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MARKING A NEW CHAPTER IN THE HISTORY OF TWAS, THE ACADEMY'S STEERING COMMITTEE MET FOR THE FIRST TIME ON 17 JANUARY 2007. THE MEETING TOOK PLACE IN TRIESTE, ITALY, AND WAS ATTENDED BY REPRESENTATIVES OF THE ITALIAN GOVERNMENT, WHICH IS TWAS'S CHIEF FINANCIAL SPONSOR, AND THE UNITED NATIONS EDUCATIONAL SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO), WHICH OVERSEES THE ACADEMY'S ADMINISTRATION.

Jacob Palis, the newly elected president of TWAS who presided over the meeting, noted that its creation reflected the "growing maturity of TWAS" and served as recognition that the Academy, given its increasing size and impact, needed "more formal mechanisms" for discussing its finances and programmatic activities with representatives from the Italian government and UNESCO.

The committee, Palis added, "is not only designed to oversee TWAS's budget and programmes, but also represents an opportunity for the Academy to officially discuss its work,

on an annual basis, with its two most important partners."

Adolfo Barattolo, deputy director-general for Italy's Ministry of Foreign Affairs, who led the Italian delegation attending the meeting, added that he

hoped "the committee's supervision would help the Academy function in even more efficient and effective ways."

Walter Erdelen, assistant director-general for natural sciences at UNESCO, observed that the Steering Committee "could serve as an important link between UNESCO and the Italian government and could help create closer cooperation among the international scientific organizations and research centres that are located in Italy and largely funded by the Italian government." He hoped, for example, that the committee could help open the door for stronger ties between TWAS and UNESCO's regional office in Venice.

The goals articulated by both Barattolo and Erdelen have been explicitly outlined in an official agreement signed by UNESCO and the Italian government in 1998. The agreement

TWAS Steering Committee Meets for the First Time

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STEERING MEMBERS

The TWAS Steering Committee is composed of one representative appointed by UNESCO; two representatives appointed by the Italian government; and two representatives from developing countries, one of which is designated by UNESCO's director-general and the other by the Italian government. In addition to Adolfo Barattolo, Walter Erdelen, Jacob Palis and Mohamed Hassan, members of the first Steering Committee include: Ismail Serageldin, director, Bibliotheca Alexandrina, Alexandria, Egypt, and Edoardo Vesentini, president, Accademia Nazionale dei Lincei, Rome, Italy.

calls for the Steering Committee to help maintain "proper coordination and rational use" of the resources at TWAS's disposal; to facilitate the functioning of TWAS's administration and programmatic activities; and to help ensure that the Academy's activities are coordinated with other international scientific institutions in Trieste and Italy, especially those operating under the aegis of UNESCO.

Specifically, the first meeting of the Steering Committee consisted of an overview of the Academy's strategic objectives and activities presented by Mohamed H.A. Hassan, TWAS's executive director; a review of the

2006 financial accounts; and a discussion of the prospects for locating a permanent home for the TWAS secretariat in Trieste.

The committee also formally approved the Academy's 2007 budget, including the financing of the Academy's affiliated organizations – the InterAcademy Panel on International Issues (IAP), the InterAcademy Medical Panel (IAMP), the Third World Organization for Women in Science (TWOWS) and the newly created Consortium for Science, Technology and Innovation for the South (COSTIS), which will operate in partnership with the Group of 77 and China.

"TWAS's first Steering Committee meeting enabled officials from all three organizations – the Italian government, UNESCO and TWAS – to begin a dialogue on the future direction of the Academy," says Palis.

"The seriousness and good will that drove our discussions indicate that we are off to a good start," Palis added. "I think I speak for all of the participants when I say that I am confident that this marks the beginning of a closer, more fruitful relationship that is likely to pay important dividends for advancing our shared objectives in mutually beneficial and effective ways." ■



BETTER RED THAN MED

WATER LEVELS IN THE DEAD SEA, A UNIQUE SALINE ENVIRONMENT, HAVE BEEN DECLINING OVER THE PAST 50 YEARS. FAROUK EL-BAZ (TAS FELLOW 1985) EXAMINES CURRENT PROPOSALS TO REPLENISH THE DEAD SEA BEFORE IT EVAPORATES INTO EXTINCTION. SUCH EFFORTS, HE SAYS, WOULD NOT ONLY ENSURE THE DEAD SEA'S LONG-TERM SURVIVAL BUT ALSO HELP TO REDUCE TENSIONS IN ONE OF THE WORLD'S MOST TROUBLED REGIONS.

In 1983, I visited the Dead Sea with my family. I fondly remember the high-pitched laughter that accompanied my daughters' repeated attempts to dive into the sea's tepid water. The harder they tried, the more difficult – indeed impossible – it became to sink beneath the surface.



erations. The sea is located in the Jordan Rift Valley on the border between Jordan to the east and Palestine and Israel to the west. Resting some 400 metres below sea level, its shores are the lowest areas of dry land on Earth, although some ice-encrusted sections in Antarctica

run deeper. It is also the saltiest body of water on our planet.

With salinity levels averaging in excess of 30 percent (producing a density that kept my daughters afloat despite their best efforts to submerge themselves), water in the Dead Sea is 10 times saltier than that of other seas (the Mediterranean, for example, has an average salinity of 3 percent). Even the world's seawater, with average salinity concentrations of 8 percent, is far less salty and buoyant than the Dead Sea.

More than two decades later, I still remember Prince El-Hassan Bin Talal of Jordan's response to my

The Dead Sea's relentless buoyancy has been known since the time of Aristotle (304-322 BCE) who wrote about a body of water "where no fish live and people float." The sea's glorious history, however, far predates the Greek philosopher's comments. It served as a refuge for King David; as the location for the cities of Sodom and Gomorrah; as a health resort for Herod the Great; and as the primary source of bitumen used to mummify the Egyptian pharaohs.

It goes without saying that the Dead Sea is a place of timeless wonder that has cast a spell on endless gen-



daughters' joyful experience. He smiled warmly. Then he quickly turned to a more serious subject, asking me to voice a scientific opinion on the options for its survival: "Med-Dead or Red-Dead?" he asked.

His comment was a shorthand reference to an issue of critical importance to the region and especially to Jordan, Israel and the Palestinian Authority, all of which border and have deeply rooted historical ties to the Dead Sea.

The sea is drying up at an increasingly rapid pace. Between 1970 and 2006, its water level dropped more than 5 percent, from 395 to 418 metres below sea level.

To reverse this alarming trend, water experts have proposed two alternative strategies, both of which would link the Dead Sea to other bodies of water. One strategy would involve digging a canal between the Dead Sea and the Mediterranean Sea, the so-called Med-Dead option. The other strategy would involve digging a canal and laying water pipes between the Dead Sea and the Red Sea, the so-called Red-Dead option. Prince El-Hassan, in effect, was asking whether, in my scientific opinion, I would prefer the Mediterranean or the Red Sea connection.

***The sea is drying up
at an increasingly
rapid pace.***

The Dead Sea draws on two sources of water. By far the major source is the Jordan River, which flows through Syria, Lebanon, Jordan and Israel. A tranquil setting and scorching temperatures lead to rapid rates of evaporation. Average winter temperatures along the sea's coast range between 20° and 35°C and rarely drop below 10°C. In summer, meanwhile, temperatures average a searing 30° to 40°C.

Yet, until the 1950s, the rate of water intake roughly equalled the rate of water loss due to evaporation. That changed, however, as Israel and, to a lesser extent, Jordan and Syria began to extract upstream

water from the Jordan River to meet the demands of their growing populations. Less than 7 percent of the upstream flow of the Jordan River currently reaches the sea, largely because of diversions made for irrigation and drinking water in support of expanding populations.

The second, less significant, source of water for the Dead Sea comes from three sparsely rain-fed channels lying to the east — Wadis Mujib, Karak and Hasa. The proliferation of irrigated farms, which draw water from these wadis, has contributed to reducing inflow to the Dead Sea.



Over the past half century, water levels in the Dead Sea have fallen at a rate of roughly one metre per year. The surface area of the sea, which was 1,000 square kilometres in 1960, has shrunk to 670 square kilometres today. While people may not be able to sink in the Dead Sea, they may soon be able to stand on its bed without getting wet. Experts estimate that if the current rate of depletion continues, the Dead Sea could disappear within the next half century, turning into an exposed environment of rock, salt and sand.

REVIVING THE DEAD

Proposals for connecting the Mediterranean Sea to the Dead Sea were formulated well before the current water crisis. Indeed they were first discussed in the mid 19th century as a way for the region to take advantage of the labour-saving benefits of water mills. Such proposals became even more appealing with the advent of hydropower for the production of electricity.

Proponents theorized that the 400-metre drop in terrain between the Mediterranean and Dead Seas

would enable the downward flow of water to drive turbines that could turn mechanical energy into electricity. Theodor Herzl, one of the fathers of Zionism, popularized the idea in his 1902 novel, *Altneuland*, or *Old New Land*. Three-quarters of a century later, US-based groups revived the idea by drafting workable construction plans, contending that the overall benefits of the

project would far outweigh its costs.

This so-called Gaza-to-Masada canal, designed by the Mediterranean Dead Sea Company in 1983, would traverse the Mediterranean coast and then cross the Gaza and Negev Deserts and parts of the west bank of the Jordan River.

The Dead Sea would undoubtedly be replenished. But there is also a distinct danger that salt water would seep into the substrate (through porous bedrock and/or fractures) to mix with the groundwater and increase its salinity. The Dead Sea would be saved but at the risk of reducing supplies of fresh drinking water in a region where every drop counts. Many observers, including myself, concluded that the trade-off was unacceptable.

Red-Dead has become the only strategy discussed by the international scientific community.

When I conveyed this concern to Prince El-Hassan, with supporting data from space images, he told me that Jordanian groundwater experts shared this fear.

Following the Jordan-Israel Peace Treaty of 1994, both options were again considered. A consensus was reached that the Red-Dead, and not the Med-Dead, option would be the best strategy for saving the Dead Sea from extinction. Over the past decade, the Red-Dead has become the only strategy discussed by the international scientific community.

The Red-Dead project calls for the construction of either a canal and/or pipelines to carry water from the northern tip of the Gulf of Aqaba in Jordan some 200 kilometres northward to the Dead Sea. The gradient would be sufficient to create a rush of water capable of both generating electrical power and channelling the

canal would amount to some US\$5 billion compared to only US\$800 million for the construction of a pipeline, which would preclude the development of tourist facilities.

HELLO SUN, GOOD-BYE ALLERGIES

The long-term economic value of the Red-Dead solution largely resides in its potential to generate tourism across the region. Low elevations, extraordinary salt concentrations and high evaporation rates create a thick haze over the Dead Sea.

In most places, such conditions would deter tourists. But that's not the case here. That's because the haze blocks ultraviolet B rays that cause sunburn, allowing tourists to bask in the sun without fearing for their health. The air, moreover, is oxygen-rich and



water through saline-filtering membranes for desalination. Most importantly, this solution would ultimately refill the Dead Sea to its original level, a process that could take 10 to 20 years to complete, depending on the amount of water pumped.

The intent of the Red-Dead project is to restore the level of water in the Dead Sea to the level of 1930, which environmentalists who have studied the Dead Sea's bacteria, chemistry and salinity stratification deem the ideal level. The Red-Dead canal/pipeline, simply put, is designed to return the Dead Sea to its former state.

Cost, of course, also enters into the calculations. Experts generally agree that the construction of a

pollen-free. Thus 'therapeutic skin tourism' flourishes year round.

At present, the most attractive blueprint for the Red-Dead project calls for the construction of a canal six or seven kilometres north of Aqaba. As the canal reaches the high bluffs of Wadi Araba, which straddles Jordan and Israel, a subterranean pipeline would pick up where the canal left off and continue northward, ultimately discharging water into the Dead Sea. When fully operational, the system would channel 1,900 million cubic tonnes of water a year into the sea, gradually raising the sea to its historic levels. Proponents of this option also note that there would be an enduring



aesthetic value to such work and that the shorelines could be used for recreation and tourism.

A project of this size, of course, must be subjected to cost-benefit analyses. In addition to the financial costs already discussed, environmentalists have also warned about potential environmental damage. They suggest that mixing water from the Red Sea with the unique aquatic system of the Dead Sea may cause many changes. They contend, for instance, that combining marine water with the delicate mix of bromide, potash, magnesium and other salts of the Dead Sea could induce algal growth or even produce toxic emissions. The colour of the water could change from blue to red to brown, and the water itself, with diverse chemical compositions, could actually separate into distinctive layers. The consequences would not only be unsightly but could also create unpredictable ecological problems.

Yet, if all works out, there would undoubtedly be appealing benefits, including the provision of energy, fresh (desalinated) water, and new potentially profitable venues for tourism. All of this, of course, means

added jobs in a region where steady employment is in short supply.

These potential benefits are not lost on Prince El-Hassan, who has just asked a committee of experts to present what he hopes will be the last scientific evaluation of the Red-Dead project – an evaluation that will likely lend strong support for moving ahead.

Perhaps more importantly, the cross-border cooperation between Jordan, Israel and Palestine inherent in such a project could help to nurture a sense of goodwill in a troubled region. Such a development would ultimately dwarf any financial considerations, no matter

how significant they may be.

We've tried 'atoms for peace'. Perhaps it's now time to turn to 'water for peace'. ■

***We've tried 'atoms
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❖❖❖ **Farouk El-Baz (TWAS Fellow 1985)**
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SUNLIGHT AND SHADOWS IN THE SOUTH

MOHAMED H.A. HASSAN, EXECUTIVE DIRECTOR OF TWAS, GAVE ONE OF FOUR PLENARY LECTURES AT THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS) 2007 ANNUAL MEETING, HELD IN SAN FRANCISCO, USA, FROM 15 TO 19 FEBRUARY. IN HIS SPEECH, HASSAN OUTLINED CURRENT TRENDS IN SCIENCE, TECHNOLOGY AND INNOVATION IN THE DEVELOPING WORLD BY POINTING TO GREAT ADVANCES IN SOME PLACES AND STAGNATION IN OTHERS. HE ALSO HIGHLIGHTED THE ROLE THAT INTERNATIONAL COOPERATION IN SCIENCE MUST PLAY IF NO NATION IS TO BE LEFT BEHIND IN A WORLD WHERE SCIENCE AND TECHNOLOGY DRIVE AND SUSTAIN ECONOMIC DEVELOPMENT.

As some developing nations invest more in science, technology and innovation, others continue to lag behind. That, in turn, has given rise to a new, more refined, categorization of countries that better reflects a nation's relative strengths in science, technology and innovation.

First, there are countries with strong science, technology and innovation capacity. These number about 25, largely consisting of countries that belong to the Organization of

Economic Cooperation and Development (OECD). They also enjoy across-the-board strengths in all areas of science and technology and have the capacity to transfer scientific and technological knowledge into products and services that boost their economies. These countries are rich in science, technology and innovation and financially well-off as well.

Second, there are countries with moderate science, technology and innovation capacity. These countries,

which number about 100, include some of the largest countries in the developing world – China, India and Brazil. But the list includes others as well: Argentina, Chile, Malaysia, Mexico and South Africa, to name just a few. It is a diverse group with wide-ranging capabilities. The majority have a degree of competence in a select number of fields. But broad pockets of weakness remain and the scientific infrastructure, including classrooms and laboratories, while improving, still

often trails the quality of instruction and equipment found among countries with strong science, technology and innovation capacities.

