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NEWSLETTER

A PUBLICATION OF THE WORLD ACADEMY OF SCIENCES

The New Space Age

The South aims for the stars

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▲ Ecuadorian scientists display a small Ecuador flag over their country's first satellite, Pegaso (Photo: Ecuadorian Civilian Space Agency); Farouk El-Baz, TWAS Fellow and pioneering advocate of space science for development. (Photo: Emily Johnson, Boston University)

Cover picture: India's PSLV-C25 rocket carrying the Mars Orbiter Spacecraft blasts off from the launch pad at Sriharikota on 5 November 2013. (Photo: ISRO)

▼ Four physicists and a mathematician won the 2015 Elsevier Foundation Awards for Early Career Women Scientists in the Developing World.

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EDITORIAL

SPACE: IT'S NOT JUST FOR SUPERPOWERS

▲ Romain Murenzi

For the past decade, China has mounted an initiative to explore the Moon, with each launch growing more ambitious. Last fall, millions of Indians celebrated when their nation put a spacecraft into orbit around Mars. Across the developing world, dozens of other nations are making forays into space. It is a time of extraordinary progress, and yet, in news coverage and public discussion, two objections frequently emerge:

Why should nations suffering from hunger be spending money on space programmes? Aren't these nations just flexing their muscle – at great cost – in a new era of geopolitical competition?

The concerns about human priorities and wise use of public resources are well justified. And yet, sometimes it seems this discussion reflects a view of science in the developing world that is stuck in the 1970s.

India and China get most of the headlines, but consider a smaller country: Peru.

Teams of faculty and students at three Peruvian universities have built four small satellites, all launched since late 2013. In the process, they have worked with colleagues in France, Russia and the United States. All of this experience will quickly build the nation's skill and capability.

Azerbaijan, Mauritius and Iraq recently have had similar breakthroughs, and others are close behind. But while competition can be good for innovation, it is simplistic to call this a new "space race". Rather, it's a new space age in which many nations are seeing opportunity.

The point is underscored time and again in our special report on space science. By some counts, 70 nations now have space programmes; 35 of them have space agencies. Even 10 years ago, this would have been inconceivable.

But satellites are not mere status symbols. A satellite in the sky brings real benefits on the ground in communication and weather forecasting. Satellites support geographic information systems (GIS), which can be used to improve urban water efficiency, or to track the spread of disease.

In Rwanda, my home country, the government in the late 1990s began to work with the Georgia Institute of Technology, the Dian Fossey Gorilla Fund International and the National University of Rwanda on remote sensing systems – using GIS, GPS and satellite imaging – to monitor mountain gorilla populations and their habitat. Such work is good for the land and for the gorillas, and it supports sustainable economic development through eco-tourism.

To say that a nation must choose between food and space science is misleading, because satellites support food production. They can help predict rainfall and drought, and assess the moisture content of soils. They can help to analyse soil quality and the condition of crops, allowing for early warning of crop failure. GIS and satellite images can guide cultivation practices.

TWAS has long advocated the value of space science for developing nations. One of TWAS's 10 membership committees is focused on Earth, astronomy and space sciences. We have awarded fellowships and prizes to space scientists. We see space science as an essential support for sustainable development, and for the post-2015 Sustainable Development Goals. Clearly, the data obtained by Earth observation and remote sensing can make powerful contributions to our communities and our people.

Why should developing nations go into space? Today, there's a more important question: Can they afford not to?

Romain Murenzi, *TWAS executive director*

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IN THE NEWS

Cities worldwide feeling more extreme heat

Cities around the world are likely to suffer more heatwaves in the future, a study has found, leading to greater need for planning regulation and urban cooling.

The study found a significant increase between 1973 and 2012 in the number of heat waves affecting the 217 urban areas around the world it examined. Also, almost two-thirds of cities saw significant rises in "extreme hot nights", which are dangerous because people have no respite from hot days.

SciDevNet:
http://bit.ly/1Phopb3

Mongolia holds rare text message vote on mining

Mongolians received a text message asking them to reply to vote for either budget cuts or the controversial expansion of copper and gold mines, bringing in billions in foreign investment. They chose the mines.

For a vast, sparsely populated country like Mongolia, a mobile vote may be the most efficient way to reach people. The result of the vote was non-binding, but was hailed by the prime minister as justification for pushing ahead with more mining investment.

