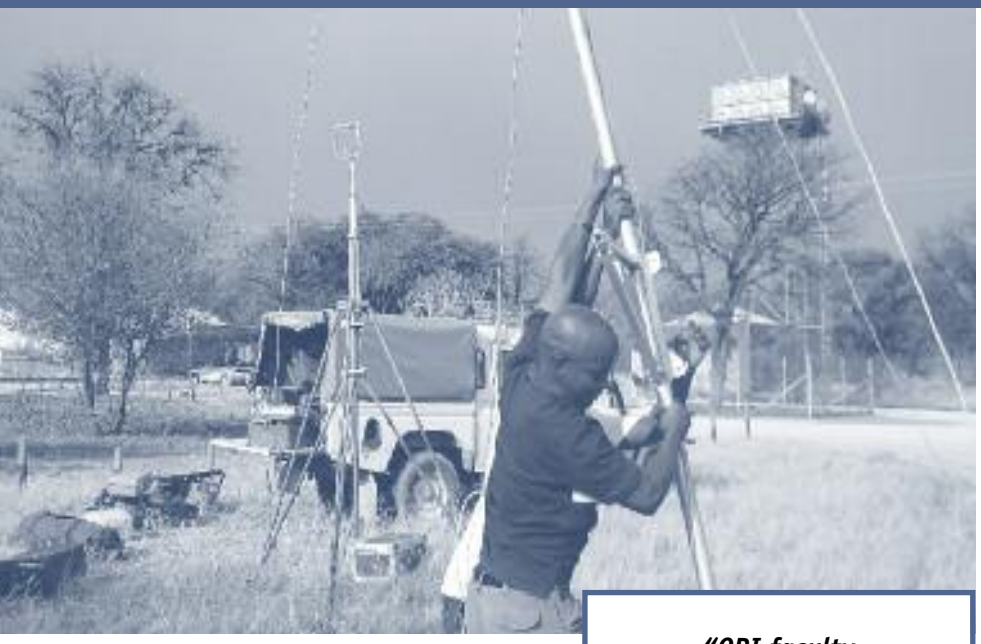
As part of a larger effort to continue the work of *BioKavango*, assistant librarian Olebo Suwe and others plan to post slides of *san* culture on the ORI website and display posters of these cultural activities in the Maun town centre. "Tourists are interested in the bushmen," she says. "They heard about them but don't know much about how they live and would like to learn more. Our efforts are designed to help enrich their experience."

ORI studies tourism in the same way that it studies hydrological or botanical questions.

THE SCIENCE IN TOURISM

ORI studies tourism in the same way that it studies hydrological or botanical questions. The institute is intent on gathering and analysing data, conducting surveys, engaging stakeholders and providing fact-based information that can serve as the basis of effective policy making.

"We examine everything, starting with cost-benefit analysis," says Joseph Mbaiwa, who earned his PhD in Parks and Recreation Science from Texas A&M University in the US. "Tourism provides jobs, but it carries costs too. For example, the elephants that tourists come to see also damage crops. Lions eat cattle and goats, increasing risks to local food supplies."



> ***"ORI faculty is reaching out internationally."***

ORI's faculty devote more than half of their time to research and classroom teaching. The rest is spent on providing community services.

ORI staff, for instance, have worked as consultants to the government. "In late 2009, we completed a plan on how the three countries bordering the Okavango Basin – Angola, Namibia and Botswana – can improve their management of the region, especially at the community level. We spoke with a wide range of people, helping them to gain the skills they need to prepare contracts and, more generally, to devise effective strategies to improve employment conditions."

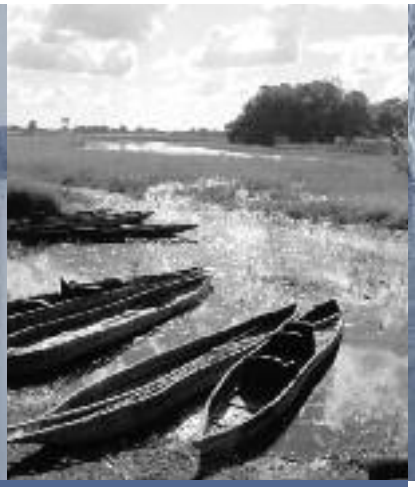
ORI staff have also worked with the Tourism and Hospitality Association of Botswana to settle disputes through joint management committees. As a result of these efforts, cattle herders have been granted some access to fenced areas under dispute and fishers have agreed not to use nets that catch fish below market size.