The ability of these countries to successfully bring their scientific knowledge and technical know-how to the marketplace is weak, although recent indicators suggest that this transition is becoming less problematic in a few countries. In February 2007, for example, the World Intellectual Property Organization (WIPO) reported that while the United States still leads the world in patent applications, Asia is rapidly narrowing the gap. China filed nearly 4,000 patent applications in 2006, more than double the year before. "New centres of innovation, particularly in northeast Asia, are emerging," a WIPO official has noted, "and this is transforming both the geography of the patent system and of future growth."

That is the good news. The bad news is that there is a third category of countries marked by weak science, technology and innovation capacity. A survey conducted by TWAS has identified 79 such countries, the majority of which are in sub-Saharan Africa and the Islamic region. These countries have very limited capacity in every field of science and technology. They have poor teaching facilities, substandard laboratories, and scant ability to transfer their knowledge and know-how into products and services, especially products and services that can compete in the international market place. Researchers in these countries lack the capacity to participate in cutting-edge scientific endeavours and many

of their most promising young scientists migrate to other nations to pursue their careers. In the majority of these countries, there is minimal government support for science, technology and innovation. More generally, there is the absence of a culture of science.

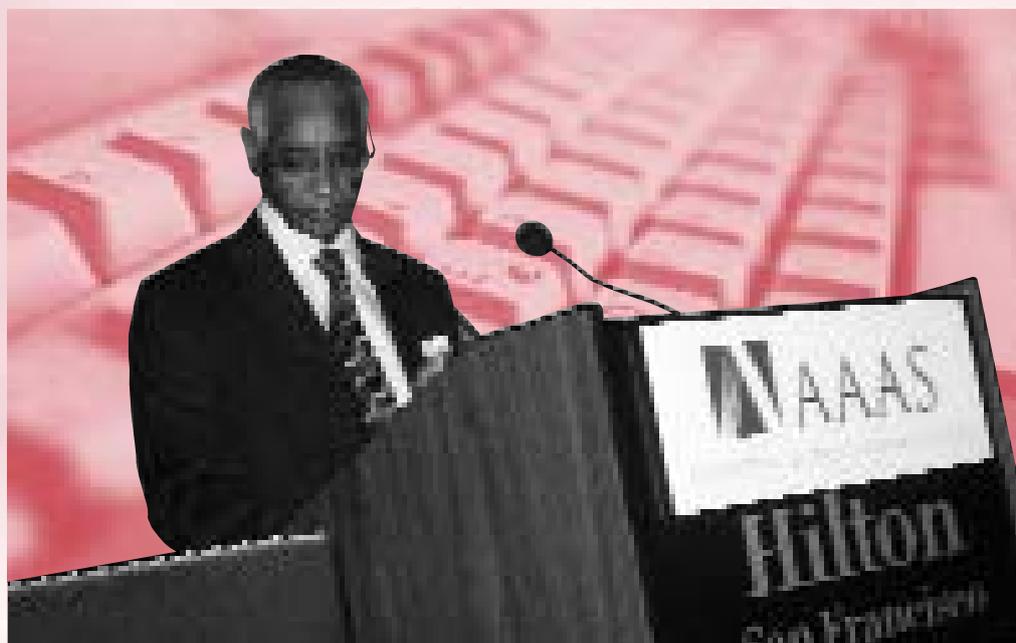
Thus the first and most significant challenge for international cooperation in science, technology and innovation is this: *How can international cooperation help reduce the divisions between nations, particularly the divisions that exist between scientifically strong and scientifically moderate nations and the 79 countries that TWAS has identified as weak in science, technology and innovation?*

Expanding the reach of science, technology and innovation to countries that have been largely left behind is one of the most critical problems of our time. But it is by no means the only one.

The problems of sustainable well-being are increasingly complex and global in their dimensions. Yet, the people who are most vulnerable to the risks posed by global assaults on the environment are often the most impoverished and marginalized people eking out an existence in the developing world.

In our interconnected world, where the internet and airline travel have truly transformed our planet into a global community, no country can fully escape the acute problems that plague other nations.

That is the message encapsulated in the Millennium Development Goals (MDGs), approved by member states of the United Nations in 2000. These goals set targets to address the world's most pressing problems – problems that stand in the way of sustainable well-being in the developing world and that threaten global peace and harmony: poverty, hunger, the spread of infectious diseases, poor education, gen-



der inequality, and lack of access to safe drinking water, sanitation and energy.

To help make progress on all these fronts, the MDGs' eighth and final measure calls for the creation of global partnerships that tap the collective talents of individuals and institutions in both the developed and developing worlds.

Experts agree that the MDGs have no chance of being met unless special attention is paid to problems of well-being – or should we say, ill-being – that exist in Africa. More than 40 percent of all Africans do not have access to safe drinking water. Seventy percent do not have access to electricity. Twenty-five million Africans are infected with HIV/AIDS, more than 60 percent of the world's total. Ninety percent of the world's malaria victims, numbering more than one million people each year, reside in Africa. Agriculture is the main source of sustenance and income for 70 percent of all Africans. Yet, in Africa, 30 million children go to bed hungry every night.

Africa may be poor, but it is not small. Its land mass, which is more than 20 percent of the Earth's land mass, covers an area larger than Australia, Brazil, Europe and the United States combined. And Africa may be weak, but it is home to some 700 million people. That's more than twice the population of the United States. Africa, in short, may be poor and weak but it cannot be ignored. In many respects, the future of our planet lies with the future of Africa. Africa, simply put, is where global attention must be focused if we are

to make progress in meeting the MDGs.

But that still leaves open the question of what tools must be summoned in our efforts to succeed. The fact is that the MDGs will not be met without strong capacity to generate and utilize science, technology and innovation and without vigorous and sustained international partnerships to help build this capacity.

As the MDGs indicate, the vast majority of these problems are related to poverty, inadequate education, poor health and degraded environmental conditions, all of which undermine society's ability to meet the basic human needs of its citizens.

Other global issues, which affect both the developed and developing world in equal measure, carry growing significance too. Global climate change is at the top of this list. But there are also issues related to energy security, access to adequate supplies of drinking water, and the over-exploitation of such natural resources as fisheries and forests.

Consequently, the second major challenge is this: *How can international collaboration in science, technology and innovation assist in solving urgent global problems facing the world today?*

Reducing the gap between rich and poor countries, and ensuring that the most critical global issues are tackled with tools that only global science, technology and innovation can provide, are daunting challenges. But these challenges cannot

be met unless a critical mass of well-trained scientists is present in all countries.

Today, experts estimate that more scientists who have been educated and trained in universities in sub-Saharan Africa have migrated to the United States than have remained in Africa. The World Bank has concluded that while skilled labourers account for just 4 percent of sub-Sahara Africa's workforce, they represent about 40 percent of its emigrants.

Experience has shown that brain drain cannot be stopped unless the most talented scientists find favourable working conditions in their homelands. Yet, as Rajiv Gandhi, the eldest son of Indira Gandhi and former prime minister of India, has noted: "Better brain drain than brain in the drain." Once a scientist has left and established roots in another country, it is difficult to lure him or her back home, although China, South Korea and Taiwan have been exceptions to this rule. Experience has also shown that a nation's scientific diaspora can be tapped, through international scientific exchange, in ways that could prove beneficial to both the scientists' host and adopted countries.

So the third challenge for international cooperation in science, technology and innovation is this: *How can global cooperation assist in converting the brain drain into brain circulation, providing benefits for both scientists and the scientific community regardless of where a scientist was born and where he or she chooses to live and work?*

Science is a global enterprise, and excellence in science has always depended on the ability of scientists to associate freely with their colleagues around the world. Such movement not only benefits international science but also serves to deepen international understanding and appreciation of cultural diversity – a welcome by-product in today's troubled world. Yet, as we all know, the free circulation of scientists, especially to the United States, has been severely restricted since the terrorist attacks in New York City and Washington, DC, in 2001.

The scientific community fully recognizes that security interests take precedence over scientific exchange. Nevertheless, it also recognizes that scientific exchange is an important instrument in the fight against ignorance, suspicion, hopelessness and terrorism.

The US State Department, urged by the US National Academy of Sciences and others, has recently taken steps to ease the burden of entry into the United States for scientists travelling from abroad. But many of our colleagues, particularly those from Africa and the Islamic region, hope that more can be done. Governments in the developing world are also discussing – and, in some cases, implementing – strategies to facilitate foreign travel by their scientists. For example, earlier this year, the foreign ministers of the African Union endorsed a proposal to grant diplomatic passports to African scientists to ease their travel across Africa.

While individual scientists from the developing world would directly

benefit from these measures, no country would benefit more than the United States. Despite its inhospitable attitudes over the past few years, the United States remains the destination of choice for the most talented students and scientists from the developing world. As critics of the policy within the United States have noted, many of the nation's top graduate programmes in science and engineering would be severely handicapped if foreign students stayed home. It is also worth pointing out that nearly half of all US Nobel laureates since 1990 are foreign-born.

Therefore, the fourth major challenge impeding international scientific cooperation is this: *How can the global scientific community persuade governments, especially the United States, to ease visa problems faced by scientists from the developing world, particularly scientists from the most impoverished and troubled regions of the developing world?*

'Information wants to be free' is the clarion call of those of us who promote its free exchange. But what we often fail to emphasize is that information – that is, quality information – is expensive to produce.

The internet and other forms of electronic communication have revolutionized the way in which scientific information is distributed, reviewed, edited and published. These trends have had an enormously positive impact on global science.

Never before have scientists in the developing world enjoyed access to such an extensive amount of current information. Never before have

scientists been able to communicate so easily and directly with their colleagues in other parts of the world. And never before has international scientific collaboration been so easy to plan, organize and implement.

But critical issues remain. Developing countries, particularly the





poorest developing countries, often do not have sufficient resources and expertise to build and maintain up-to-date electronic communications systems. Bandwidth is still too narrow in much of the developing world, and expensive on-line subscription rates prevent many scientists from having access to the most current literature.

So the fifth challenge is this: *How does the global scientific community help ensure that scientists in all nations have access to new information and communication technologies and to the most current scientific literature?*

The challenges for international cooperation in science, technology and innovation for sustainable well-being are many. I have just touched on the most significant ones. Now I would like to turn to the bright side of the equation: The opportunities for international cooperation, which are no less numerous and no less significant than the challenges. In some cases, they are one and the same.

There are new fields of science and new cutting-edge technologies, which promise to have extraordinary impacts on global well-being.

- *Information and communication technologies (ICTs)* are not just highly specialized fields in their own right but also ‘enabling’ forces that help to advance all fields of science and technology. ICTs, in fact, have led to a melding of fundamental and experimental research through the facilitation of mathematical modeling.

- *Biotechnology* is having a strong impact on agriculture, public health, medicine and environmental science, transforming each in new and unexpected ways.

- *Nanotechnology* promises to revolutionize materials science; to bring physics, biology and chemistry closer together; and, ultimately, to have broad-ranging implications in a variety of critical areas, including water, energy, human health and the environment.

- *Space science and technology* help us to monitor environmental change and devise effective responses to a host of ecological problems, including deforestation and desertification.

Several developing countries, especially those with growing scientific and technological capabilities, have been eager to embrace and to pursue these new technologies.

China and Brazil, for example, have joined together in an initiative leading to the launch of two satellites designed to chart land and ocean resources. Two more satellites are planned for 2008. Nigeria has launched two remote sensing satellites and will launch its first communications satellite, in collaboration with China, this year.

China is investing substantial sums of money in nanoscience and

nanotechnology. That investment is paying off handsomely in terms of publications. In fact, a recent survey found that, in 2004, Chinese scientists published the largest number of papers on nanotechnology in international peer-reviewed journals, exceeding the number of papers published by scientists in the United States. Brazil, India and South Africa are also making substantial investments in nanotechnology.

India’s investment in ICTs is well known. The nation now enjoys world-class status in this field and is home to a number of corporations that rank among the largest and most influential in the world, including Infosys, Wipro and Tata Consultancy Services.

Brazil, Malaysia, Pakistan, South Africa and many other developing countries have all invested enormous resources in the development and expansion of ICTs. And let us not forget that South Korea, a nation that in 1962 had a gross national product of just US\$2.3 billion (comparable to that of Uganda) embraced ICTs as one of the key sectors in its plans for long-term sustainable growth – first in terms of telephony technologies and more recently in terms of the internet. Today South Korea’s GDP, which exceeds US\$765 billion, ranks 11th in the world.

Then, there is the field of biotechnology. Again, developing countries have taken significant steps in joining the global scientific community. Malaysia, for example, has embarked on a broad-based biotechnology programme to increase national wealth

and improve the well-being of its citizens. China has made biotechnology a top priority, launching five large biotechnology research centres. In Africa, Nigeria has developed a national biotechnology policy and Ghana has drafted a bio-safety law that is now awaiting legislative approval. Governments across Africa have acknowledged the need to develop capacity in biotechnology and are now trying to match their rhetoric with action.

All of this adds up to new opportunities for international cooperation in science, technology and innovation – opportunities that hold the promise to advance both science and sustainable well-being.

Science for the sake of science is no longer sufficient justification for doing science in many parts of the world where budgets are limited.

Today increasing attention is being paid to creating organizations and even disciplines that focus on the complex interactions between human and environmental systems. We have seen this effort unfold in the development of a series of conferences held by the United Nations during the 1980s and 1990s, culminating in the World Summit on Sustainable Development held in Johannesburg, South Africa, in 2002.

And we have seen this in the creation of an international project aimed at linking knowledge to action: the Initiative for Science and Technology for Sustainability (ISTS) at the Kennedy School of Government at Harvard University, USA. TWAS is delighted to be a partner in this effort, joining the US National Academy of Sciences, AAAS and

many other research institutions in both the developed and developing world.

ISTS has done an excellent job in articulating the principles of sustainability science and of raising the profile of this concept in both the scientific and development communities. It has done an equally impressive job of highlighting examples of sustainability science and creating a broad conceptual framework for understanding why certain institutions devoted to science-based sustainable development succeed, while others do not.

As mentioned, not only have countries like Brazil, China and India made increasing commitments to science, technology and innovation; they have been joined by other countries such as Chile, Malaysia, Mexico, Pakistan and South Africa.

Yet political leaders in low-income countries with low scientific and technological capabilities are also making increasing commitments to both research and development and regional cooperation in science and technology.

For example, at the African Union (AU) Summit, held in January 2007 in Addis Ababa, Ethiopia, 53 African leaders discussed regional strategies for the promotion of science and technology. They announced that 2007 would be the year of African scientific innovation. And they also agreed to focus on issues related to science and technology at the next African Union summit to take place in Accra, Ghana, this July.

Africa's leaders have expressed support for science and technology

in the past. But the meetings were followed by meagre results and ultimately disappointment and despair. This time the level of commitment – and enthusiasm – is different. And this time the results could well be different.

Leaders at the AU Summit strongly recommended that each African country should spend at least 1 percent of its GDP on science and technology. Such a recommendation has been made several times before. This time, however, it may actually be fulfilled.

In fact, several African nations, most notably those that have also embraced democracy and good governance, have increased their investments in science and technology in a substantial way. These countries include Ghana, Kenya, Nigeria, Rwanda, South Africa, Tanzania and Zambia.