Quartz:
http://bit.ly/1DOijJz

End of cap will devastate Jamaican farmers

From the end of next year, a change in European Union policy will likely force hundreds of thousands of people across Jamaica and beyond out of traditional work and into poverty. The change is the end to the existing cap on European sugar beet production, which will flood a sugar market already experiencing historicly low prices. George Callaghan, chief executive of the Sugar Industry Authority in Jamaica, calls the change in EU policy an "earth-shattering event" for the island.

The Guardian:
http://bit.ly/1AgD96k

Costa Rica: 75 straight days on renewable energy

Costa Rica has achieved a clean energy milestone by using 100% renewable energy for a record 75 days in a row.

Thanks to heavy rainfall, which powered four hydroelectric plants in the first three months of the year, no fossil fuels have been burnt to generate electricity from December 2014, said a report released in late March 2015. In 2014, 80% of the energy used came from hydropower, while geothermal energy made up about 10%.

The Independent:
http://ind.pn/1FQIHI8

India's urban lakes are drying up

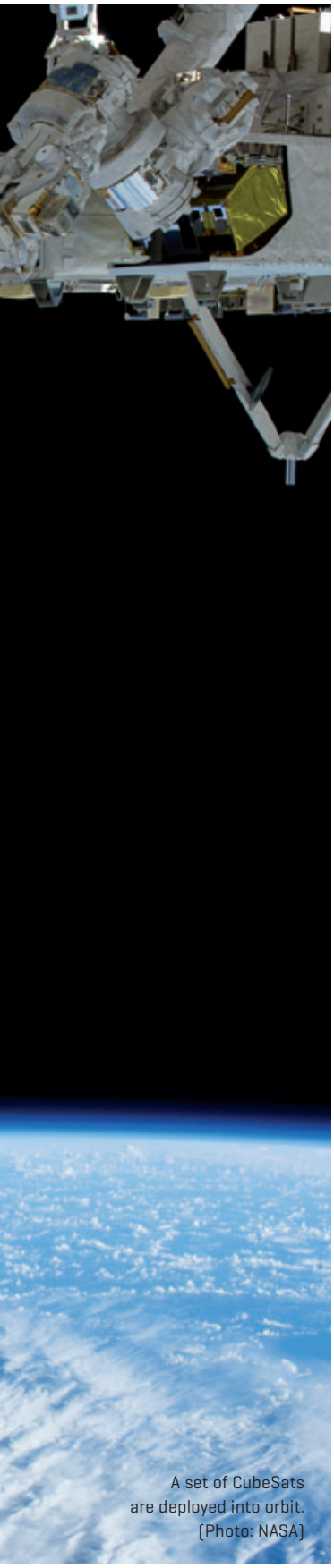
The water table of Ahmedabad, India, is dipping at an alarming rate because of unfettered urbanisation and industrialisation. Other Indian cities are having similar experiences.

The city's proposed solution is to revive the groundwater levels by restoring its lost lakes. The solution may sound simple but carrying it out on the ground is a daunting task. An optimistic Ahmedabad Municipal Corporation says it will identify the lakes under threat and then draw a plan to revive them.

Down to Earth:
http://bit.ly/1Azqo3G

SPACE SCIENCE

THE NEW SPACE AGE



A set of CubeSats are deployed into orbit. (Photo: NASA)

India is orbiting Mars. China is on the Moon. Even nations like Turkmenistan, Ecuador and Malaysia are sending satellites aloft. But what do they all hope to accomplish?

by **Sean Treacy**

Not long ago, a 41-metre rocket thrust off a launch pad in China and ascended toward space. Once it escaped Earth's atmosphere, it released a little cube, only 10-by-10-by-10 centimetres. And then, as the cube slowly stretched out the solar panels on its sides and drifted into orbit, a control room in Ecuador burst into applause.

The box was Ecuador's first satellite – a compact, inexpensive device called a CubeSat. This one was named Pegaso – Spanish for Pegasus – and on 26 April 2013 it was the centre of attention for a huge portion of Ecuador's 15 million people. In the days after the launch they toasted to Pegaso across the country, and some painted the word "Pegaso" on their cars. A song by an Ecuadorian rap artist received frequent radio airtime. One Ecuadorian radio station reported that a child born the night of the launch had been named after the satellite.

"It was something unbelievable, incredible," said Ronnie Nader, mission director of the Ecuadorian Civilian Space Agency. "A whole country that normally thinks of football or politics or whatever thing, they spent 15 minutes in space in their minds, watching that rocket soar."