"We are making progress," says Mbaiwa. "We don't always say or write things that all parties like. For example, we determined that the tourist lodges were not disposing waste properly. They didn't like that, but we have to make our recommendations and keep our integrity intact by serving as honest brokers. "

ON THE INTERNATIONAL FRONT

ORI faculty is also reaching out internationally. The institute, in fact, has forged partnerships with universities in Europe and the US. It also serves as the host of the Africa Climate Change Network. Other projects include:

The Okavango River Basin Commission: ORI advises this three-country commission, comprised of representatives from Angola, Botswana and Namibia. The com-



mission, headquartered in Maun, is responsible for co-managing the Okavango watershed. Namibia currently has urgent water needs, and, if trends continue, Angola will certainly have even greater needs in the future. ORI's strategy focuses on nurturing collaboration between Botswana and its neighbours while, at the same time, making every effort to preserve the water quality of the delta.

EduLink: This EU-funded programme, which ORI manages, is designed to raise the quality of research proposals. There is a similar institute operated by the University of Zimbabwe's Lake Kariba Research Station, where Moses Chimbari, ORI's deputy director for research management, worked before coming to Maun. "We realized that one of the biggest weaknesses in Africa's academic community is not knowing how to obtain funds," says Chimbari. "When the call from the EU came, I wrote to EduLink and told them we needed training in how to develop a proposal. We initially engaged our senior faculty," he explains. "Then we trained 20 faculty in Sudan. And we now plan to expand our training efforts."

EcoHealth: This USD600,000 initiative, funded by Canada's International Development Research Center (IDRC), is a five-year multi-disciplinary study of public health in local villages. It involves some 12 scientists working in a broad range of related fields, including nutrition, agriculture, anthropology, biodiversity and land use. The goal is to place public health at the centre of the development process, and to examine the multiple factors that determine good health and add to the citizenry's well-being and productivity. The project will focus on three villages. Work teams will be comprised of staff and graduate students whose efforts will be guided by discussions with stakeholders and community advisory boards.

The Future Okavango (TFO): This five-year project, sponsored by the German Federal Ministry of Education

FUNDERS

ORI has many funding and research partners, including Canada's International Development Research Centre (IDRC), the German Federal Ministry of Education and Research (BMBF), the UK's Department for International Development (DFID), the United Nations' Environmental Protection and Sustainable Management of the Okavango River Basin (EPSMO), the US National Science Foundation (NSF), various agencies of the European Union (EU), the Global Environmental Fund (GEF) and the Volkswagen Foundation. Most of the faculty collaborate with various universities abroad, including the University of Florida, University of Virginia, University of California at Los Angeles, Ohio State University, University College-London, University of Rennes, University of Bergen and University of Namibia.



and Research (BMBF) and launched in 2010, will examine the vital role that ecosystem services play within the larger economic system as determined by the ability of natural systems to generate clean water, healthy air and fertile soil. A variety of studies will examine such broad areas of interest as hydrology and climate change in the Okavango Basin. The studies will concentrate in part on how people interact with their environment to improve their health and social and economic well-being – for instance, by relying on indigenous plants for their pharmaceuticals and on the region's unique flora and fauna to attract tourists.

ORI will seek to enhance its research expertise.

CHALLENGES AHEAD

ORI will continue to do – and indeed expand upon – what it does best. That is, it will seek to develop and enhance its research expertise while increasing its outreach to the community.

An exciting prospect is the Ecosystem Services for Poverty Alleviation project, announced recently by the UK government for four regions of the world, including sub-Saharan Africa.

Since funding must come through a British partner, the institute has sent Caspar Bonyongo, a senior faculty member, to the UK to strengthen ORI's relationship with potential partners. "We started approaching individuals early on," Chimbari, ORI's deputy director, explains. "Wellington Masamba, deputy director for research services, and Bonyongo will also go to Gaborone to recruit faculty from the main campus to support us."

The heads of district departments, the tourism industry, the land board and the village chiefs are represented in ORI's stakeholder advisory board. "A project will not go anywhere without them," says Chimbari. "The most important thing is for our science advisory board to be satisfied that what we're doing has both scientific merit and societal impact."

A major challenge for ORI has been recruiting new faculty to fill 10 staff vacancies. Several factors work against them, especially when seeking to attract senior faculty. The value of Botswana's currency, the *pula*, has fallen by nearly half in the past decade against South Africa's rand, and salaries have not kept pace with other countries. Other issues include the lack of advanced local medical care, which forces faculty to have to fly to Gaborone for checkups and treatments. There is also a general lack of cultural opportunities in Maun.