The government of Nigeria, for example, has provided US\$5 million to launch an endowment fund for the African Academy of Sciences. Nigeria has also announced plans to launch its own national science foundation, modelled after the US National Science Foundation. It has pledged US\$5 billion to the founda-





that his country has dramatically boosted expenditures on science and technology from less than 0.5 percent of GDP a few years ago to 1.6 percent today. He also publicly committed his nation to increase investments in science and technology to 3 percent of GDP within the next five years. That would make Rwanda's investment in science and technology, percentage-wise, comparable to that of South Korea and higher than most developed countries. A nation teetering on collapse less than a decade ago and still living in the shadow of genocide has embarked on a path leading to science-based sustainable development. Rwanda remains poor, but it is no longer hopelessly poor.

Last year, Uganda received a US\$25 million loan from the World Bank to support science and technology within the country, including the creation of centres of scientific excellence that will not only serve Uganda but also the entire region. The grant was given, in part, because of Uganda's successful efforts to build its own scientific and technological capacities, particularly in the fields of public health and agricultural science.

This year, Zambia will receive a US\$30 million loan from the African Development Bank to support teaching and research at the University of Zambia and to provide postgraduate fellowships to some 300 students majoring in science and engineering. At the AU Summit, the president of Zambia, Levy Patrick Mwanawasa, proclaimed that building capacity in science and technology is the only means to develop his country.

The president of Malawi, Bingu wa Mutharika, who heads one of the region's poorest countries, acknowledged at the AU Summit that building scientific and technological capacity provides the only sure way to break the long-standing cycle of extreme poverty that has gripped the African continent for decades. "We have depended on donor countries for scientific development for so long," he noted. "It is time we commit more resources in our national budget to advance science and technology." He urged his minister of finance to make science and technology a budget priority and to provide additional funds for this effort on a sustained basis. He also pledged to create international centres of excellence in the fields of hydrology and biotechnology.

What makes the prospects for international cooperation on science and technology for sustainable well-being so promising, even (or perhaps especially) when it comes to Africa, is that the global scientific community will not be acting alone in this effort.

Over the past several years, there have been increasing commitments by governments in the developed world, and particularly among G8 countries, to support science, technology and innovation in low-income countries and especially in Africa.

In 2005, the Commission for Africa Report, *Our Common Interest*, solicited by the United Kingdom's Prime Minister Tony Blair and published during the G8 Summit in Gleneagles, UK, called on G8 countries to provide US\$5 billion to help

tion's endowment fund, money that is to be derived from revenues generated by the nation's oil and gas industries. Only one nation in sub-Saharan Africa – South Africa – currently has a national science foundation.

At the AU Summit, the president of Rwanda, Paul Kagame, announced

rebuild Africa's universities. The report also called for investing an additional US\$3 billion to help establish centres of scientific excellence in Africa. The G8 member countries unanimously pledged to support these recommendations – a decision that was greeted with enthusiasm in Africa and throughout much of the world.

Yet, to date, G8 member countries have officially authorized only US\$160 million of support, targeted for the creation of networks of centres of excellence proposed by the AU's New Partnership for Africa's Development (NEPAD). Equally distressing, little of this money has actually been transferred to Africa. The international scientific community has an important stake in the success of this initiative and it must continue to urge G8 countries to fulfil the pledges that they made in Gleneagles some 18 months ago.

The World Bank, through the Science Institutes Group (SIG), based at the Institute for Advanced Study in Princeton, New Jersey, USA, has provided loans for the creation of scientific centres of excellence – so-called Millennium Science Institutes – in Brazil, Chile, Turkey and Uganda. The institutes offer scientists from developing countries an opportunity to conduct world-class research and to pursue cooperative projects with colleagues in a broad-range of scientific fields.

Several foundations have supported projects in science-poor countries that emphasize scientific and technological capacity building. Many of these efforts have focused

ONE OF FOUR

The other plenary lecturers at the AAAS 2007 Annual Meeting in San Francisco included John H. Holdren, AAAS president and director of Woods Hole Research Center and John Heinz Professor of Environmental Policy at Harvard University; Larry Page, co-founder of Google; Nobel Laureate Steven Chu, director of Lawrence Berkeley National Laboratory and professor of physics and applied physics at Stanford University; and Susan Solomon, co-chair, Working Group 1, Intergovernmental Panel on Climate Change (IPCC), and senior scientist at the US National Oceanic and Atmospheric Administration (NOAA). The AAAS is the world's largest general scientific society and the publisher of Science magazine. The annual meeting drew more than 5,000 people. For additional information, see www.aaas.org.

on education and training for young scientists in the world's least developed countries.

Rising levels of scientific excellence in developing countries – most notably, Brazil, China, India and South Africa – have opened new opportunities for South-South collaboration in education and research.

- Agreements, for example, have been signed between TWAS and the governments of Brazil, China, India and Pakistan to provide more than 250 scholarships a year to graduate and postgraduate students in developing countries to attend universities in the donor countries. TWAS pays for the plane ticket. The host countries pay for all other expenses, including accommodation and meals. This is the largest South-South fellowship programme in the world.
- Brazil's pro-Africa programme supports scientific and technological capacity building in the Portuguese-speaking countries of Angola and

Mozambique. The programme includes research collaboration activities with Brazilian institutions.

- China's Development Fund for Africa, approved in 2006, will provide US\$5 billion over the next five years to assist African countries to achieve the MDGs through cooperation with China.



- The joint Brazil, India and Senegal biofuels project in Senegal will seek to transfer Brazil and India's expertise in the development of biofuels to one of Africa's most scientifically proficient nations.
- The India, Brazil and South Africa (IBSA) tripartite initiative, signed by the ministries of science and technology, will provide funds to engage in joint problem-solving projects that focus on developing products with commercial value.

What does all of this rush of activity add up to? Is it just another episode of fleeting interest in countries and in people that have been left behind? Or are we entering a new era marked by sustained investments in science, technology and innovation, not just in the developed world but, increasingly, in the developing world as well?

I believe that we have more reason for optimism than cynicism, and that we may indeed be witnessing the beginning of a transformational moment in global science and science-based sustainable development.

But for us to seize this moment, we need to develop and implement an action agenda designed to sustain

– and expand – international cooperation in science, technology and innovation.

The Intergovernmental Panel on Climate Change (IPCC), when issuing its 'policy summary' in February, proclaimed that we had reached a 'tipping point' in our understanding of climate change. As Susan Solomon and other scientists who participated in this sterling example of international cooperation in science noted, it was now "unequivocally" true – indeed more than 90 percent certain – that human activities are responsible for altering our climate and for causing a significant rise in average global temperatures.

We have reached another tipping point as well. This tipping point has to do with the growing capabilities in science and technology across the globe. These capabilities are rapidly transforming our existing bipolar world of science and technology – anchored in North America and Europe – into a multipolar world of science marked by the growing capabilities of Brazil, China, India, Malaysia, South Africa and other nations.

As the list of developing countries that garner strength in science and technology increases in the coming years, the key question is this: will just a handful of additional countries become scientifically strong, while the rest are left behind? Or will international cooperation in science and technology help all countries into the fold – ultimately transforming science-based sustainable well-being into a global phenomenon?

The answer to this question lies, in part, in how the international scientific community responds to the challenges and opportunities that stand before it.

The chances for success have rarely been brighter. The consequences of neglect and indifference have rarely been more troubling. The international science community should seize this moment. If we don't, it could well fade into history as a lost opportunity that we – as both scientists and citizens – can ill afford to lose. ■

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ON 16 JANUARY 2007, TWIN BOMBINGS AT MUSTANSIRIYA UNIVERSITY, LOCATED IN A MIDDLE-CLASS NEIGHBOURHOOD IN THE CENTRE OF BAGHDAD, KILLED MORE THAN 60 IRAQI STUDENTS AND MAIMED AND INJURED HUNDREDS OF OTHERS. THE VICTIMS WERE MOSTLY YOUNG WOMEN EITHER ON THEIR WAY TO CLASS OR LEAVING CAMPUS TO RETURN HOME.

LIFE AND DEATH IN IRAQ

“I saw unbelievable things,” Dyana Ayad, a 20-year-old student, later told reporters. Ayad had just completed her Arabic elocution class and was leisurely joining a crowd of fellow students at a campus bus stop when the bombs went off. “There were tiny pieces of papers, burned papers everywhere. And dark smoke, white smoke. I saw arms, legs, body parts flying in the air. The sky was raining burning paper and body parts.”

The attack took place less than a kilometre from the home of Jerew Dakhil, a long-time Iraqi researcher and science administrator who is currently serving as president of the Iraqi Academy of Sciences.

In 2006, Dakhil was elected to TWAS, becoming just the third Iraqi scientist to receive this recognition (the first, Salih J. Wakil, was elected an Associate Fellow in 1998, and the second, Saleh Hussein, was elected a Fellow in 2005).

Dakhil was honoured for his contributions to the research and development of control systems engineering, electronic and computer engineering and informatics and computer software, as well as for his efforts to promote the teaching and research of science and engineering in Iraq.

On 17 January, the day after the bombings, the editor of the *TWAS Newsletter* conducted a telephone interview with Dakhil. Excerpts follow.

What is daily life like in Iraq?

In a word, terrible. In two words, terrible and deadly. In the immediate aftermath of the US-led invasion in March 2003 we experienced a period of looting. The Iraqi Academy of Sciences suffered the same fate as many other institutions across the nation and especially in Baghdad. Equipment was destroyed or stolen. Books and journals too. Funding completely stopped.



Jerew Dakhili

Salaries went unpaid. We faced desperate financial circumstances and found that it was virtually impossible to work. I had neither a desk nor chair in my office, a situation that lasted for nearly two years. Yet, for the most part, we could walk the streets without fear of being shot. That was basically the situation from 2003 to 2004. Over the past two years, the Iraqi government has released a significant amount of funds for the academy and other educational and cultural institutions. We

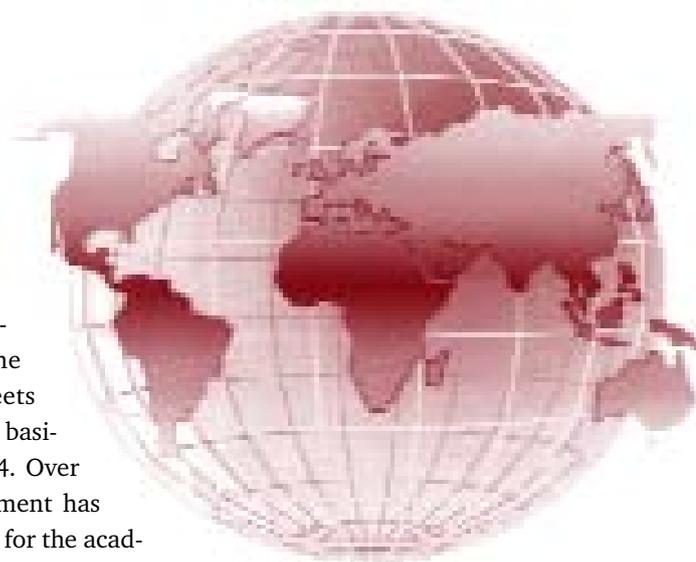
are now being paid. And we have received enough money to refurbish our offices, purchase equipment and recover some of the books and journals that were lost to looters. However, the security situation has grown steadily worse and I must say that it is now dire. A few days ago, a friend of mine who worked at the University of Technology, where I had previously served as president, was kidnapped. We have not heard from him since. Just yesterday, a coordinated mid-

day bombing attack at Mustansiriya University killed 60 students. The randomness and persistence of the violence means that no one is safe. Even more unsettling, insurgents seem to be targetting university professors and, increasingly, students. Hunting them down. It's estimated that some 500 academics, including 180 in just the past year, have been killed. The only thing that has improved since the invasion is the internet connection. This has allowed us to keep up-to-date with scientific and political information from the outside world. The academy continues to publish books and to issue the *Iraqi Journal of Science*. But we can no longer hold meetings or seminars. It's simply too dangerous for people to come. I try to go to the office each day for a couple of hours. But I vary my times and take different routes when I come and go.

Tell us about the Iraqi Academy of Sciences.

Created in 1947, the Iraqi Academy of Sciences is the oldest active science academy in Iraq. In the region, only the Egyptian and Syrian Arabic language academies are older. The

Iraqi academy is involved in all spheres of knowledge, ranging from the basic sciences to the humanities. For example, in addition to concentrating on biology, chemistry, physics and the other natural sciences, the academy has a department in the applied sciences that focuses on agriculture, engineering and medicine. There's also a humanities department that is responsible for the fields of economics, history, geography, law, social science and philosophy. And there's an Arabic/Islamic heritage department, which collects and examines information on





cultural and historical issues that have shaped the region. The 50 to 60 books that we publish each year are largely Arabic texts. We currently have 37 'active' members (a number set by our statutes). They are eminent scientists and scholars in a broad range of fields, supported by a large number of scientists designated as associate members. Iraq is home to one of the world's oldest civilizations and enjoys a deeply rooted tradition for honouring and rewarding those who pursue knowledge. The academy is well positioned to continue and expand on that tradition. In fact, the president of the academy

reports directly to the prime minister and enjoys the same official status as other government ministers. But for the moment we are paralyzed by the violence and fear that grips our nation. Until issues of security are satisfactorily addressed and people are safe, it is difficult to envision that any progress can be made in advancing the academy's worthy goals.

Describe what your childhood was like and what led you to become an academic and university administrator.

I was born in 1942 in a small town in Al-Samawah in southern Iraq. I was the eldest of eight children and grew up with three brothers and four sisters. Both of my parents were illiterate. My mother truly valued education and insisted that I go to school. Thanks to her encouragement, I attended one of the two primary schools in my hometown. As one of the top students in my class, I received a government scholarship in 1960 to study at Imperial College in London, where I earned a bachelor of sciences degree in electrical engineering. I then went on to obtain two advanced degrees from the UK's Brunel University – a master's in systems engineering in 1967 and a doctorate in electronic engineering in 1972. Upon graduation, I decided to return to Iraq for both personal and professional reasons and I have rarely regretted that decision. I have enjoyed an interesting and diverse career as a researcher, teacher and administrator. As a child, I dreamed of being an engineer and I am thankful to have been given the opportunity to fulfil this dream and to make, I believe, important contributions to both science and to my country.



Please tell us about your research.

I have pursued a variety of research topics over the course of my career focusing largely on two fields. My first field of research is automatic control systems engineering, where I have investigated the so-called Eigenvalue and Eigenvector sensitivity problem of multivariable control systems largely related to environmental degradation and the ageing of components. I have also examined the global stability of model adaptive control systems and the so-called 'learning con-

trol method' designed to improve the efficiency of repetitive tasks performed by robots. My second field of research is informatics and computer systems engineering, where I have worked on microprocessors and machine language translation. I have focused on Arabic text-to-speech analysis, leading to an extensive set of rules for the conversion of Arabic texts. In addition to my own research, I have spent a great deal of time trying to improve technical education in Iraq, largely by promoting vocational training, continuing education and, most recently, electronic and virtual learning. In terms of administration, I served as president of Basrah University from 1985 to 1993 and the University of Technology from 1993 to 2001, focusing a good deal of my attention on expanding the faculties of science and technology. In terms of science policy, I headed the Iraqi Board of Scientific Research from 1994 to 1996 and the Iraqi Commission of Innovation from 1999 to 2002. Between 2001 and 2002, I was president of the Commission of Technical Education, a national agency that operated within the office of the minister of higher education and scientific research. The commission's primary responsibility was to provide oversight to Iraq's nine pre-eminent colleges of technology and 27 technical institutes with a combined enrollment of more than 50,000 students. For a brief time, I also held the post of science advisor at the office of the president of the republic. Today, in the midst of Iraq's current troubles, I lead a project, sponsored by the Iraqi Academy of Sciences, that seeks to provide computerized translations of scientific and technical glossaries from other languages into Arabic. The goal is to create an Arabic glossary for such terms. Many words in Arabic have never been devised for scientific and technological terms originating in the United States, Europe and other scientifically advanced countries and regions. For example, no Arabic words exist for internet, nanotechnology or microprocessor. Our project is intended to fill this linguistic void. The ultimate goal is to help empower Arabic scientists and technologists by making it easier for them to participate in the global scientific community and to convey their findings to the public. After all, if there is no word for it, it is hard to convey what you are doing – let alone why.