Why would an underdeveloped country want to launch objects into space? Though the reasons may not be obvious, they are many. Satellites can improve vital mobile services and help track natural hazards ranging from deadly droughts to crop-devouring insects. More subtly, space sciences push countries to improve their technological know-how and motivate future scientists to think big. Now, more and more developing countries are taking advantage, and the world is entering a new space age joined by nations great and small.

At least 35 developing countries now have their own space agencies, and about the same number have had a satellite in orbit. In the two years since Pegaso's launch, Peru, Uruguay and Turkmenistan have also reached Earth's orbit for the first time. Other countries, such as Costa Rica, Ethiopia and Tunisia, are planning to finish their first satellites in coming years.

Mazlan Othman, Malaysia's first astrophysicist and the former director of the United Nations Office for Outer Space Affairs (UNOOSA), said this drive for developing countries to enter space science is partly due to space's special power to instill optimism.

"The human spirit is moved by space, and recently we – especially the young – are roused by space travel," Othman said. "What is inspiring in the US and Europe is equally inspiring in a developing country."

Nader agreed. "The idea of a space programme is to develop – to develop your own technology, your own technological culture, your own approaches," he said. "You can buy the country a satellite, but you cannot buy them their self-respect."

THE NEW BIG NAMES IN SPACE

Emerging nations such as India and China are leading the way in developing world space science, both of them launching ambitious missions. The recent surge in space missions has even led some media outlets to call it a new space race, though it bares little resemblance to the fierce Cold War competition that went by the same name. In fact, both countries have developed satellite programmes that are continuously expanding numerous benefits for people on the ground.

▲ The Indian control room celebrates after the country's Mars mission successfully put a satellite into orbit around the Red Planet. (Photo: Manjunath Kiran/AFP)

India impressed the world in September 2014 when it successfully sent the satellite Mangalyaan into the orbit of Mars. The Indian Space Research Organization is now the fourth agency in human history to reach Mars – and the only one to succeed on its first try. Mangalyaan continues to collect data on the red planet's surface and atmosphere today, and is expected to continue orbiting for years.

"Everything was developed here, and the cost is only about 1/10th of the cost of what other nations pay," said TWAS Fellow U.R. Rao, who led the Indian Space Research Organisation from 1984 to 1994. "But it has been that way since the very beginning. Even our first satellite was just about three-quarters (of the normal cost). We started with a far smaller budget."

Rao is broadly credited with establishing satellite technology in India in 1972. In the decades since, India has placed at least 70 satellites in Earth orbit for remote sensing, communications and other purposes.

Rao said India's satellite network is probably one of the most cost-effective satellite programs in the world today. He listed uses for satellites such as water resource management, agriculture management, and even medicine, because stronger communications networks are connecting remote populations to city hospitals. The country now has over 930 million mobile phone subscribers, more than 40% of them in rural areas.

Another example of a successful Indian satellite is Oceansat-2, launched in September 2010, which uses remote sensing to forecast the weather and identify good zones for fishing.

▶ Chinese satellite technology captured this image of Poyang Lake, China's largest freshwater lake and a globally important wetlands area. (Photo: SDIM)

◀ Mazlan Othman (left) and U.R. Rao.

And no matter the project, space science is a driver of India's technological growth.

"For the Mars mission, the technology development was an important challenge, because we have to keep our scientists on par," said Rao.

China's space programme has also captured worldwide attention. Its most widely recognised accomplishment was the successful landing of an unmanned spacecraft named Chang'e 3 on the Moon in 2013 – the first time any country had done that in 37 years.

In 2017, China plans to launch another spacecraft to the Moon, Chang'e 5, expected to collect up to 2 kilograms of lunar soil and return to Earth. China also plans to launch a space station in Earth orbit by 2020, and its first manned Moon mission around 2028.

With over 230 satellites in orbit, China has also been a key participant in using space technology for development. One major use for those satellites is Earth observation, useful for monitoring the climate and assisting during natural disasters. China has many reasons to prioritize disaster response in particular, from the Wenchuan Earthquake in 2008 that killed over 69,000 people and left millions homeless to the devastating 2010-11 drought that made it harder for millions to access water. China's Gaofen project has already launched two high-resolution Earth observation satellites, and plans to launch four more by 2020.

▲ Guo Huadong and Chen Fang.