"We can offer an exciting environment for young researchers," ORI's director Susan Ringrose maintains (see sidebar, p. 38). "For them, the financial package may not be as important as the challenges posed by the research agenda and the issues they will be able to explore. They are, after all, trying to build a career. For senior faculty with family commitments and retirement on the horizon, the challenge is much greater."

A challenge of a different sort is preparing for the

INNOVATIVE EXPERIENCES IN SCIENCE AND TECHNOLOGY SERIES

For the past decade, TWAS – in collaboration with several other organizations and funding agencies, including the United Nations Development Programme's Special Unit for South-South Cooperation (UNDP-SSC), the Global Environmental Facility (GEF) and the Packard Foundation – has published a series of profiles of scientific institutions of excellence in the developing world. The case study on the Okavango Research Institute, which is summarized here, is the first with our new partners, the Science Initiative Group (SIG), which heads the Regional Initiative in Science and Education (RISE) of the Carnegie Corporation of New York. Previous case studies can be browsed online at www.twas.org. For print copies of the profiles, contact info@twas.org. To learn more about SIG and RISE, see sites.ias.edu/sig.

new UB campus, which is planned to grow around ORI on a tract that is projected to expand from 60 to more than 100 hectares. Within UB's organizational framework, ORI is currently part of the office of academic affairs. But it will soon join a new division of research innovation and graduate study.

The Maun campus will consist of four schools at the outset: applied ecology, cultural and heritage studies, tourism and hospitality, and entrepreneurship. The campus will have an estimated student population of 5,000. This represents an enormous logistical challenge that could drain the energy and skew the focus of all its constituent parts, including ORI.

Finally, an ongoing challenge that always hovers over the work and plans of ORI is the competition for the water supplied by the Okavango River. In a region where drought is predominant, many potential users covet this precious resource. The Okavango River Basin Commission (OKACOM) is structured to address this issue in a rational and collaborative way. But no one can foresee the possible political changes or economic stresses that might suddenly disrupt the current civil discourse.

"The main problem for wetlands everywhere is drainage – people taking the water out," says Eben Chonguica, OKACOM's executive director. "Wetlands account for just 2% or 3% of the Earth's surface. Yet they are vital to life and one of the most efficient mechanisms for carbon sequestration. Our best hope is that policymakers continue to rely on the soundest science in making decisions about the Okavango."

Chimbari is equally convinced that ORI can make a difference. "Our banner is 'engaged research'," he says. "There has been debate about that. But it's our aspiration. We have 33 positions for PhDs. That's a substantial number for any institution. In southern Africa, people have been afraid of scientists, would never go near them let alone listen to what they had to say. We plan to change that.

What I want to do is to be able to go into any bar or sports club or school in Maun and ask someone: 'What does ORI do?', and I want them to be able to tell me. I want them to understand the value of science in their lives." ■

A DISEASE NEGLECTED NO MORE

TWAS HAS JOINED FORCES WITH THE MALAYSIA-BASED INTERNATIONAL SCIENCE, TECHNOLOGY AND INNOVATION CENTRE FOR SOUTH-SOUTH COOPERATION (ISTIC) IN AN EFFORT TO IDENTIFY RESEARCH FINDINGS IN THE DEVELOPING WORLD THAT HAVE BEEN SUCCESSFULLY CONVERTED INTO NEW PRODUCTS, PROCESSES AND SERVICES. THE WINNER OF THE FIRST 'ISTIC-TWAS AWARD FOR ENTREPRENEURSHIP' WAS RAHMAH NOORDIN OF THE INSTITUTE FOR RESEARCH IN MOLECULAR MEDICINE (INFORMM), UNIVERSITI SAINS MALAYSIA. NOORDIN WAS HONOURED FOR HER WORK ON DIAGNOSTIC KITS FOR LYMPHATIC FILARIASIS, A NEGLECTED DISEASE OF POVERTY.

Lymphatic filariasis is caused by microscopic parasitic worms that are transmitted from person to person through mosquito bites. The disease is endemic in 83 countries. Some 1.1 billion people are at risk. More than 120 million are infected.

The thread-like worms that cause lymphatic filariasis live in the hosts' lymphatic system. Although it causes significant morbidity among the poor, the disease is rarely fatal. As a result, it is given low priority in the healthcare system of developing countries.