What does the future hold for you and for Iraq?

Given what I and most other Iraqis have been through the past several decades – wars, sanctions, violence and now the destruction of our lives in a very savage way – it is hard to predict what will happen next. It's estimated that more than 3,000 Iraqi academics have left the country. But, as they say, life must go on. People continue to go to work and children continue to go to school. Some die, some get hurt and most return home to face the same dangers and uncertainties again the following day. My wife, a retired professor of control systems engineering, worked at the University of Basra and the University of Technology for more than 30 years. She remains with me here in Baghdad. But my children have left. My son, who is a doctor, currently lives in the United Kingdom. My daughter, who is a radiologist, lives in Syria. Another

son, who is a computer engineer, is on his way to Australia to begin his studies for a doctorate degree in computer networking. All Iraqis, whether living here or abroad, are victims of the current strife. We can only hope that peace, prosperity and happiness await us in the future. But for now, there is no hope in sight. ■

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COMBATTING HIV/AIDS IN UGANDA

'LIFE SCIENCES IN AFRICA: EXAMPLES OF SUCCESSFUL EXPERIENCES IN SCIENCE AND TECHNOLOGY LAGGING COUNTRIES' WAS THE TOPIC OF DISCUSSION AT A SPECIAL HALF-DAY SYMPOSIUM HELD AT THE TWAS GENERAL CONFERENCE IN BRAZIL LAST NOVEMBER. AT THE SYMPOSIUM, PETER N. MUGYENYI (TWAS FELLOW 2004), HEAD OF UGANDA'S JOINT CLINICAL RESEARCH CENTRE, SPOKE ABOUT HIS COUNTRY'S SUCCESSFUL EFFORTS TO CONTROL THE SCOURGE OF HIV/AIDS. IN THE FOLLOWING ARTICLE, MUGYENYI DESCRIBES HOW THESE EFFORTS HAVE UNFOLDED AND THE IMPACT THAT THEY HAVE HAD.

Less than a decade ago, many international health experts agreed that successfully treating HIV/AIDS, which requires a carefully sequenced daily application of antiretroviral drugs, would be impossible in Africa. Their reasoning went like this: the high cost and limited availability of medicines, combined with the rigorous and relentless regimen required by the cocktail of drugs used to treat the disease, placed such programmes beyond the reach of Africa's impoverished, poorly-educated victims.

Such views have since been thoroughly discredited, thanks in part to the work of institutions like the



Joint Clinical Research Centre (JCRC), based in Kampala, Uganda.

JCRC has demonstrated that those affected by HIV/AIDS in Africa are just as eager, willing and able to receive effective treatment as victims in other parts of the world, and that the disease, as a result, need not be a death sentence

whether you live in Los Angeles, USA, or Kampala, Uganda.

The JCRC was founded in 1991 at the height of the HIV/AIDS epidemic in Uganda. At the time, an estimated 15 percent of all adults in Uganda – some 3 million people – were infected with the disease. Among

pregnant women living in cities, the percentage exceeded 30 percent.

HIV/AIDS was – and remains – a calamity of historic dimensions. Since it was first identified in 1981, more than 23 million people have died worldwide. Some 40 million are currently living with the virus. Experts estimate that 15,000 new HIV/AIDS infections occur each day.

The disease has left a deep and permanent scar across the globe, particularly on the world's poorest, most marginalized people. Ninety-five percent of those living with AIDS reside in developing countries, including nearly 26 million in sub-Saharan Africa. In Uganda, the first cases appeared in 1982. Soon after, the constant litany of lives lost was being matched by a growing sense of despair that nothing – absolutely nothing – could be done about it.

For Uganda, the 1980s and early 1990s were among the most difficult years in its history. A poor, landlocked country in east Africa torn by civil war and unrest, it also found itself at the epicentre of the HIV/AIDS epidemic. Between 1966-1986, an estimated 1 million Ugandans lost their lives due to the political and social upheavals experienced under the regimes of Milton Obote and Idi Amin. In January 1986, Yoweri Museveni led the National Resistance Movement (NRM) to power, initiating a relatively stable political era. Unfortunately, by that time, the country, with a population of only 10 million, was facing perhaps an even graver and potentially more devastating crisis than civil unrest and oppression: Uganda possessed one of the highest HIV/AIDS infection rates in the world.

HIV/AIDS not only represented a death sentence for individual Ugandans but also struck a devastating blow to families and, more generally, society as a whole. Tens of thousands of spouses lost their partners and hundreds of thousands of children were forced to grow up without one or both of their parents. With so many people falling ill and dying, often during the prime years of their lives, the HIV/AIDS epidemic deepened



***Ninety-five percent
of people living
with AIDS reside
in developing countries.***

a profound economic crisis. Some experts estimate that the impact of the disease on both morbidity and mortality nationwide has reduced

Uganda's gross domestic product by 2 percent annually – an economic loss that this impoverished country can ill afford.

JCRC, the first clinic of its kind in Uganda, took up office space in the early 1990s in an old, colonial era royal residence on Mengo Hill on the outskirts of the nation's capital city of Kampala. Considering that the country had a 15 percent rate of infection at the time, it was an inauspicious beginning for an institution seeking to address a problem that seemed intractable.

In light of the dire situation, President Museveni defined JCRC not as a conventional health clinic but as an innovative emergency medical facility, and he called on JCRC to quickly devise and implement an effective strategy for mitigating the scourge of HIV/AIDS in Uganda.

Today, some 15 years later, JCRC's main facility on Mengo Hill is part of an intricate nationwide network of more than 50 research and treatment centres. JCRC's initial annual budget was US\$150,000. Now, it has an annual budget of US\$15 million and employs 300 people, including 100 highly skilled medical researchers and doctors.

At the time, no one could say with assurance what was the best way forward because no clear clinical roadmap existed for charting successful interventions.



PAVING THE WAY

Since the mid 1990s, JCRC has participated in PAVE (Preparation of AIDS Vaccine Evaluation) studies designed to explore the prospects for devising a vaccine to combat this deadly disease and to examine the potential impact that widespread use of a vaccine would have on sexual behaviour.

The first PAVE study, which JCRC participated in, began in 1989 with funding from the World Health Organization (WHO) and examined 1,000 HIV-negative study-subjects over five years, seeking to identify a cohort population suitable for HIV vaccine trials – if and when a promising vaccine would become available.

To underscore the importance of preparing for possible HIV vaccines, JCRC undertook another PAVE study (1994-1998), with funding from the US National Institutes of Health (NIH). More than 1,400 volunteers from the Ugandan military, an HIV/AIDS high-risk group, were asked to participate. The study sought to determine whether people would alter their behaviour if an effective HIV vaccine were developed. The results, based on psychological counselling, interviews and testing for sexually transmitted diseases, showed that participants were unlikely to become more reckless or irresponsible in their sexual behaviour if they had access to a vaccine.

These two studies demonstrated that HIV vaccine studies were not only feasible in Uganda but that JCRC could test HIV-candidate vaccines if they became available.

In 1996 JCRC began preparation for a trial of ALVAC, a recombinant HIV-candidate vaccine developed by Pasteur Mérieux, a French vaccine research and pharmaceutical company. The study involved 40 healthy HIV negative volunteers. Twenty received the vaccine and 20 served as controls. Ugandan scientists trained at JCRC and abroad conducted sophisticated tests and assays to determine immunological responses to the vaccine in a state-of-the-art laboratory built with funds provided by the US National Institutes of Health and Family Health International.

Considering the early stage of HIV vaccine development, it was remarkable that only 25 percent of the total cohort did not demonstrate a desirable immunological response to the vaccine. Nevertheless, the overall findings showed that the vaccine was not robust enough in its present form to be effective. The trial, however, provided valuable scientific input for future vaccine development and has opened the way for additional vaccine trials in Africa.

While no one expects a vaccine to be successfully developed in the near future, HIV vaccine studies and trials now underway in several African countries, including Kenya and South Africa, indicate that the continent where the disease is most prevalent – and most devastating – will be directly involved in these efforts. That's potentially good news not just for Africa but also for the entire world.

The most pressing problem was that huge numbers of people were dying of AIDS with no known effective therapy to combat it. Highly active antiretroviral therapy (HAART) was discovered in 1995. But only a tiny minority of Ugandans could afford the treatment. JCRC staff realized that an effective strategy would require close partnerships with the ministry of health and other stakeholders on a broad range of fronts, including improved research, treatment, training, infrastructure

and capacity building. JCRC staff also realized that whatever measures proved effective would have to be rapidly and widely implemented if the nation had any chance of reversing the devastating trend.

Uganda, at the time, was not the best place to launch such an ambitious public health initiative. Years of civil war had left both the economy and infrastructure in tatters. The devastation and chaos that ensued compelled a large portion of Ugandan doctors and scientists – an

estimated 40 to 50 percent – to flee the country. Long-standing research and public health institutions, ranging from universities to community healthcare centres, faced severe budgetary and personnel shortages. They had neither the money nor the skills to respond effectively to the crisis.

From its inception, JCRC's biggest asset has been its strict adherence to best practices in medical research and clinical care, and its ability to work with reputable partners affiliated with international organizations, world-class universities and research centres in developing and developed countries. For example, several months after it was launched, the centre forged a partnership with the University of California San Francisco, USA, to conduct a groundbreaking study on the use of low-dose Zidovudine (ZDV). It also worked closely with Uganda's own centres of excellence, most notably Makerere University's medical school.

ZDV was the first and, at the time, the only available antiretroviral drug. However, it was being used in higher doses than today, often causing severe side effects that sometimes proved fatal. Research carried out at JCRC established that ZDV could be used in lower, less toxic doses and still be effective, setting the stage for a major breakthrough in the treatment of the disease.

Since then, JCRC has continued to conduct behavioural studies and drug trials, including projects focusing on epidemiology, immunology, molecular biology and pharmacology. Many of these studies have been carried out in collaboration with such health research institutions as Case Western Reserve University, USA, the Tropical Institute of Medicine, Hamburg, Germany, and Yokohama University, Japan. Working with the UK's Medical Research Council, the Uganda Virus Research Institute in Entebbe and the University of Zimbabwe, JCRC has recruited more than 3,000 patients for a clinical trial aimed at identifying best practices for the use of antiretroviral drugs in Africa by focusing on patient responses to existing therapies. The

data has greatly facilitated the expansion of such therapies, helping both to improve and save the lives of millions of Africans infected with HIV.

JCRC's involvement in clinical trials is part of the centre's larger efforts to play a leading role in promoting continent-wide best practices in HIV/AIDS research, care and treatment. The centre, for example, heads projects of both the African Dialogue on AIDS Care (ADAC) and AIDS Care and Research in Africa (ACRiA), funded by the Rockefeller Foundation and the Doris Duke Foundation, respectively.

Begun in 2001, ADAC aims to address gaps in HIV/AIDS care by supporting programmes for disseminating and sharing best practices across the region; assisting locally based research in HIV/AIDS care; mentoring young scientists and technicians; and advocating increased funding for HIV/AIDS staff training and patient treatment across the region.

ACRiA, meanwhile, provides grants of up to US\$80,000 over a two-year period to promising young Africans who often find themselves at a disadvantage when seeking funds, especially competitive funds from international foundations and multilateral aid agencies. The programme's main



Peter N. Mugenyi

JCRC's biggest asset has been its strict adherence to best practices in medical research and clinical care.



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The most important effort of JCRC has been the distribution of antiretroviral drugs throughout Uganda.

objective is to address the paucity of research designed to improve the management of HIV/AIDS in Africa. A second inter-related objective is to build scientific research capacity in African institutions, largely by supporting promising young researchers.

To date, ACRiA has awarded grants to 15 African scientists. Thanks to the programme, researchers in the Congo, Ghana, Kenya, Malawi, Nigeria, South Africa, Tanzania and Zimbabwe, some of the world's poorest nations, are now working on a wide range of issues related to HIV/AIDS. Primary areas of focus include the prevention of HIV transmission from mother to child; improved understanding and treatment of such HIV/AIDS-related opportunistic infections as tuberculosis; the spread of HIV/AIDS-related cancers; challenges posed by drug resistance; and ways to improve counselling and increase testing rates among at-risk populations. Three key criteria have driven the selection of successful applicants: the quality of their proposal; the

track record of those who will be involved in the project; and the project's relevance to issues of concern to Africa.

JCRC's record for effectiveness has led outside agencies to turn to the centre as a national and regional focal point for healthcare training and capacity building. The US National Institutes for Health (NIH), for example, currently funds a JCRC Clinical Operational and Health Services Research (COHRE) programme that enables Ugandan doctors and clinical scientists to receive fellowships both for short-term training and earning advanced degrees. The World Health Organization (WHO) has chosen JCRC as a regional 'knowledge hub', which enables the centre to function as a pan-African training institute for HIV/AIDS-related laboratory, clinical and social services. Healthcare providers from Lesotho, Nigeria, Sudan, Yemen and Zambia have participated in this initiative.

But of all the efforts in which JCRC has been involved, the most important, by far, has been the introduction and subsequent distribution of antiretroviral drugs throughout Uganda.

The effort began in 1992 soon after the centre's creation. At the time, launching such an initiative was thought to be extremely difficult, and scaling it up, especially at a rapid pace, virtually impossible.

Nevertheless, through a comprehensive programme that married state-of-the-art medical science to the best available clinical and healthcare practices, the centre soon showed that it was indeed possible to bring effective treatment to bear on an unprecedented crisis that posed a dire threat to Uganda's future. Beyond the immediate concern of combatting the HIV epidemic, the programme, which subsequently came to be known as the 'JCRC network model', also helped to build Uganda's research and clinical capacity.

Prior to the centre's antiretroviral treatment efforts, Uganda's HIV/AIDS treatment facilities were few in number and largely located in the city of Kampala. The main constraint was by far the exorbitant cost of antiretroviral drugs, which Uganda and indeed other poor countries could not afford.

More than 80 percent of all Ugandans live in rural areas where poverty is most acute. The challenge was to devise a system that would reach the then unreachable and, at the same time, generate sufficient revenues to cover a portion of the costs.

HIV/AIDS treatment programmes will only succeed if they are sensitive to the situation on the ground, not just in terms of the health crisis but also in terms of overall economic and social conditions. If facilities are too few in number, if those that exist are located far from where the majority of people live, and if the drugs are inaccessible and too expensive for most people to use, the epidemic will continue to spread and intensify.

In the past, sufficient resources for researching and treating HIV/AIDS in Africa have been difficult to secure because so many people had sadly accepted that the disease was a death sentence and the constraints associated with AIDS treatment in Africa insurmountable. They had concluded that a nation's scant resources would be better spent on solvable problems where time, money and expertise would make a difference.