"Earth observations have been proved as an invaluable technology to monitor disasters and mitigate disaster effects on society, the economy and the environment," said TWAS Fellow Guo Huadong, the director of the CAS-TWAS Centre of Excellence on Space Technology for Disaster Mitigation (SDIM) in Beijing.

On 15 March, the centre co-hosted a working session, "Earth Observations and High Technology to Reduce Risks" at the Third UN World Conference on Disaster Risk Reduction in Sendai, Japan. Other co-hosts included high-profile space technology organziations such as UNOOSA and the European Space Agency. The session released a report providing guidance on how the technology could best be used to reduce risks from natural disasters in the coming decades.

"Developed countries generally have Earth observation resources to respond and recover from major disasters, while the effects on developing countries can be devastating and long-lasting," added TWAS Young Affiliate Chen Fang, SDIM's executive deputy director.

> "Developing countries have their own problems that need solutions that only their own satellites can offer." *Mazlan Othman*

A SOURCE OF SELF-RELIANCE

Any satellite capable of communications, navigation or Earth observation creates an incredible array of applications. These tools make space science an advantageous part of country's science and technology development.

The Algerian Space Agency used UN-SPIDER, which collects international information gathered by satellites, to analyze a huge increase in swarming locusts in North Africa in 2012. Scientists could track the locusts' paths, find their breeding grounds, and kill them with pesticides. The same system provides a wildfire warning system, tracks wildfires globally and studies the atmosphere to lower risks from disasters such as hurricanes.

But the international system is imperfect enough that many developing nations have been establishing space programmes of their own.

"Most people think there is no reason for developing countries to build their own satellites because all the satellites have been built by the developed countries and all we need to do is use the data," said Othman. "I don't agree with that because developing countries have their own problems that need solutions that only their own satellites can offer."

One example is the lack of Earth observation satellites in an orbit following Earth's equator, she said. Malaysia built a satellite for equatorial imaging that was launched in 2009, but it has since ceased working. Now there are no functioning Earth observers trailing the equator, though Singapore and Brazil are working on satellites for that purpose.

Away from the equator, Earth-imaging technology is still locally important. South Africa has used it to better understand environmental changes within its borders, said Jane Olwoch, managing director of Earth observation for the South African National Space Agency. It tracks the growth of cities, for example. Also, if a country owns its own satellite, it can begin to track the progress of a flood or a fire immediately without having to work through an international agreement.

"At the international level," Olwoch said, "I think it's extremely important for every country to have a satellite for those emergency situations, that one would want to do quickly, without being put on a waiting list of other important national priorities."

Still, international partnerships can help. South Africa makes any images from South African satellites freely available, she said. That allowed it to help neighbouring Namibia as it faced deadly floods in 2011. The images helped to determine where to move people.

> What we consider the best reason of all for making something in space, the most practical reason, is the growing of the people. *Ronnie Nader*

Without a strong base of national space science, researchers in the developing world often have to turn to other countries to support their work, said Rafael Navarro-González, a planetary scientist at the National Autonomous University of Mexico (UNAM) in Mexico City. Navarro-González won a TWAS Prize in 2009 for




◀ From left: Jane Olwoch, Rafael Navarro-González, Jonathan Weltman and Ronnie Nader.

▲ The Ecuadorian control room prepares for the launch of their first satellite, Pegaso. [Photo: Ecuadorian Civilian Space Agency]

▼ An African student gets close to a CubeSat satellite as part of Africa2Moon's educational programme. [Photo: Africa2Moon]

his discovery of Mars-like soils in the Atacama Desert in Chile, now used as training ground for Mars missions. He frequently collaborates with NASA, and influenced the design of the Mars rover Curiosity.

It's difficult to do Mars-related science in Mexico, he said. Though Mexico entered space in 1985 with the satellites Morelos I and II, the Mexican Space Agency was established in 2010 and has to focus on science with clear applications. Navarro-González' research funding mainly comes from the National Council of Science and Technology (CONACYT) instead.