Nevertheless, according to the World Health Organization (WHO), each year lymphatic filariasis accounts for the loss of 5.8 million Disability Adjusted Life Years (DALYs, a measure of time lost due to premature death and disability). That is the highest total of DALYs for any of the diseases that have been studied.

Lymphatic filariasis, simply put, is a disease that keeps people unhealthy and poor.

In about 10% of chronic cases, infections also lead to grotesque swelling, especially in the lower extremities. Blockages caused by the worms in the lymphatic system prevent fluids from circulating normally – the all-too-familiar symptoms of elephantiasis.

Global statistics, however, obscure the fact that

there are differences between lymphatic filariasis infections – and that some types of this neglected disease are more neglected than others.

Some 90% of lymphatic filariasis is caused by the worm *Wuchereria bancrofti*. Not surprisingly, most research and control efforts have focused on this target.

The remaining 10% of cases are caused by two related species, *Brugia malayi* and *Brugia timori* – so-called brugian filariasis. Whereas bancroftian filariasis is more widespread in Africa, brugian filariasis is found in Asia. Brunei, Indonesia, southern parts of India, Malaysia, the Philipppines, Thailand, Timor Leste and Vietnam are among the endemic countries.

Lymphatic filariasis is a disease that keeps poor people unhealthy and poor.

ERADICATION SCHEME

In 1993, the International Task Force for Disease Eradication declared lymphatic filariaisis to be one of six potentially eradicable diseases and, in 2000, WHO initiated the Global Programme for Elimination of Lymphatic Filariasis (GPELF).

GPELF aims to both stop transmission of the parasite by mosquitoes – for instance, through the use of insecticide-treated bed nets – and to eliminate the disease-causing worms from infected people through mass distribution of medicines that kill the filarian worms.

Between 2000 and 2007, the efforts of GPELF have prevented an estimated 6.6 million new cases of filariasis from developing in children, and have thwarted the progression of the disease in another 9.5 million people who had already contracted it. Public health officials believe that the programme is on track to eliminate the disease by 2020. As a country with only small pockets of remaining infection, Malaysia hopes to eradicate lymphatic filariasis by 2013.

The idea of the so-called 'mass drug administration' (MDA) programme is to provide doses to the entire 'at-risk' population for a period ranging from 4 to 6 years. To achieve this, it is important to identify the limits of the 'at-risk' population so that the boundaries of the endemic areas can be continually assessed and areas from where the disease is thought to have been eliminated can be monitored. Such efforts rely on accurate disease diagnosis.

NIGHT AND DAY

The traditional method of diagnosing brugian filariasis involves pricking a finger and taking a sample of blood for analysis under the microscope to confirm the presence of *microfiliariae*, the larval stage of the worms.

However, the blood sample must be taken at night when the microfiliariae are active in the hosts' blood vessels. During the day, the microfiliariae typically hide in the blood capillaries of internal organs. Even when samples are taken and analysed at night, which

puts a strain on the technical healthcare services, this method lacks sensitivity and can miss between 25% and 50% of positive cases.

Moreover, when the detection method is switched from microscopy to more modern biotechnological techniques, such as PCR (polymerase chain reaction), night time sampling is still required. As PCR detects the presence of parasite DNA, the worms must be circulating in the blood at the time the sample is taken.

A simple and rapid diagnostic test is needed to get around this problem and to make life easier for the technicians. Such a test should be based on detecting the antibodies produced by the host in reaction to the parasite since these are present in the blood at all times.

For bancroftian filariasis, a rapid antigen test is commercially available for mapping and monitoring activities. However, because of the differences between the species, the test does not detect infections of brugian filariasis. Thus for brugian filariasis, a rapid diagnostic tool is needed.

LABORATORY DEVELOPMENTS

Rahmah Noordin, an expert in medical parasitology, began work on the causal agents of brugian filariasis in the early 1990s. By 1998, she had successfully isolated a gene that codes for the protein found on the surface of the filarian worms, which provokes the hosts' immune response.

Spurred on by this, she cloned the gene (named *Bm17DIII*) into bacteria and then coaxed the bacteria to start producing versions of the filarian protein – so-called recombinant proteins. Using affinity chromatography, she was able to purify the proteins (*Bm*R1) in large enough quantities for testing in the laboratory.