JCRC strongly disagreed with this bleak assessment, insisting that resource and logistical constraints could be overcome and that effective treatment could be made available to millions who were dying a mainly preventable death.

For all of these reasons, officials responsible for the project decided to pursue a strategy that called for

charging clientele who could afford to pay a fee of US\$2 to US\$5 for the tests, diagnosis and treatments that were rendered. That represented a substantial sum in a nation where more than 90 percent of the population lives below US\$2 per day.

At the same time, JCRC also reached out to national and international scientific institutions to jointly pursue externally funded research projects designed to address the HIV/AIDS crisis in Uganda. These projects not only enabled the centre to pursue world-class research, but they also generated overhead revenues that were used in part to help operate the centre, which was largely, but not entirely, funded by the government.

Using both patient fees and research overhead funds, JCRC extended care to those who could not afford to pay and to build capacity to enhance the centre's effectiveness. This strategy not only saved thousands of lives but also provided JCRC an opportunity to train large numbers of healthcare providers and to establish one of the most advanced diagnostic and monitoring laboratories in sub-Saharan Africa.

At first, JCRC's clientele consisted mostly of bankers, businesspeople, and government and hospital workers who could afford to pay or who were employed in places that covered their healthcare costs. The centre's overall funds remained small and the money that could be shifted to cover – or subsidize – the costs of impoverished patients even smaller.

TRoublesome Trends

While Uganda remains one of the world's most noteworthy success stories when it comes to combatting HIV/AIDS, recent trends suggest that progress in preventing the spread of the disease has stalled and, in fact, has taken a small but troublesome step backwards. In December 2006, UNAIDS and the World Health Organization (WHO) issued a report indicating that the overall prevalence of HIV/AIDS in Uganda, based on a nationwide survey, has risen from 6.2 percent to 6.4 percent of the population. The report attributed the increase to less diligent use of condoms and a rising number of men who were having sex with multiple partners. The report also suggested that the trend was due to a decrease in the rigour and visibility of the government's prevention programmes. Emmanuel Otaala, Uganda's state minister for primary healthcare, responded to the report by saying that the government "must repackage the messages" of its HIV/AIDS prevention campaign "in a format that can be understood by the people." If nothing else, last year's disturbing survey results confirm that constant vigilance must be the abiding principle of HIV/AIDS prevention efforts – whether the focus is on individual behaviour and responsibility or broad based governmental policies and programmes.



Critics accused JCRC of catering to the rich and ignoring the poor. However, there was no other way that JCRC could get the treatment programme off the ground because virtually all international sponsors at the time considered HIV/AIDS treatment a 'no go' area. To make matters worse, diagnostic tests proved prohibitively expensive. As a result, medical staff often could not determine whether a patient had contracted HIV/AIDS until telltale symptoms appeared.

In the 1990s, the government estimated that one million Ugandans were living with HIV/AIDS and about 200,000 were in dire need of antiretroviral therapy. As public awareness of the availability of potentially life-saving treatment spread across the country, demand for such treatment rose dramatically. To improve the cost-effectiveness of its efforts, JCRC began to develop 'field' facilities and to provide training for the personnel who would staff these facilities.

The effort not only curbed expenses but also made treatment more readily available. As a consequence, demand for services continued to rise while the cost of providing such services declined. A nationwide referral system kept staff at all health facilities in close contact with one another and, more importantly, enabled patients easily to locate the facility closest to where they lived. To expedite training, an expert 'mobile' team was created to travel from one location to another. 'Cyber' centres, launched in 2002 with the aid of satellite uplinks, accelerated the pace of training even further.

JCRC, in short, trained the staff of each new clinic, provided generic antiretroviral drugs in a cost-effective

manner, performed laboratory monitoring tests, and introduced monthly monitoring and evaluations in each JCRC-affiliated facility, which now number more than 50.

Through these efforts, Uganda has developed a framework for a national public healthcare system for the diagnosis and treatment of HIV/AIDS. The system consists of community health clinics, regional laboratories, satellite uplinks and centres of research excellence. The number of people receiving antiretroviral drugs,

thanks in part to JCRC and its affiliated institutions, rose from several hundred in the early 1990s to several thousand by the late 1990s. Today, it exceeds 70,000.

In a nation where an estimated one million people are infected with HIV/AIDS, and where recent statistics indicate a disturbing upswing in the number of new victims after years of

steady decline (see box, p. 27), it is clear that Uganda still has a long way to go to curb this deadly epidemic. Nevertheless, JCRC's success indicates that all is not lost and that with relatively modest funds and a good plan of action, the lives of those infected with the disease can be both saved and improved.

JCRC represents a success story where stories of success are difficult to find. The scourge of HIV/AIDS will not be defeated in the short term. But Africa now has reason to believe that the disease can be contained, casting thin rays of hope on the dark, bleak picture of death and despair that has become the hallmark of HIV/AIDS in the world's most impoverished continent. ■

The number of people receiving antiretroviral drugs rose from several hundred in the early 1990s to more than 70,000 today.



BOTANICAL BIOCHEMISTRY IN BOTSWANA

BORN IN ETHIOPIA AND EDUCATED IN ETHIOPIA AND THE UNITED STATES, BERHANU ABEGAZ (Twas Fellow 1998) HAS CONDUCTED HIS RESEARCH INTO THE CHEMISTRY OF NATURAL PRODUCTS AT THE UNIVERSITY OF BOTSWANA SINCE 1994. HIS WORK HAS BEEN HONOURED WITH NUMEROUS AWARDS, INCLUDING THE FIRST C.N.R. RAO AWARD FOR SCIENTIFIC RESEARCH.

Berhanu Abegaz has spent more than 30 years working in Africa, returning to his native Ethiopia immediately after obtaining a PhD from the University of Vermont, USA, in 1973. This doctoral training provided Abegaz with a thorough grounding in basic and applied chemistry. His academic education, together with the skills and knowledge acquired in the field, have allowed him to pursue a career investigating naturally-occurring chemicals in plants, especially those chemicals that can have either beneficial or potentially harmful effects on human health.



For 21 years after his return to Ethiopia, Abegaz worked in the department of chemistry of Addis Ababa University. Then, in 1994, he took up a chair at

the University of Botswana in Gaborone, Botswana. His quest to isolate and characterize plant secondary metabolites, which has led to some 125 publications, has been extremely fruitful. For instance, of the 157 known homoisoflavanoids,

Abegaz and his colleagues have characterized about 40, while in the class of structurally novel 4'-deoxyisoflavonoids, of which only 20 were known in the mid 1980s, half have been isolated in Abegaz's laboratories.

Moreover, research led by Abegaz has directly touched on Africa's most urgent needs. For example, many strains of the malaria-causing *Plasmodium* parasite have become resistant to one of the most commonly used anti-malarial drugs, chloroquine. Abegaz's dis-

covery of anti-plasmodial compounds with the potential to reverse this resistance to chloroquine could become critical agents in Africa's continuing fight against malaria. Abegaz has also discovered other natural products with activity against cancer, trypanosomiasis (sleeping sickness) and other parasitic diseases.

Taken as a whole, his work has contributed to the advancement of chemistry research and the building of scientific capacity. His involvement in various TWAS programmes across the continent has been critical to his success (see boxes on pages 32 and 35).

Abegaz's efforts and achievements have been honoured by the International Foundation for Science

and turn these challenges into successes may lie in a comment he made in a recent interview with *The Scientist* magazine. "It makes sense, given the scale of our problems and the scarcity of money for conducting research," he said, "to focus our resources on areas of concern and also on areas where we have a relative advantage, for example by investigating indigenous knowledge."

These principles have both dictated and inspired his research, which simultaneously addresses and exploits opportunities related to two major challenges facing Africa. One is the threat posed to the survival of the continent's biodiversity through the increasing exploitation of indigenous plants on which many com-



(IFS) and the Danish International Development Agency (DANIDA). He has also received the Pierre Crabbe Award of the International Organization of the Chemical Sciences in Development (IOCD), which was given "in recognition of his distinguished contribution to the advancement of science and education in a developing country."

In 2006, Abegaz was awarded the inaugural C.N.R. Rao Prize for Scientific Research launched by the outgoing TWAS president and designed to honour distinguished scientists from the developing world who have made significant contributions to science in their native countries.

The answer to how Abegaz has managed to overcome the challenges of carrying out research in Africa

munities rely for foods, cosmetics, flavours, spices and medicine. Because many African institutions do not have drug development programmes, scientists seeking to carry out research on natural products lack a sound basis for the selection of plants for scientific examination. Such strategies include the use of bio-assay-guided fractionation to isolate and identify bio-active substances and the more recent combinatorial chemistry and high-throughput robotic screening techniques used in other parts of the world.

Against this background, Abegaz has made commercially exploited plants priority targets in his research efforts. At the same time, he has sought to build the capacity of scientific institutions to get the job done.



BENEFICIAL BOTANICALS

“The fact that a given plant has become a traded item is an important development in efforts to investigate plants for the purpose of discovering novel secondary metabolites with marketable properties,” says Abegaz.

Sure enough, the use of ethnobotanical information has enabled Abegaz and his team to enhance their understanding of the scientific basis for many of the cultural practices associated with the use of such plants.

His strategy has been to investigate botanical specimens derived from plant parts – for example, roots or tubers – purchased from traditional markets in Botswana, Ethiopia, Kenya, Tanzania and Uganda. The first step is to grow them under controlled conditions, either in a garden or glasshouse, or by micro-propagation using tissue culture techniques.

It has been an exciting and fruitful experience through which Abegaz has identified

Abegaz has identified many new chemical structures with novel biological properties.

Through his ethnobotanical observations, Abegaz learned that one particular species, *B. capitata*, is widely used in Botswana for the treatment of a range of ailments, including gonorrhoea. Following extensive laboratory work, the plant yielded ten interesting and potentially useful metabolites, including two novel derivatives of knipholone.

Abegaz’s work attracted the interest of Gerhard Bringmann, a German synthetic and organic natural product chemist, who was intrigued by the novel structures of

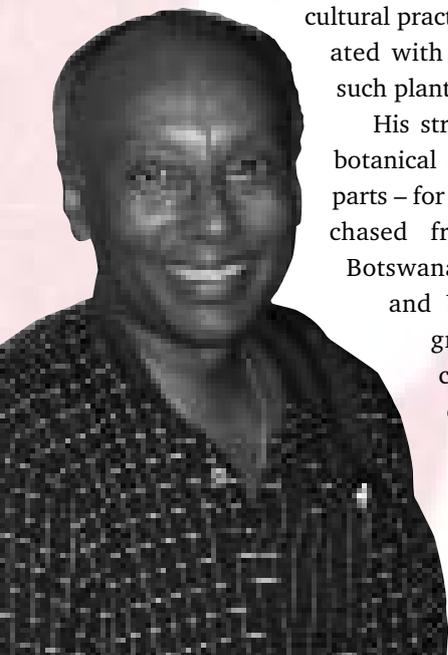
these PAQs. Indeed, Abegaz and his collaborators discovered that *Bulbine* species are a far richer source of PAQs and IFNQs than the related species from which these secondary metabolites were first isolated, *Kniphofia*.

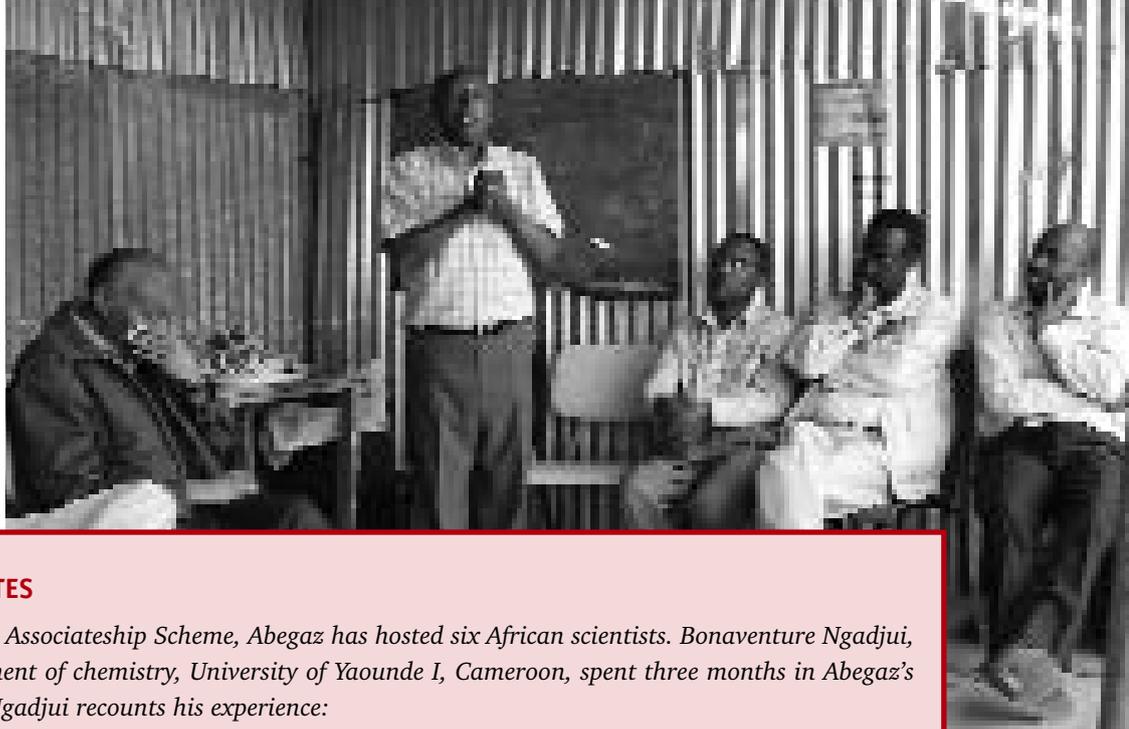
Another major plant group that the Abegaz team has worked on is the *Hyacinthaceae*. Southern Africa is one of the two known centres of diversity of this bulb-forming family.

“This plant has long been used by traditional healers,” says Abegaz. “We characterized 40 homoisoflavonoids, some of which we have shown to possess activity against colon and breast cancer cell lines.”

many new chemical structures with novel biological properties. Some of his most cited results have been in the area of the relatively new class of secondary metabolites, phenylanthraquinones (PAQs) and isofuronaonaphthoquinones (IFNQs).

PAQs have recently generated much excitement owing to their potent anti-plasmodial activity, especially as a new class of anti-malarial compounds. Abegaz and his team based their investigations on the genus *Bulbine* (family Liliaceae). Although this plant genus of more than 40 species grows throughout southern Africa, only four species had been investigated for secondary metabolites.





ABEGAZ AND ASSOCIATES

Under the TWAS-UNESCO Associateship Scheme, Abegaz has hosted six African scientists. Bonaventure Ngadjui, a professor at the department of chemistry, University of Yaounde I, Cameroon, spent three months in Abegaz's laboratory in Botswana. Ngadjui recounts his experience:

*"After an International Organization of the Chemical Sciences in Development (IOCD) meeting in March 1996 in Zimbabwe, I was invited by Abegaz to participate in a mini-symposium held the following day at the University of Botswana. During my stay there, I had the opportunity to visit the department of chemistry and was impressed with its high-tech research facilities. Apart from the standard separation techniques, none of these facilities were available in Cameroon, so I asked Abegaz if he could invite me for a research visit. In July that same year, I received an invitation. I took with me samples of *Dorstenia kameruniana* (family Moraceae), which is used in folk medicine to treat many diseases. An article based on the research I did in his laboratory was published in the journal *Phytochemistry*. More soon followed.*

"Since then, I have been invited back to Abegaz's lab each year for three months, most recently thanks to the support of the TWAS-UNESCO Associateship Scheme as well as the chemistry department of the University of Botswana.