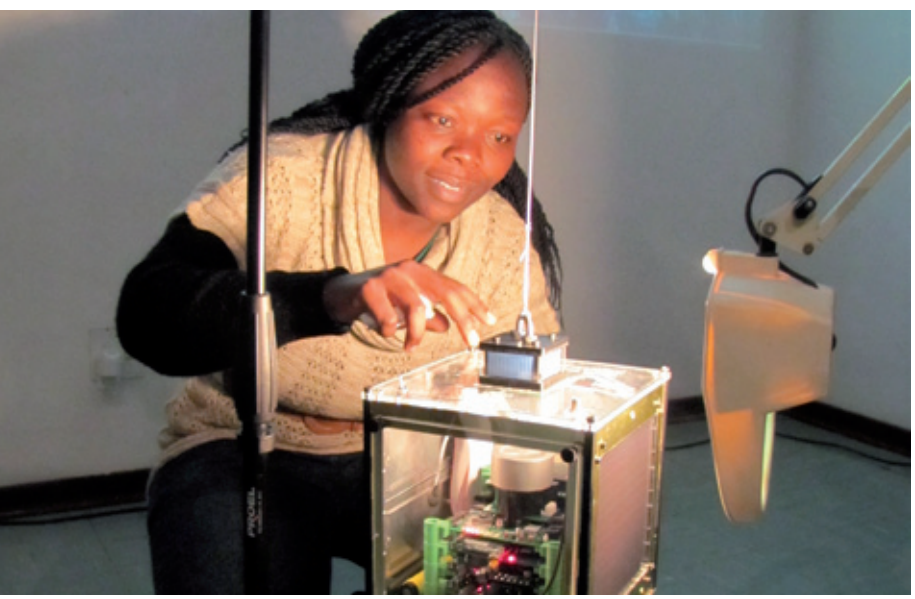
"It's very important that Mexico or any country develops a space program for the benefit of their own society and the growth of technology," he said.

UNIVERSAL ASPIRATIONS

Despite the extraordinary accomplishments in the South, critics remain. Why, for example, should Africans want to send a spacecraft to the Moon while there is so much suffering at home? Isn't that just a waste of resources that could be used for basic needs?

Those are questions Jonathan Weltman, the project administrator of a nonprofit programme called Africa2Moon, hears often. He says he rejects the premise of the question as condescending. His usual response: Why hasn't Africa been to the Moon already?

The organization is currently taking ideas for an eventual scientific Moon mission, but at this early stage it's primarily working to create excitement about the idea. The goal is to inspire and educate Africans about space science from a young age, and ultimately get an African Moon mission launched. It runs an in-school programme throughout southern Africa all the way down to the kindergarten level. "Kids today who become aware of it and inspired by it may have an opportunity one day to even work on it," he said.



Weltman said that reaching young children is important because of their reaction: They learn to dream big. "You're talking to somebody who has this open mind, and then you just talk about our ability as humankind to go beyond our planet, to look at other worlds," he said. "And it doesn't matter if you do it in the developed world or the developing world, you get that reaction."

Space can have that power whether the science is focused on machines or people. Othman recalls that when the first Malaysian astronaut, Sheikh Muszaphar Shukor, went into space in 2007 to do biological experiments at the International Space Station, Malaysia was ecstatic.

"There was a realization of what a person would need to be to go into space – healthy, that sort of thing," she said. "And then, what are you going to be doing in space? All of that created a great awareness of the bigger effects of space."

The Ecuadorian Civilian Space Agency made use of Pegaso for just that purpose. The CubeSat provided Ecuadorian scientists and engineers with a chance to create their own technology, such as a unique design for a radiation shield. And once launched, it succeeded in its main mission: giving Ecuadorian children a clear window into space.

Pegaso beamed direct video from orbit into classrooms. It also sent a signal with data that the students learned to decode, using maths to determine its position in orbit. Nader said that helps them understand the practical uses for the mathematics and physics they learn in school.

"What we consider the best reason of all for making something in space, the most practical reason," Nader said, "is the growing of the people." ◘

Q&A WILL SPACE SCIENCE NURTURE DEVELOPMENT?

by **Cristina Serra**

Developing countries are increasingly interested in space, but they also need to feed their people and improve health care. Are these goals in conflict? Three high-level experts see space science as vital for on-the-ground progress – and even for peace.

The "space race" of decades past has evolved into a busy "space era", with dozens of nations opening agencies and deploying rockets and satellites. Missions to Mars and the Moon get headlines, but today much of the activity is focused on Earth-observation, early warning of natural disasters and improved communication.

And yet, in many discussions about space science and technology for developing nations, there's an undercurrent of doubt. Should they invest in space programmes if that diverts resources from compelling needs such as education, health, and economic development?