Preliminary tests based on enzyme-linked immunosorbent assays (ELISA), which are carried out in 64-well microtitre plates and produce a colour-change reaction in positive samples, successfully demonstrated the high diagnostic value of the *Bm*R1 recombinant protein. In 2000, Noordin filed a patent on the protein in India, Indonesia and Malaysia. In 2007 and 2009, respectively, the patent was granted in Malaysia and Indonesia.

In the meantime, Noordin focused her efforts on transforming her ELISA-based system of detecting the filarian antibodies – which requires a range of laboratory capabilities, refrigeration of supplies and skilled

ISTIC

The International Science, Technology and Innovation Centre for South-South Cooperation (ISTIC) was established under the auspices of UNESCO following the Doha Plan of Action, which was adopted by the head of states and governments of the Group of 77 and China during the Second South Summit of the Group of 77 in June 2005. As mandated, ISTIC acts as an international platform for South-South cooperation in science, technology and innovation with the overall goal of increasing the capacity for the management of science, technology and innovation throughout the developing world. The organization is based in Kuala Lumpur, Malaysia, and is supported by the government of Malaysia. For additional information, see: www.istic-unesco.org.

technicians – into a system that can be deployed quickly and easily in the field.

The aim was to replicate the rapid antigen test kit that is commercially available for bancroftian filariasis – a system somewhat similar to familiar pregnancy testing kits that can be used by virtually anyone, anywhere.

In 2001, a licensing agreement was signed between the *Universiti Sains Malaysia* and Malaysian BioDiagnostic Research Sdn. Bhd. to commercialize the rapid diagnostic kit under the trademark *BRUGIArapid*™.

By 2002, the test kit was available on the market in an initial format as a 15-minute dipstick test. In 2004, following additional laboratory tests and development, a second generation of the test, a cassette format, was produced: a system that gives a positive response (revealed by a blue line on a white background) just a few minutes after a drop of blood from an infected person has been placed on it.

"The fact that results can be obtained immediately on-site is especially important from the programme manager's perspective," says Noordin. "This allows timely decisions, rapid feedback to the community and immediate epidemiological follow-up."

Malaysia hopes to eradicate lymphatic filariasis by 2013.

FIELD WORK

Noordin's main target for the *BRUGIArapid*™ kit was always the GPELF. As a result, she evaluated the system's sensitivity and specificity extensively both in the laboratory and field trials.

"Many international institutions were involved in the validation studies," says Noordin. "One of the most important was a multi-centre laboratory evaluation commissioned by WHO and coordinated by the Centers for Disease Control and Prevention in the United States. The stringent validation exercise showed excellent results for *BRUGIArapid*™, with more than 90% detection of positive samples and no 'false positives' among the control samples of blood from uninfected people."

Field-based evaluations of *BRUGIArapid*™ followed. In Malaysia, for example, the Sarawak Health Office carried out one field study, while further afield, trials were undertaken in Alor, Indonesia, and in Timor Leste and by the WHO Lymphatic Filariasis Support

WINNERS OF ISTIC-TWAS ENTREPRENEURSHIP AWARDS

The authors of 17 case studies from 15 developing countries, selected through an open call, were invited to a workshop in Penang, Malaysia, on 6-7 September 2010, to present their work to an expert jury panel. At the close of the two-day workshop, the jury selected the following winners of the first ISTIC-TWAS Entrepreneurship Awards:

- **First place (USD5,000): Rahmah Noordin**, *Universiti Sains Malaysia, Penang, Malaysia – for her work developing simple, rapid and effective diagnostic tests for filariasis caused by parasitic worms of the* Brugia *genus.*
- **Second place (USD3,000 award): Philippe Rasoanaivo**, Institut Malgache de Recherches Appliquées, *Madagascar – for his development of a potential blockbuster drug, derived from the roots of a native tree, to treat erectile dysfunction.*
- **Third place (USD2,000 award): Hipolito Ortiz Laurel**, *Postgraduate College, Montecillo,* Mpio. de Texcoco, *Mexico – for his design of the 'Kiss Me' harvester for picking the fruit of the prickly pear cactus, or 'tunas'.*

Centre in Australia, which confirmed the test to be very useful as a field-diagnostic tool for GPELF.

Based on these results, since 2005, WHO has endorsed *BRUGIArapid*™ for use in the GPELF. WHO, in fact, now relies on *BRUGIArapid*™ as a tool for helping to determine the prevalence of brugian filariasis in endemic areas and for certifying whether regions or countries are free of lymphatic filariasis after a minimum of five years of MDA.