"During these ten years of collaboration, I have found Abegaz to be an exceptional scientist – one who is always ready to find the scientific explanation to a problem and does not get discouraged easily.

"Together, we have published more than 20 high quality scientific papers and others have been submitted or are now in preparation. Five Cameroonian students have also defended their PhD theses based on this collaboration."

Also from these plants, Abegaz and his team discovered an isoquinoline alkaloid with an unusual carbon skeleton that they believe is formed by a previously unknown biosynthetic pathway.

The plant, *Salsola somalensis* (family Chenopodiaceae), sold in markets in Ethiopia, has given Abegaz encouraging results towards the possible development of drugs to treat tapeworm infestations. In cooked meat, the infective stage of the tapeworm life cycle, the cysts, have normally been killed. However, in Ethiopia, people often eat raw meat, making tapeworm infestations relatively common. Residues from chloroform and ethyl acetate extracts of the roots of *S. somalensis* were found

to contain novel isoflavonoids. These curious structures have shown strong activity against freshly ex-cysted tapeworms – the stage that, after being ingested, develops into the adult worm in the human host.

Abegaz and his team, together with Bonaventure Ngadjui, University of Yaounde I, Cameroon (see box, page 32), have also worked on the relatively unstudied genus *Dorstenia*, which belongs to the fig and mulberry family and is represented by about 170 species.

Before Abegaz's first paper on *Dorstenia*, only one of these species had been mentioned in the chemical literature. However, several species belonging to this genus are important medicinal plants in Africa. In

Ethiopia, for example, they are sold to treat gout and various skin diseases, while in Cameroon, a decoction of the leaves of *D. psilurus* is used to treat headaches, rheumatism, snake bites and stomach disorders. This successful collaboration of two African scientists has led to the discovery of 51 of the 71 mono-, di- and tri-prenylated and geranylated flavonoids and coumarin derivatives listed in the *Dictionary of Natural Products* under the genus *Dorstenia*.

PLANT TOXICITY

Apart from his search for potential pharmaceutical products derived from Africa's rich biodiversity, Abegaz's work has touched on another important area

considered to be the cause of neurolethyrism, a neurodegenerative disease that leads to weakness and paralysis of the lower body. Abegaz's research has paved the way for the possible re-arrangement of the ODAP molecule, shifting the balance of naturally occurring ODAP molecules from the active isomeric form to an inactive form – a finding that could ultimately lead to the treatment of the disease.

INDUSTRIAL PLANTS

Two species of the tree genus, *Rhamnus*, are found in Africa, namely *R. staddo* and *R. prinoides*, the African dogwood, which is widespread in eastern and central Africa. Investigations of the secondary metabolites of



– the study of plant toxicity. In particular, he has focused on the toxic principles of *Lathyrus sativus*, the grass pea.

This leguminous vegetable is known as the 'insurance crop' of Africa and Asia because it produces reliable yields even when all other crops fail under extreme weather conditions such as too little rain – drought – or too much rain – flooding. Unfortunately, although *Lathyrus* seeds contain high levels of protein, they also contain variable amounts β -oxalyl-L- α , β -diaminopropionic acid (ODAP). This chemical, which mimics one of the body's neurotransmitters and thus interferes with nerve impulses, is

Abegaz has made noteworthy contributions to the promotion of science in Africa.

R. prinoides have enabled Abegaz to move his research into the industrial sphere. African dogwood, which tolerates drought and frost conditions, has piqued Abegaz's interest thanks to the uses to which its various parts are put. The fruits, for example, are used to treat ringworm infections, while the leaves and stems are used to treat malaria and other ailments. In addition, a bittering agent for use in domestic beverages can be extracted from the leaves and stems.

"We have studied the above-ground parts of this plant and have isolated and characterized some 20 compounds, including seven glycosides of emodin

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anthrone, five flavonoids and three naphthalenic derivatives,” says Abegaz. “Organoleptic evaluations of one of the novel compounds we isolated and named geshoidin showed that this compound was responsible for the typical flavour of the domestic beverage,” he adds.

More recent studies have shown that *R. prinoides* can serve as a commercial hopping agent in the same way as more traditional hops are used in the brewing industry to add the characteristic bitter taste to beer.

Abegaz’s work on the industrial applications of natural products has also involved essential oils. Research done in collaboration with Nigit Asfaw of the Ethiopian Spice Extraction Company, for example, has led to

graduate from the University of Botswana with a PhD degree in chemistry did so at a ceremony presided over by the country’s president.

Abegaz, not surprisingly, has made noteworthy contributions to the promotion of science in Africa. He was one of the founders of the Chemical Society of Ethiopia and served as its first president for four years. He was also the founding editor of the *Bulletin of the Chemical Society of Ethiopia*, which has become one of the leading journals in Africa and is now included in international abstracting and indexing databases.

To fulfil his vision of bringing African researchers together in a common effort to enhance chemical research, in 1984, he helped establish the Natural



the successful marketing of essential oils from such indigenous species as ginger and cardamom.

SCIENTIFIC MENTOR

In a tribute to commemorate his 60th birthday, the 2007 issue of ARKIVOC, an open-access journal for organic chemistry, described Abegaz’s laboratories as an excellent environment for educating young African research students. The journal notes that the first PhD degrees in chemistry awarded by both Addis Ababa University and the University of Botswana, in 1989 and 1999, respectively, were to students mentored by Abegaz. Indeed, the first student to

Abegaz is indeed an African success story and is leaving a trail for others to follow.

Products Research Network for Eastern and Central Africa (NAPRECA), an organization that he continues to support. He was also the founding coordinator of the Network for Analytical and Biological Services of Africa (NABSA), a network that is committed to the promotion of intra-African cooperation in chemical sciences. He is an enthusiastic participant in several TWAS programmes designed to build scientific capacity in Africa, including the TWAS-UNESCO Associateship Scheme and the TWAS Research Professors in Least Developed Countries programme (see boxes, pages 32 and 35, respectively).



Beyond the borders of Africa, Abegaz offers his expertise to the United Nations University, the University of Uppsala, Sweden, and the International Foundation for Science (IFS). As well as being a TWAS Fellow, he is a member of the American Association for the Advancement of Science (AAAS).

In a forum preceding the African Union Summit for Science and Technology that took place in January 2007, Abegaz acknowledged that scientists working in Africa often face daily struggles that undermine their ability to get things done. He referred to those who continue to do science in Africa as 'die-hards'. What he failed to mention is that some die-hards continue to succeed and that they deserve our thanks and support. Abegaz is indeed an African success story and is blazing a trail for other African scientists to follow. ■

ABEGAZ AND ADDIS ABABA

In 2005, TWAS launched its TWAS Research Professors in Least Developed Countries (LDCs) Programme. Berhanu Abegaz was among the first TWAS Fellows to be appointed, allowing him to spend a month at the department of chemistry, Addis Ababa University, Ethiopia.

Apart from his technical lectures on free radical and organometallic chemistry given to postgraduate students, he also spent time with university departmental section coordinators discussing laboratory safety and presented a lecture on how to make effective presentations to both staff and students.

"During my stay, I also took part in a series of meetings hosted by the Chemical Society of Ethiopia (CSE) and the recently established Federation of African Societies of Chemistry (FASC)," says Abegaz.

In addition, he participated in the annual general meeting of the Natural Products Network for Eastern and Central Africa (NAPRECA) and has developed an agreement with a professor at the Ethiopian university for exchange visits with his laboratory in Botswana.

"This was a really enlightening experience for me," adds Abegaz. "It was very interesting to see a group of postgraduate students who were highly motivated and interested in following a professional career in chemistry."

With mentors of the quality of Abegaz – and with his undoubted enthusiasm for his research – these students, and natural product chemists elsewhere in Africa, enjoy a better chance of success.



BUILDING EARTH SCIENCES CAPACITY

TWAS TEAMED UP WITH FORGEA INTERNATIONAL, A GEO-MINING AND ENVIRONMENTAL TRAINING AND COOPERATION CENTRE BASED IN SARDINIA, ITALY, TO ORGANIZE A SERIES OF FOUR WORKSHOPS. THE FOUR TWO-WEEK COURSES PROVIDED STATE-OF-THE-ART TRAINING FOR SOME 90 STUDENTS AND MIDDLE-LEVEL PROFESSIONALS FROM NORTH AFRICA, THE MIDDLE EAST, THE BALKANS AND EASTERN EUROPE.

Sardinia ranks among the most mineral-rich places on the planet. Since prehistoric times, its mineral wealth has been exploited by numerous civilizations. Stone Age cultures, for example, used the island's obsidian – a glass-like stone of volcanic origin – to make arrowheads and other cutting instruments, and the Romans mined the island's silver deposits.

More recently, coal, lead, zinc and even gold have been extracted from the island's rich mineral seams. The Industrial Revolution of the 1800s both created a demand for Sardinian ores and provided the technological advances to increase production. Thus, many towns centred on mining quickly developed, and the island's universities, including the University of Cagliari, became centres of expertise in mining and mineralogy.



In the 1960s, however, diminishing returns meant that many mines were forced to close and Sardinia was left with a legacy of unemployment and a scarred landscape. The island's educational institutions quickly refocused their activities on the environmental effects of mining and, in particular, how

these effects can be ameliorated. Thanks to this legacy, in 1997, the United Nations Educational, Scientific and Cultural Organization (UNESCO) inaugurated Sardinia's Parco Geominerario Storico e Ambientale (Historic and Environmental Geomining Park), which covers eight areas of the island, as the world's first such park.

Based on the local expertise and the mineral and industrial heritage of Sardinia, since 1998 Forgea International has organized courses for young and senior pro-



professionals from developing countries, sponsored by the Italian government's Ministry of Foreign Affairs. In 2006, TWAS entered into partnership with Forgea International to collaborate in the organization of four workshops aimed at building the scientific capacity of scientists and decision makers from developing nations and countries with economies in transition bordering the Mediterranean Sea.

Many developing countries extract and exploit their mineral resources. Yet many lack the expertise to continue exploiting such resources in a sustainable manner. As a result, mines and quarries often pollute the surrounding soils, watercourses and coastal areas.

In addition, much of the so-called 'waste' unearthed by the exploitation of minerals can actually be used, thus adding value to material that was once discarded, again often in ways that create environmental problems. Developments in science and technology also now allow many materials, including ceramics and concrete, to be recycled and re-used in novel ways that are both environmentally benign and economically preferable.

Against this background, TWAS and Forgea International, based in Cagliari, Sardinia, organized a series of four training workshops, each of which was attend-

ed by some 20 to 25 participants from North Africa, the Middle East and the Balkans/eastern Europe. The inclusion of the Balkan and eastern European countries – as requested by the Italian Ministry of Foreign Affairs, the project sponsor – marked the first time that TWAS activities have extended to include this region.

WORKSHOPS

The initial step in the implementation of the projects was to appoint Maurizio Iaccarino (TWAS Associate Fellow 1997) as the scientific coordinator. During his tenure as assistant director-general for the natural sciences at UNESCO (1996-2000), Iaccarino was instrumental in the creation of the Sardinian *Parco Geominerario Storico e Ambientale* and has worked on many high-level projects, including the World Conference on Science, held in Budapest, Hungary, in 1999.

"The ultimate aim of these workshops is to help build a critical

mass of trained personnel in the target countries who can implement environmentally friendly procedures for extracting, using and recycling mineral resources," says Iaccarino.

Ambassador Ugo Leone, president of Forgea, agrees, adding: "As well as training university lecturers – 'training the trainers' – and graduate students, we are also looking to assist middle-level professionals, including ministry personnel, who are at the sharp end of policy decisions and programme implementation. In this way, we hope that we can make an impact."

Developments in science and technology allow many materials to be recycled and re-used in novel ways.



Two of the four workshops covered ‘Capacity Building in Environment-related Issues in Geo-mining and Coastal Zone Management’ and were held on 27 November to 8 December 2006 and on 26 February to 9 March 2007. Each of these courses was designed by Riccardo Tombolini of the University of Cagliari, appointed by Iaccarino as the ‘course director’.

The other pair of workshops covered ‘Capacity Building in Environment-related Issues: Recovery and Recycling of Construction Materials’. These courses, designed by a second course director, Sergio Meriani, University of Trieste, were held on 22 January to 3 February and 19 to 30 March 2007.

Each two-week workshop took place at the *Università per il Sulcis Iglesiente*, in Monteponi, near Iglesias, Sardinia. The region is home to a critical mass of geo-mining and environmental expertise thanks to the presence of such institutions as the University of Cagliari, the Centre for Advanced Studies, Research and Development in Sardinia (CRS4) and the Institute of Environmental Geology and Geoengineering of Italy’s National Research Council (CNR). Other lecturers included Leonardo Disperati, Centre for Geotechnologies, University of Siena, who lectured on the application of remote sensing techniques for the management of mining areas; Robert Missotten, chief of the Global Earth Observation Section and secretary of the International Geoscience Programme in UNESCO’s Division of Ecological and Earth Sciences, who lectured on UNESCO’s earth science programmes and activities;

**The four workshops
were attended by
87 participants from
13 countries.**

and Pietro Baratono of the Italian Ministry of Infrastructures, who lectured on the European Community’s directive on construction products.

Participants received practical training during a series of computer-based laboratory sessions. For example, during the first workshop, David Poulter, School of Ocean and Earth Science, National Oceanography Centre, Southampton, UK, introduced participants to UNESCO’s open-access Bilko software package – a system for teaching and learning remote sensing image analysis skills (see www.bilko.org). Indeed, the use of global information systems (GIS) to map and analyse mine sites and pollution problems was a major component of the first and third workshops.

Lectures and laboratory exercises were supplemented by visits to sites of geological interest within the *Parco Geominerario Storico e Ambientale*. Several of these visits, including the visits to Porto Flavia – a mining site that dates back to 1614 but that reached its peak output in the late 19th century and that is renowned for innovating a system of loading ships with ore directly from conveyor belts rather than by hand – and to the archaeological site of Monte Sirai – an ancient Phoenician settlement dating back to 750 BCE – were sponsored by the local government, the

Provincia di Carbonia Iglesias. Participants of the second workshop also had the opportunity to visit a working coal mine run by Carbosulcis S.p.A.

PARTICIPANTS

The four workshops were attended by 87 participants from 13 countries. The most well represented countries were Morocco, Tunisia and Turkey, followed by Algeria, Bosnia and Syria. Participants from such countries as Albania, Jordan, Lebanon, Oman and Serbia also attended.

“What makes these workshops different,” explains Iaccarino, “is that they not only include sessions taught by the lecturers but that the participants also present their own case studies to learn from one another. This is critical,” continues Iaccarino, “as it helps the participants gain a wider understanding of the challenges and the solutions in developing-country conditions. It also helps participants to broaden their networks of contacts in their own areas of expertise.”

Among the participants’ case studies were presentations by G. Mohamed Yaser Al Saka, General Organization for Cement and Building Materials (GOCBM), Syria, who presented his work on ‘Applications of Clean Production in the Cement Manufacturing Industry’, and Asim Olun, a chemist at Dumlupinar University, Kütahya, Turkey, who spoke on ‘The Utilization of Industrial Wastes Containing Boron in the Cement Industry’.