In the following Q&A, TWAS talked with TWAS Fellow Laban Ogallo, former director of IGAD climate prediction and application centre, Nairobi, Kenya, who is currently leading an IGAD-UNDP project on capacity building for regional disaster resilience; Francisco Javier Mendieta, the director of the Mexican Space Agency; and Wu Ji, the director general of the National Space Science Center, Chinese Academy of Sciences (CAS). The email interviews were conducted by TWAS staff writer Cristina Serra.

Space research has long been carried out mainly by the United States, Russia (and the former Soviet Union) and Europe. Now, some developing countries are nurturing their own ambitions. Do developing countries really need space programmes in light of the other challenges they face?

Ogallo: Space science has been effectively used in developed countries to improve and advance almost all socio-economic sectors including aviation, transportation, communication, water management, urbanization and others. Investment in peaceful uses of space science and technology in support of progress in developing countries must be an integral component of long-term national development.

Mendieta: Space enables tackling societal needs such as the digital divide with communication satellites, agriculture, natural resources, fisheries and environmental issues with Earth monitoring satellites, as well as different types of security (internal, alimentary, sanitary, environmental). In addition, the space industry provides jobs in quality and quantity: as an extension of the aerospace sector, more developing counties are entering the space sector both with foreign direct investment and with local supply-chain small and medium enterprises.

Wu: Space programmes are not the first priority for developing countries. Economic development and solving fundamental social problems are much more demanding for the governments. However, for large developing countries such as China, India and Brazil, space programmes can be a useful tool to help development. Satellite communication and broadcasting can bring modern world information to the rural areas; satellite remote-sensing can give updated information of land-use and disaster monitoring. Taking into account other benefits, such as the political effect and their service also to the national defence, it is not that expensive to have an independent space programme.

Is there a model of "space science for the South" that is different when compared to the US or the Soviet Union 50 years ago?

Mendieta: Building scientific and technical capacities is a general goal

> The objective of space science programmes is to discover. Therefore cooperation in space science is fundamental. *Wu Ji*

among developing countries. There must be a careful reflection on balancing the government budget for space systems and services to attend their societal needs and the budget to participate in space exploration in cooperation with developed countries. Nowadays, we are encountering a different and evolving economic scenario in the space sector, hence developing countries can take advantage of the best practices of developed countries and "jump" directly onto new schemes to foster their space sector. Finally, "space science for the South" can really be a new opportunity, since many developing countries have specificities that can require particular space solutions, for example tropical orbits.

Wu: At the beginning of the space age, in the 1960s, there was a space race between the Soviet Union and the US. The political purposes were much more important than science and benefits for human beings. Even now, some of the space exploration programmes are still aiming at gaining political power and influence. Developing countries have shortcuts to develop their own programmes: they could start space programmes from micro satellites or even cube-satellites. Once a satellite is in space and operating, the effect on the public is also huge and the government's investment can get support from the general public very easily.

Ogallo: Effective space science applications in developing countries require enhanced capacity building, education, and regional investments in basic infrastructure and research. Developing countries should adopt systems that take advantage of what is available and planned, but also include scenarios that will allow them to escape being disadvantaged in future.

What kind of return on investment (ROI) could developing countries have from investments in space research?

Wu: The ROI comes from several aspects. First of all, from engineering education. Building a spacecraft requires knowledge from many disciplines such as mathematics, physics, mechanics, chemistry, electrical engineering and optical engineering. Secondly, if a satellite can carry an application payload, such as a transponder or a camera, it will bring solid return on applications in communication, remote sensing and other fields. Finally, there is certainly a political return from the successful space mission.

Ogallo: To calculate ROI one has to be able to assess investment benefits data and assess against the cost of investment, which is sometimes very hard to do. The kind of ROI that could be adopted by developing countries will not only be thematic, but also regional specific. These will require a framework for their standardization to enable to make some comparison across various sectors, countries and regions.

Mendieta: Several developing countries are already benefitting from the ROI in the aeronautical field: Mexico has been witnessing a sustained growth in this sector, both in manufacturing and also in R&D activities. The space field can be thought as a natural prolongation of the aeronautical world, but nowadays another sector is decidedly contributing: information technology and communications, for example in the expanding global navigation satellite system applications. As in the aeronautical field, Mexico is starting

to attract space companies to make alliances and even establish some facilities in the country; the Mexican Space Agency is working to get training, technology transfer and, in the mid-term, production transfer. The ROI will be in high-level job creation, export figures, regional development and technology balance.

Could space science be used to promote cooperation among nations and be a basis for science diplomacy in developing countries?