BRUGIArapid™ has helped public health officials in South Korea to confirm that it has successfully eliminated lymphatic filariasis, following the testing of 3,000 school children ages 10 to 12. In Brunei and Malaysia, it is currently helping ministries of health to determine whether MDA needs to be continued in some areas and in confirming the infection/transmission status in areas where MDA is deemed no longer necessary. Public health officials expect that the rapid test will also be useful in surveillance activities after elimination has been achieved.

R&D is helping Malaysia achieve a knowledge- and innovation-based economy.

MOVING ON

Despite the success of the *BRUGIArapid*™ test kit, the fact that it was only detecting brugian filariasis limited its impact in areas where brugian and bancroftian versions of the disease were occurring.

Noordin tackled this challenge by isolating a second gene to produce a second recombinant protein (*BmSXP*). The *BmSXP* protein antigen is useful for detecting antibodies to both forms of the disease. The pan-filarial rapid test (named *pan LFrapid*™) was developed and placed on the market in 2006.

In addition to collaborating with colleagues in Europe and the United States, Noordin has worked



with local scientist, Taniawati Supali, from the University of Indonesia, a respected scientist who has done research on filariasis in Indonesia and who the Indonesian Ministry of Health often consults on issues related to the disease. Supali has been using the rapid tests in her filariasis research projects. Such regional collaboration is especially significant, as Indonesia is the country with the largest population living in brugian-filariasis-endemic areas.

The success of the diagnostic kits has led to a Phase II operational research project funded by the Bill & Melinda Gates Foundation and implemented through the Task Force for Global Health, headquartered in the United States.

"This project is a collaborative effort involving USM, the Ministry of Health in Malaysia, the Task Force for Global Health, and the US Centers for Disease Control," notes Noordin. "Any issues related to the performance of the tests in the field will be addressed." The results will help guide WHO in formulating guidelines for pre-certification and post-MDA surveillance in Malaysia and other brugian-filariasis-endemic areas such as Indonesia.

The two kits developed by Noordin, *BRUGIArapid*™ and *pan LFrapid*™, have already helped – and continue to help – a number of filariasis-endemic countries in the South in their disease control and elimination programmes. Indeed the kits have had a positive impact on the health and quality of life of the people who have had access to them.

"And because both kits are being produced by a local manufacturer," Noordin observes, "the research and development we have done is helping Malaysia in its drive towards achieving a knowledge- and innovation-based economy." ■

HONORARY DOCTORATE

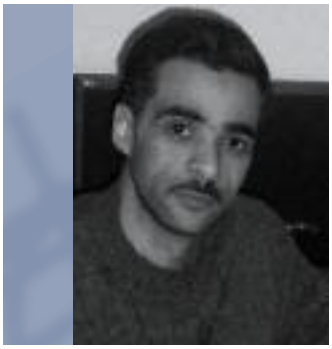
• **Atta-ur-Rahman** (TWAS Fellow 1985) has been awarded an honorary doctorate degree in science by the King of Malaysia Sultan Mizan Zainul Abidin in October this year. The degree is being granted in appreciation of Atta-ur-Rahman's "extraordinary and outstanding scientific achievements in the field of organic chemistry and natural products chemistry and for his immense contribution to the development of science and technology education in Pakistan and the Muslim world." Atta-ur-Rahman has 843 publications in organic chemistry, 18 patents, 103 books and 59 chapters in books. He received honorary doctorate degrees from Cambridge University in 1987, Coventry University in 2007, and Bradford University and the Asian Institute of Technology in 2010. He is a Fellow of the Royal Society and is an honorary life

Atta-ur-Rahman

Fellow of Kings College, Cambridge University in the UK. He won the prestigious UNESCO Science Prize in 1999, several civil awards from the government of Pakistan, and international prizes that include the ECO Prize, Khwarazmi Award, ISESCO and Engro Prizes. He was conferred the TWAS Prize for institution building in 2009 and the Austrian government's highest civil award (*Grosse Goldene Ehrenzeischen am Bande*) in 2007 for bringing about revolutionary changes in higher education in Pakistan. He was chairman of the federal Higher Education Commission from 2002 to 2008 and Minister of Science and Technology from 2000-2002. Atta-ur-Rahman is currently the Coordinator General of the Organization of the Islamic Cooperation's (OIC) Standing Committee on Science and Technology (COMSTECH).