Concerning coastal zone management, Khalid Margaa, Ministry of Management of Territory, Water and Environment, Morocco, described his work, carried out in collaboration with the University of Sciences, Rabat, on ‘The Risks of Pollution in the Mediterranean Sea’, and Nawar Tareq Al Husseini, Environmental Research Centre, Royal Scientific Society, Jordan, highlighted the ‘Environmental and Socio-Economic Impacts Analysis of the Proposed Red Sea–Dead Sea Conduit’ (see ‘Better Red Than Med’, p. 4).

“The case study presentations were generally excellent,” says Sergio Meriani, supervisor of the second and fourth

courses. “We even managed to integrate some of the submitted case studies directly into the main courses by inviting a number of participants to present their work in more detail.”



Ugo Leone

FEEDBACK

Following each workshop, participants were asked to complete an anonymous questionnaire aimed at providing TWAS and Forgea with feedback on the organization and contents of the courses. The responses were typically supportive.

Participants observed that the course material covered would not be forgotten once they returned to their home countries and their regular employment.

“I plan to present an open lecture at my university,” said one participant. “I will also disseminate the concepts I learned at other meetings and present them to our chamber of commerce.”

“I will prepare a detailed report about the workshop programme to submit to my organization,” said another. “I am sure that the knowledge I have acquired will be taken into consideration in our daily working practices.”

Other comments provided insights into the amount of networking that went on – not only during the formal course itself, but also during the evenings and other allotted free time.





“I have had the chance to meet people from different countries who can be of value to me in my work,” said one participant. “I took the opportunity to swap examples of applications with other participants and lecturers,” said another, while a third one commented: “Following the workshop, I plan to develop two projects between my country and three other North African nations.”

DEVELOPMENT ISSUES

“Unprecedented changes in the theory and practice of economic development are leading to new forms of collaboration with developing countries,” explained Forgea’s Ugo Leone at a press conference to publicize the workshops and highlight the support of Sardinian government entities in the TWAS-Forgea initiative. “Italy may have reduced its military presence in certain conflict zones, but this has been balanced by an increase in humanitarian aid. This is not just emergency medical aid, but also includes the transfer of knowledge and know-how.

“Launched nine years ago with a specific focus on geominig and environmental issues,” continued Leone, “Forgea – with its new partner, TWAS – is now well positioned to make important contributions to an economic sector that is critical to the future well-being of many countries in the developing world and many countries with economies in transition.”

“TWAS’s input into this series of four workshops has been instrumental,” adds Iaccarino. “Not only does

Formal and – perhaps more importantly – informal networks have been established.

the ‘TWAS brand’ bring with it a degree of international credibility, but it also highlights to the local government in Sardinia and the national government in Rome that Italy – through the transfer of its knowledge and expertise – can play a crucial role in the sustainable development of its poorer neighbours.”

With the formal and – perhaps more importantly – informal networks that have been established during this series of four workshops, it is hoped that the investment made by the Italian government – although designed to cover only the costs of the workshops – will have a lasting effect in the target countries long after the participants of the final workshop return home. ■

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HOW CAPACITY IS BUILT

TWAS AND THE THIRD WORLD NETWORK OF SCIENTIFIC ORGANIZATIONS (TWNISO) HAVE HELD A SERIES OF WORKSHOPS SPONSORED BY THE UNITED NATIONS DEVELOPMENT PROGRAMME'S SPECIAL UNIT FOR SOUTH-SOUTH COOPERATION (UNDP-SSC), EACH EXAMINING AN ISSUE CRITICAL FOR SCIENTIFIC AND ECONOMIC DEVELOPMENT. THE EIGHTH WORKSHOP IN THE SERIES, CO-SPONSORED BY THE UNITED NATIONS UNIVERSITY'S INSTITUTE FOR ADVANCED STUDIES (UNU-IAS), ASKED THE QUESTION: HOW CAN COUNTRIES BUILD CAPACITY TO SUPPORT SUSTAINABLE DEVELOPMENT?

There are 193 countries in today's world. However, fewer than 40 are classed as 'developed' countries where people enjoy high standards of wealth and health.

The level of development – in terms of both the economic well-being and the health of its population – of the remaining 150 or so nations, many of which are located in the South, varies widely.

The Millennium Development Goals (MDGs), announced by former UN Secretary General Kofi Annan in 2000, call for the elimination or reduction of poverty and hunger, universal education, gender equality, improving the health of mothers and children, combating diseases, sustainable use of environmental resources, and the development of fair and open trading regulations and global partnerships.



The MDGs can only be achieved through the application of knowledge and, in particular, knowledge of science and technology. Indeed, over the past 200 years, developed countries have effectively used science and technology to drive their national progress.

For developing countries to fully exploit all that science can offer, however, they need to build and sustain educational and scientific capacity, both at the individual and institutional level. The challenge is to nurture and maintain a critical mass of highly qualified and innovative teachers, technicians and scientists in every country so that they, in turn, are able to build the capacity of such groups as farmers, women and the urban poor.

However, despite the international community's emphasis on capacity building, there are still no clear guidelines on how to achieve 'built capacity'.



To examine these issues, the Third World Network of Scientific Organizations (TWNISO) teamed up once again with TWAS and the United Nations Development Programme Special Unit for South-South Cooperation (UNDP-SSC) to organize the eighth in a series of workshops aimed at tackling critical science and development challenges. For this workshop, an additional partner, the United Nations University Institute of Advanced Studies (UNU-IAS), based in Japan, joined the sponsors.

The workshop, ‘Capacity Building for Sustainable Development’, held in Trieste, Italy, on 10-13 October 2006, brought together 19 scientists and other development workers from 14 countries in the South, who interacted with a six-member advisory board of TWAS Fellows and other eminent researchers (see box, this page). Given the over-arching topical nature of the workshop, several other people interested in sustainable development issues also requested to attend the workshop to interact with the participants during the discussion sessions. These included: Ravinder Bhatia, staff member of the international educational programme ‘The Scholar Ship’ (www.thescholarship.com); Mosad Elmissiry, Department of Electrical Engineering, University of Zimbabwe; Vikram Soni, National Physical Laboratory, New Delhi, India; and Faith Wanjiru, coordinator and founding member of the Youth Agency in Development of Science, Technology and Innovations (YADSTI, www.yadsti.org), Kenya.

By bringing together a diverse group of participants, each with a different case study to present, and giving them an opportunity to engage in interactive

dialogue and discussion, several key themes emerged which participants considered critical to successful capacity building experiences.

DEFINITIONS

“One of the biggest tasks facing those addressing the challenge of sustainable development is the need to generate the capacity to apply science and technology towards this goal.”

That was how Faridah Shah, chair of the advisory board, introduced the workshop – an introduction

ADVISORY BOARD

Farida Shah (TWAS Fellow 2002), chief executive officer, BioIT Technologies (M) Sdn Bhd, Malaysia, chaired the advisory board for the ‘Capacity Building for Sustainable Development’ workshop.

Other advisory board members included:

- *Dorairajan Balasubramanian (TWAS Fellow 1997), L.V. Prasad Eye Institute, Hyderabad, India;*
- *Linda Chisholm, Human Sciences Research Council, South Africa;*
- *Francisco Simplicio, Division for Knowledge Management, UNDP-SSC;*
- *Zinaida Fadeeva, research associate, UNU-IAS;*
- *Yoko Mochizuki, Education for Sustainable Development Programme, UNU-IAS.*



that neatly outlined the aims of the workshop. Exactly how is scientific and technological capacity built – and what can be learned from those case studies that have successfully demonstrated the building of scientific capacity?

But what exactly is ‘capacity building’? According to the United Nations Development Programme (UNDP), ‘capacity building’ is defined as:

- the creation of an enabling environment with appropriate policy and legal frameworks;
- institutional development, including community participation (of women, in particular); and
- human resources development and strengthening of managerial systems.

The UNDP also notes that capacity building is a continuous, long-term process in which all stakeholders participate, including government ministries, local authorities, nongovernmental organizations, professional associations and academics.

“Based on this, several important inputs are required for capacity building,” says Shah. “These include education and, in particular, higher education, to train high-level scientists; resources and physical infrastructure such as buildings, laboratories, research stations and consumable supplies; the importance of integrating research into regional and international science programmes; and the long-term value of linking research to development in a wider policy context.”

Capacity building is a continuous, long-term process in which all stakeholders participate.



Among the over-arching themes highlighted by Shah when considering the application of science and technology to sustainable development was the need:

- to consider issues more systematically rather than in isolation;
- to recognize that sustainable development issues are likely to be interdisciplinary or multidisciplinary in their focus;
- to acknowledge the role of multiple actors and the importance of partnerships with communities, governments and other interested organizations; and
- to emphasize issues of particular concern to girls and women.



IN ACTION

Many of the 19 case studies presented during the four-day workshop covered one or more of these issues. Shirshendu Mukherjee, International Centre for Genetic Engineering and Biotechnology (ICGEB), India, and Sergio Pastrana, Cuban Academy of Sciences, for example, highlighted the role of education in developing national capacity in biotechnology. William van der Berg, working for the United Nations Environment Programme (UNEP) in post-conflict Afghanistan, and Benjamin Sita, University of Pretoria, working in the border region between Malawi, Mozambique and Zambia, emphasized the need to work with local communities.

In Afghanistan, van der Berg worked with local people to rehabilitate traditional sources of drinking and irrigation water. “More than 25 years of war and conflict have resulted in the breakdown of social and traditional systems of natural resource management,” explained van der Berg. “Pilot projects addressed issues at the individual village level. By building capacity – and trust – at this level, we were able to begin tackling issues affecting not only the target village, but nearby villages as well – issues such as the management of pastureland and other commonly held property.” (See box, p. 48).

“The Rural Livelihoods Consortium (RLC) is comprised of universities, research institutes and non-governmental organizations,” explained Sita. “The

People must be trained to think ‘outside the box.’

region we work in is home to people that speak *Chinkyanja*, who, despite the national borders between them, share a common history and common traditions.”

Through their work, which has involved a network of stakeholders, RLC has helped resource-poor farmers in the region improve their crop yields, process their products and gain access both to micro-credit loans and markets. As a result, farmers have now intensified their production of staple crops. This has not only led to greater food security but also greater crop diversification for local and regional markets. Higher earnings, in

turn, have enabled farmers to buy farm machinery, creating a fledgling machinery market in the region (see box, p. 48).

Girls and women were the focus of several case studies. In Nigeria, for example, Damian

Asawalam, Michael Okpara University of Agriculture, described how introducing new varieties of high-yielding rice has helped women farmers in eastern Nigeria to increase yields; and Lutfor Rahman, Association for the Advancement of Information Technology, Bangladesh, described how women doctors have been assisted in learning how to use computers and the internet. Despite initial questions concerning how such communication technologies could help general practitioners, internet search engines and e-mail discussion groups now play integral roles in these women’s daily lives.



SHARING INNOVATIVE EXPERIENCES

The case studies presented during the workshop will be edited and presented to a wider, non-technical audience as part of the UNDP-TWAS-TWNSO Sharing Innovative Experiences series of publications that will be distributed free-of-charge throughout the South and made available on the internet (tcdc.undp.org/widenew). In this way, it is hoped that, not only will the lessons learned from the case studies be more widely disseminated, but that the key themes that emerge will also be brought to the attention of donors, aid agencies, nongovernmental organizations, policy-makers and other stakeholders. Indeed, the ultimate goal of this project is that, by sharing these experiences, others will be able to build required capacity both more quickly and more efficiently by melding the experience to their own set of circumstances. This should help many developing nations in their efforts to attain the Millennium Development Goals and provide benefits for all.



OVER-ARCHING ISSUES

While the workshop covered a range of subjects, from scientific inputs into traditional agriculture to the use of modern communication technologies, and the case studies were presented by a wide range of organizations – including community-based organizations, universities and research institutions, governmental organizations and international organizations – some common themes emerged that can provide a guide to building capacity for sustainable development.

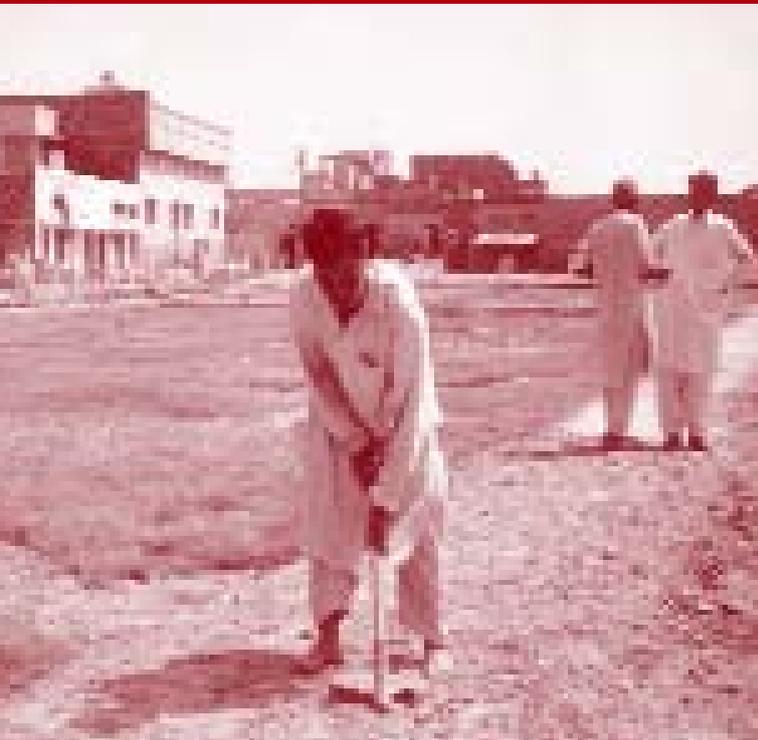
Among these over-arching issues was the need to break down barriers. Such barriers include those often present when communities seek help from local officials, as was the case in Pakistan highlighted by Muhammed Mahmoud, Community Action Programme (CAP), Pakistan (see box, p. 57), or, conversely, when governments seek to persuade private compa-

nies to invest more in research and development, as was highlighted by Connie Vedovello, Brazilian Innovation Agency (FINEP), Brazil.

“To break out of the status quo,” said Zinaida Fadeeva, UNU-IAS, “such barriers must be overcome and people must be trained to think ‘outside the box.’”

Similarly, communities – whether resource-poor farmers living in remote areas, or research scientists working in academia – also need help to forge links with other development sectors. Participants agreed that successful capacity building often depended on successful lobbying, especially at the level of local and national government.

“Raising awareness and establishing a dialogue with politicians is important,” said Fadeeva. Indeed, although certain projects initially failed to attract the interest of politicians, once they had established a



track record of success, politicians were eager to publicly endorse them. “This was the case with our project to renovate the parks in slum areas of Faisalabad,” confirmed CAP’s Muhammed Mahmoud.

“Developing links with the local press and highlighting successful initiatives is a good way of raising the profile of a project in political circles,” added Shah, who urged participants to investigate such opportunities on their return home.

Participants also identified the need for involving local communities in the development and design of

projects so that they have a feeling of ‘ownership’. In this way, local ‘leaders’ can then seek to influence policymakers to “break out of the status quo”.

“Communities must be convinced that they can manage things for themselves,” confirmed Timmi Tillmann, Indigenous Knowledge and Peoples Network for Capacity Building in Mainland Mountain Southeast Asia (IKAP). IKAP works in Cambodia, China, Laos, Myanmar, Thailand and Vietnam and is concerned with the right of indigenous communities to determine their own path to sustainable development. This is achieved partly through designing a series of interactive workshops to ‘train the trainers’ and encourage networking among different indigenous communities so that they can learn from one another.

Involving local communities and facilitating them to take action on their own can help avoid a major pitfall of earlier development projects – that of making people reliant on donor agencies.

“Pilot and demonstration projects are also important,” said Fadeeva. “People must see to believe.”

Indeed the replication of successful experiences was rapid in areas where the impact of the project could be seen – such as the improved yields in farmers’ fields in the RLC programme in southern Africa.

“Scientists must also use pilot projects to develop ideas towards commercialization,” added Shah.

Such projects were highlighted in several case studies, including Melaka Biotechnology Corporation, a private company founded by Shah that is now commercializing the by-products of two research and



development projects: the micro-propagation of herbal, aromatic and ornamental crops, and the extraction of essential oils from aromatic plants (see ‘Biotechnology: Prospects and Challenges’, *TWAS Newsletter*, Vol. 18, No. 4, pp. 36-41). Melaka has also set up the infrastructure to help ‘incubate’ other biotechnology-based businesses and is providing entrepreneurship experience for young businesspeople in Malaysia with an interest in biotechnology.

During the workshop, Parameshwar Iyer explained how scientists at the Indian Institute of Science, Bangalore, are investigating the best ways of growing and processing biodiesel that can be used as a substitute for fuel oils; and Dawit Abate, Addis Ababa University, Ethiopia, revealed how several small-scale mushroom producing companies had been established as a result of research and development that now allows mushroom spawn to be produced without such contaminants as the spores of unwanted fungi.

CONNECTIONS

Feedback from participants has highlighted the fact that the workshop format, which provides ample time for discussion after each paper, created a vibrant ‘group dynamic’. Despite the diverse experiences presented by participants, many have agreed to remain in contact with one another to continue the exchange of ideas and experiences. With this in mind, TWAS,

TWNSO and UNDP-SSC are investigating ways to facilitate such a network.

In the meantime, participants have been asked to revise their case study reports based on comments from the advisory board. These improved case studies will then be edited into a standardized format and published by TWAS, TWNSO, UNU-IAS and UNDP-SSC in 2007 as volume 14 of the *Sharing Innovative Experiences* series (see box, p. 45).

Distributing the printed case studies free-of-charge and via the internet will ensure that the participants’ capacity building efforts will reach a broad audience, including decision makers. This should help others replicate the successful experiences and accelerate capacity building and the diffusion of sustainable development into new regions and different sectors of developing countries’ economies – the ultimate goal of the project and of the sponsoring organizations. ■

**People must see
to believe.**

CASE STUDY: AFGHANISTAN – REVITALIZING OLD CUSTOMS

More than 25 years of conflict have removed a generation of men from many rural regions of Afghanistan, fragmented families and divided villages, littered agricultural fields with mines, and severely damaged traditional systems of irrigation – karez, underground pipelines that lead from a spring to a village. Indeed karez were often used to hide arms and ammunition during the conflicts and were thus targeted and destroyed by invading forces.

Against this background, William van der Berg entered Afghanistan as part of the Community Based Natural Resource Management (CBNRM) component of the United Nations Environment Programme's Post Conflict Branch (UNEP-PCoB).

In 2005, PCoB began a series of pilot projects to demonstrate both to the people of Afghanistan and the government that local people could plan and implement projects to effectively manage their natural resources if provided with small-scale financial and technical assistance.

Just a few years later, several villages have revitalized their karez systems, which now enables them to irrigate tree nurseries and orchards. In Barzagan, a village in the northwest of the country, for example, villagers were provided with almond and apricot seeds and saplings and trained in fruit-tree grafting procedures. An extension to their revitalized karez also provides uninterrupted irrigation water to the nursery and orchard. The irrigation water is also used on small vegetable plots and for grain crops cultivated on small plots of land.



Once the issues of water and fruit trees have been dealt with in a village, PCoB moves to neighbouring villages to replicate the experience. It also enters a second phase of the natural resource management rehabilitation project – that of persuading villages in a region to work together to restore and collectively manage their rangelands.

“This involves building trust between communities that may once have been at war with one another,” says van der Berg. “We try to develop a network based on group trust and seek to convince participants that if any member of the group pulls out or does not contribute his or her fair share, the project will fail. In practical terms, this is achieved by linking the funds available to mutual cooperation. By working together, however, the villages have the strength to defend themselves against outsiders such as nomads who could conceivably come in and destroy their joint efforts almost overnight.”

CASE STUDY: SOUTH AFRICA – CROSS-BORDER SOLUTIONS

The Rural Livelihoods Consortium (RLC) brings together the following groups: the University of Pretoria, South Africa; Oregon State University, United States; the Malawi offices of the International Institute of Tropical Agriculture (IITA) and the International Centre for Research in Agroforestry (ICRAF); Total Landcare, based in Malawi but with links to Washington State University, United States; and International Development Enterprises, Zambia.

RLC partners work to address the main challenges fac-

ing smallholder farmers, including challenges related to crop yields and access to markets.

Before the project began, farmers in the area of Africa bordered by Malawi, Mozambique and Zambia, who share a common language and heritage, were mainly subsistence farmers, selling what excess they could at local markets. In addition, they were using low-yielding varieties of staple crops that had no tolerance to drought, pests or diseases. As a result, soil fertility was

declining and there was little or no access to equipment such as irrigation pumps and tubing.

To tackle these issues, a research network of consortium members, designed to link university academics with nongovernmental organizations and private enterprises, was established. This was followed by the introduction and dissemination of low-cost, labour-saving irrigation technologies, such as a treadle pump based on an Indian design, and a device for alerting farmers when the soil contains enough water. Successful low-input practices were then scaled up throughout the region, as were simple processing technologies that can be used to add value to crops.

As a result, small companies have been trained to make treadle pumps and other equipment, smallholders have greater access to research results through the dissemination of databases on CDs and discussion forums, and



farmers now use simple drying technologies to produce chili peppers, paprika and other horticultural products for markets further afield – thus gaining valuable extra income.

CASE STUDY: PAKISTAN – GREENING CITY SLUMS

As recently as 2002, Jinnah Park, like many others in and around the slums of Faisalabad, a city of 2.5 million inhabitants located some 100 kilometres from Lahore in eastern Pakistan, was little more than an open sewer and mud bath. ‘Farmers’ kept illicit herds of buffalo to provide milk to the local residents and, after the rains, large ponds of stagnant water provided breeding grounds for mosquitoes. Young women were particularly affected, as they were afraid to leave their homes alone. Even ‘bride prices’ – the payment that a groom gives to his future wife’s family – were severely reduced.

With the help of Community Action Programme (CAP), residents were organized and began lobbying the local government – with some success. First, buffalo herds were forced to leave. Then sewers and drains were repaired and machinery was brought in to remove the piles of refuse that had collected over the years.

But this was only the start of the clean-up process. Following additional lobbying, the residents’ association was provided with tools, seeds, young trees and building materials.

Now, the park has been transformed into a green oasis. Gravel paths, lit at night, allow women to walk safely; carefully tended lawns provide space for children to play;

and nurseries are producing more young trees for planting in the park and others like it that are being transformed by CAP working with local residents elsewhere in Faisalabad. The park can even be rented as a venue for weddings, with the funds that are raised divided among local residents. CAP has empowered local residents by informing them what they might achieve by organizing themselves and lobbying the local council to do no more than fulfil its legal obligations. The result has been a win-win situation for everyone. Even local politicians have visited the site to claim some ‘reflected glory’.



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PEOPLE, PLACES, EVENTS

INDIAN PARLIAMENT

• **M.S. Swaminathan** (TWAS Founding Fellow) has been nominated by India's President A.P.J. Abdul Kalam as a member of India's upper house of the parliament in April 2007. The President selects 12 upper house members for their expertise in the fields of art, literature, science and social services. Swaminathan is India's best-known



M.S. Swaminathan

agricultural scientist and is considered to be the scientific leader of the Green Revolution of the 1960s, the foundation of today's sustainable agriculture. He has been director of the Indian Agricultural Research Institute, New Delhi, head of the International Rice Research Institute, Philippines, and director general of the Indian Council of Agricultural Research. For his work, Swaminathan has received several awards including the World Food (1987), the Tyler and Honda Prizes (both 1991) and the United Nations Environment Programme (UNEP) Sasakawa award (1994).

TWAS YOUNG AFFILIATES

• The TWAS Regional Office for Central and South Asia (TWAS-RO-CASA) announced the first TWAS Young Affiliates in February 2007. The five affiliates include highly re-

spected scholars from a wide range of disciplines and countries: Bozikov Utkir Abdulloevich (mathematics, Uzbekistan); Ramakrishna Subramaniam Anantha (physics, India); Aisha Mohyuddin (biomedical sciences, Pakistan); Reza Afshari (clinical toxicology, Iran); and Swapan K. Pati (theoretical sciences, India). The Young Affiliate membership programme was launched during the last TWAS General Conference (September 2006) in Angra dos Reis, Brazil.

HONORARY FELLOWSHIP

• **C.N.R. Rao** (TWAS Founding Fellow and immediate past president) was conferred an honorary fellowship from St. Catherine's College, University of Oxford, UK, in March 2007. Rao, a renowned chemist, has received a number of prestigious awards, including the Einstein Gold Medal from UNESCO (1996), the Hughes Medal of the Royal Society of London (2000), the India Science Prize (2004) and the Dan David Prize (2005). He is currently Linus Pauling research professor and honorary president of the Jawaharlal Nehru Centre for Advanced Scientific Research in Jakkur, Bangalore, India.

HONORARY RESEARCH FELLOW

• **Sospeter Mwijarubi Muhongo** (TWAS Fellow 2004) was made an honorary research fellow of the Chinese Academy of Geological Sciences in February 2007. Muhongo, a Tanzanian geologist, is the first director of the Regional Office for Africa of the International Council for Science (ICSU), chairman of the Scientific Board of the United Nations International Geoscience Pro-



Sospeter Mwijarubi Muhongo

gramme (IGCP) and professor of geological sciences at the University of Dar es Salaam, Tanzania. For his work, he received the first Robert Shackleton Award for Outstanding Research in the Precambrian Geology of Africa (2004) and served as president of the Geological Society of Africa. He will receive his official certificate and title from the Chinese academy at a formal ceremony to be held in China later this year.

RESEARCH COOPERATION AWARD

• **Uppungunduri Aswathanarayana** (TWAS Fellow 1997) was awarded the first International Research Cooperation Award for 2007 by the American Geophysical Union (AGU), the world's largest geoscience society with 46,000 members across 140 countries. This new award recognizes individual scien-



Uppungunduri Aswathanarayana



tists or small scientific teams that have made outstanding contributions to furthering earth and space sciences and using science for the benefit of society in less favoured nations. A geochemist and specialist in geoenvironment research, Aswathanarayana is honorary director of the Mahadevan International Centre for Water Resources Management in Hyderabad, India. He has previously served as professor and director of the Centre of Advanced Study in Geology, dean of the Faculty of Technology of the University of Sagar in India, professor and head of the department of geology at the University of Dar es Salaam, Tanzania, and as an adviser on environment and technology to the Ministry for the Coordination of Environmental Affairs, Mozambique. For his work, he received the Excellence in Geophysical Education Award from AGU in 2005. His second AGU award will be presented to him during a ceremony in May 2007 in Acapulco, Mexico.

INTERNATIONAL PRIZE

- **Roshdi Hifni Rashed** (TWAS Fellow 1991) was awarded the King Faisal International Prize for Islamic Studies in January 2007. Rashed was selected for his studies, authentication, commentaries and translations of Muslims' contributions to pure science, especially their achievements in mathematics and optics. He is emeritus research director of the *Centre National de la Recherche Scientifique* (CNRS) of France and honorary professor at Tokyo University, Japan. In his work, he has gained worldwide recognition for his methodology, originality and depth of under-

standing in the history of Arabic science. He is especially known for a six-volume work on the history of Arab contributions to science and four-volume work on analytical mathematics between the third and fifth Hejira centuries (approximately between the 10th and 12th centuries CE). He has received a number of previous awards, including the Legion of Honour for scientific research (1989) from the President of France, the Avicenna Gold Medal from UNESCO (1999) and the TWAS Prize for the History of Science in 1990.



Roshdi Hifni Rashed

FAROUK EL-BAZ AWARD

- The Geological Society of America (GSA) Foundation has established the Farouk El-Baz Student Award at Boston University in April 2007. With an endowment of US\$100,000 by the State of Qatar, up to one male and one female student will be awarded US\$2,500 each on an annual basis. In 1999, the GSA established the Farouk El-Baz Award for Desert Research to recognize excellence in arid land studies with annual awards totalling US\$10,000. El-Baz (TWAS Fellow 1985) is research professor and director of the Center for Remote Sensing at Boston University. He also worked on NASA's Apollo programme. El-Baz hopes that the



Farouk El-Baz

new student award will bring more attention to desert research and support the field's further advancement.

BRAZILIAN ACADEMY

- **Jacob Palis** (TWAS Fellow 1991 and current TWAS president) has been elected president of the Brazilian Academy of Sciences (ABC). Palis, a professor of mathematical sciences, previously served as vice president of ABC. He replaces Eduardo Moacyr Krieger (TWAS Fellow 1995). Palis has served in various capacities at the International Mathematical Union and the International Council for Science (ICSU) and has chaired the scientific councils of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy, the Swiss Federal Institute of Technology (ETH) in Zürich, and the *Collège de France* in Paris. He is also the recipient of several honours, including the Brazilian National Prize for Science and Technology, the Grand-Croix National Order of Scientific Merit from the President of Brazil, and the Trieste Science Prize in mathematics (2006).

WHAT'S TWAS?

TWAS, THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD, IS AN AUTONOMOUS INTERNATIONAL ORGANIZATION THAT PROMOTES SCIENTIFIC CAPACITY AND EXCELLENCE IN THE SOUTH. FOUNDED AS THE THIRD WORLD ACADEMY OF SCIENCES BY A GROUP OF EMINENT SCIENTISTS UNDER THE LEADERSHIP OF THE LATE NOBEL LAUREATE ABDUS SALAM OF PAKISTAN IN 1983, TWAS WAS OFFICIALLY LAUNCHED IN TRIESTE, ITALY, IN 1985, BY THE SECRETARY GENERAL OF THE UNITED NATIONS.

TWAS has more than 800 members from 89 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 Ministry of Foreign Affairs of Italy.

The main objectives of TWAS are to:

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

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

❖ costis.g77.org

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

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 94 science academies worldwide established in 1993, whose primary goal is to help member academies work together to inform citizens and advise decision-makers on the scientific aspects of critical global issues. ❖ www.interacademies.net/iap

The secretariat of the InterAcademy Medical Panel (IAMP), a global network of 64 medical academies and medical divisions within science and engineering academies, relocated to Trieste in May 2004 from Washington, DC, USA. IAMP and its member academies are committed to improving health worldwide, especially in developing countries.

❖ www.iamp-online.org

WANT TO KNOW MORE?

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

FELLOWSHIPS

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

GRANTS

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

EQUIPMENT

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

TRAVEL

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

CONFERENCES

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