TWAS-AAS-MICROSOFT AWARD

• Three African scientists were awarded the 2010 TWAS-AAS-Microsoft Award for Young Scientists. The award, funded by Microsoft Research, recognizes outstanding research in computer sciences conducted by young African scientists who have or show promise to have an impact in the developing world. The award ceremony took place on 26 February 2011 at the Hilton Hotel in Nairobi, Kenya, during the 5th TWAS-ROSSA (Regional Office for sub-Saharan Africa) Young Scientists' Conference. Each winner received a cash prize of EUR7,000. The winners were **Fayçal Djeffal**, associate professor in the Department of Electronics, Faculty of Technology, at the University of Batna in Algeria, for contributions to the development of new soft-computing-



Fayçal Djeffal

Konrad Scheffler

Moustafa Youssef

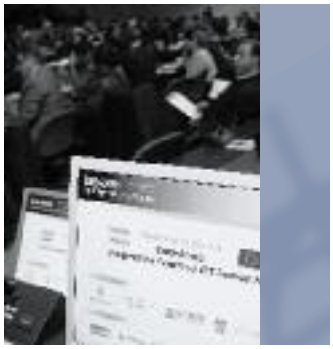
based approaches to study nanoscale electronic devices and circuits; **Konrad Scheffler**, associate professor in the Computer Science Division, Department of Mathematical Sciences, in Matieland, South Africa, for contributions to bioinformatics and computational biology, particularly in the modelling of molecular evolution; and **Moustafa Youssef**, assistant professor in the Department of Computer Science and Engineering, Egypt-Japan University of Science and Technology (E-JUST), in Alexandria, Egypt, for contributions to mobile and wireless networks, particularly in the design, analysis and implementation of location determination systems. For additional information, see twas.ictp.it/prog/prizes/twas-aas-microsoft-award.

TWAS-ROESEAP SYMPOSIUM

• The TWAS-ROESEAP (Regional Office for East and South-East Asia and Pacific) Symposium on Industrial Biotechnology was held at the Congress Centre "Vision Hotel" in Beijing, China, from 26-30 August. The objective of the symposium was to review the most recent progress in the area of industrial biotechnology in developing countries. The symposium provided an opportunity for researchers from developing countries to exchange ideas, share experiences and promote international collaboration to accelerate the commercialization of new products and new technologies. Discussions revolved around five major areas: biorefinery of fuels and chemicals; production of bulk fermentation products; biocatalysis and biotransformation; development of novel bio-based processes; and emerging disciplines such as industrial systems biology and industrial synthetic biology. The symposium was organized by the Chinese Academy of Sciences' Institute of Microbiology within the framework of activities carried out by TWAS-ROESEAP. For more information about TWAS-ROESEAP and its activities, see www.beijing.twas.org.

CENTRES OF EXCELLENCE

• The EuroAfrica-ICT project, of which TWAS is a participant, has launched a database of African centres of excellence in the field of information and communication technologies (ICTs). The database, which aims to provide key information to potential research collaborators, currently includes nearly 100 centres of excellence from 29 African countries. The next Euro-Africa-ICT event will be the 4th EuroAfrica-ICT Cooperation Forum



Euro-Africa

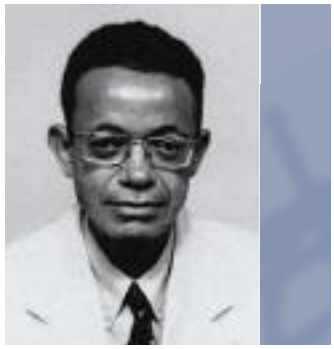
on ICT Research in Cape Town, South Africa, on 14-15 November 2011. For more information about the database and EuroAfrica-ICT project, see euroafrica-ict.org.

PRIZES FOR YOUNG SCIENTISTS

• The Pakistan Academy of Sciences and TWAS have announced two new prizes to honour young scientists from Pakistan, the "Abdus Salam Prize in Science" and the "Salimuzzaman Siddiqui Prize in Applied Science and Technology." The prizes replace the TWAS Prize for Young Scientists from Pakistan. The Pakistan Academy of Sciences will make an annual call for candidates. The two prizes follow the general framework of the TWAS Prizes for Young Scientists from Developing Countries. For more information, see twas.ictp.it/prog/prizes/twas-prizes-for-young-scientist-in-developing-countries.

IN MEMORIAM

• **Félix Malu wa Kalenga** (TWAS Founding Fellow) died on 29 April 2011 at age 74. Malu Wa Kalenga earned his MSc (1963) from University of California, Berkeley, USA, and PhD (1969) from Louvain University, Belgium. He was professor in the Faculty of Applied Sciences at the University of Kinshasa, Democratic Republic of the Congo; general commissioner of Atomic Energy, Congo; director, *Service Présidential d'Etudes* (SPE), Congo; and president of the National Science Council. He also served as a member of the Board of Governors, International Atomic Energy Agency (IAEA), Vienna; president of the General Conference, IAEA; and a member of the Board of the United Nations University, Tokyo, from



Félix Malu wa Kalenga

1977-83. He was granted several honours during his career, including Commandeur, National Order of the Leopard, Congo; International Prize, Energy for Mankind, USA; and Knight of the Order *La Pléïade*, France. He was a member of *Académie Royale des Sciences d'Outre-Mer*, Belgium; Pontifical Academy of Sciences, Vatican; and African Academy of Sciences, Nairobi, Kenya.

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 nearly 1,000 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:

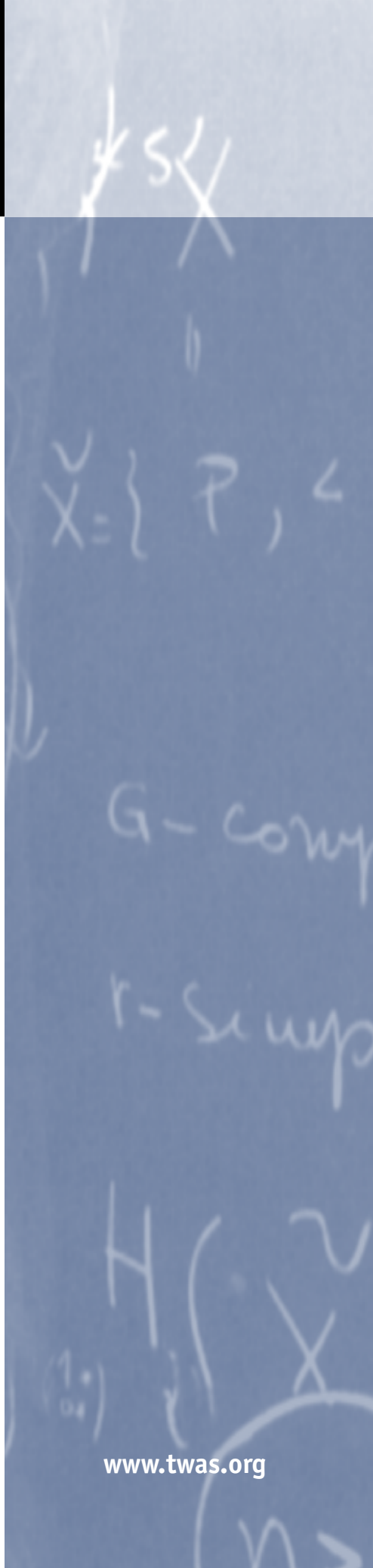
- Recognize, support and promote excellence in scientific research in the South.
- Provide promising scientists in the South with research facilities necessary for the advancement of their work.
- Facilitate contacts between individual scientists and institutions in the South.
- Encourage South-North 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 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 South-South and South-North partnerships in science and technology. ⋯⇢ **costis.g77.org**

TWAS also played a key role in the establishment, in 1993, of the Organization for Women in Science for the Developing World (OWSDW, formerly the Third World Organization for Women in Science, TWOWS). Some 3,200 women scientists from more than 90 countries in the South are members of OWSDW, making it the largest organization of women scientists in the world. Its main objectives are to promote the leadership of women in science and technology in the South and to strengthen the participation of women in science-based development and decision-making. The secretariat of OWSDW is hosted and assisted by TWAS.
⋯⇢ **www.twows.org**

Since 2000 TWAS has provided the secretariat for IAP, the global network of science academies. IAP, which was established in 1993 as the 'InterAcademy Panel on international issues', unites more than 100 science academies worldwide; provides high-quality independent information and advice on science and development to policymakers and the public; supports programmes on scientific capacity building, education and communication; and leads efforts to expand international science cooperation.
⋯⇢ **www.interacademies.net/iap**

Since 2004 TWAS has also hosted the secretariat of the InterAcademy Medical Panel (IAMP), an association of the world's medical academies and medical divisions of science academies. IAMP is committed to improving human health worldwide through the coordinated action of its 69 members. ⋯⇢ **www.iamp-online.org**



www.twas.org