Ogallo: Space-based science and technologies have provided tools and systems for many applications including support to global, regional and national security monitoring and early warning. That has contributed immensely to intelligence information gathering and other applications that continue to improve global and regional peace agendas.

Mendieta: The space research is an ideal scenario for cooperation among countries: the International Space Station is the iconic example, and future large-dimension missions, both robotic and human spaceflight, will definitively rely on international cooperation. Developing countries must find ways to enter this cooperation scenario, starting even with modest participation and enhancing their involvement in an adaptive way.

Wu: Yes. The objective of space science programmes is to discover, avoiding duplications since the discovery can be claimed only once. Therefore cooperation in space science is fundamental. There is an international organization, called the Committee on Space Research – COSPAR – whose mission is to promote international cooperation in space research. Many research institutes from developing countries are members of COSPAR.

> I believe that a win-win scenario can be reached with cooperation between developed and developing countries. *Francisco Javier Mendieta-Jimenez*

Should developed countries be partners in assisting developing nations to increase their own capacity building in space science?

Mendieta: I believe that a win-win scenario can be reached with cooperation between developed and developing countries as it has been, for example, in the Mexican aeronautical sector. By establishing in Mexico, companies have developed their supply-chain network, not only because of the geopolitical location of Mexico or the low-wage workmanship, but because of the growing production of high-level technicians and engineers, as well as applied research centres that can provide high-level local R&D capabilities.

Wu: I am sure that developed countries are happy to assist developing countries in building their own space programmes, particularly in space science. The reason is that nobody would like to repeat what others have already done. Therefore, helping each other and focusing on key scientific unknowns are primary goals of all scientific communities. In COSPAR, there is a capacity building programme to help the developing countries participate in space research programmes.

Ogallo: Developed countries should be partners to developing nations to increase global capacity building in space science and technology, and developing countries should have their own strategy and a well-defined agenda for peaceful use of space science and technology.

BIOGRAPHIES

Laban Ogallo, a 2002 TWAS Fellow, professor of meteorology at University of Nairobi, and former director of IGAD climate prediction and application centre, Nairobi, Kenya. His main areas of research interest include climate change, climate modelling, prediction and applications of climate information in integrated disaster risk reduction, and sustainable development efforts.

Francisco Javier Mendieta-Jimenez is the director general of the Mexican Space Agency. He first served as the director of the Applied Physics Division at the Centre for Scientific Research and High Education of Ensenada, Baja California (CICESE), then served as the centre's director general.

Wu Ji is the director general of National Space Science Center, Chinese Academy of Sciences. He is a full member of the International Academy of Astronautics (IAA), and a fellow of IEEE. Wu was the chief designer and project manager of the payload and application system of Geo-space Double Star Program. Currently, he is the project manager of payload subsystem of Chang'e-3, an unmanned lunar exploration mission operated by the China National Space Administration.

In the past, space science had a powerful military and intelligence orientation. Has this changed since the end of the Cold War?

Wu: Top-level space technologies are still confidential because of their intrinsic characteristics. However, general space technology is already considered a field that university students can master in a few years. The basic knowledge can be found in textbooks. They are not secret anymore, therefore, it can be mastered by any developing country. If some country considers it a military confidential technology, this in the end would block that country from knowledge acquisition and cooperation.

Ogallo: Connecting space science to military and intelligence orientation is still a big issue in developed and developing countries. Education on immense opportunities from peaceful applications of space science, supported with strong education and capacity-building frameworks, needs to be enhanced and continued to help demystify these issues.

> "Developing countries should have their own strategy and a well-defined agenda for peaceful use of space science and technology."
>
> *Laban Ogallo*

Mendieta: I am convinced that developing countries are all privileging peaceful uses of space.

Last year, India mounted its first mission to Mars. China has a very ambitious Moon programme. Do you think that developing countries will move in this direction? With what benefits?

Ogallo: Space science provides competitive advantage in some areas of development, and I believe that developing countries will attempt to invest collectively to improve knowledge of our galaxy, maximizing opportunities at regional, national and local levels.

Mendieta: Space research is an enormous booster for technological development, and all developing countries wish to enter this scheme to enhance their competitiveness. However, many countries cannot afford the heavy investments needed for huge space missions and tend to privilege space applications for societal needs. A wise and innovative strategy must be devised to help these countries cooperate, make alliances or even participate in joint developments, in a win-win scenario.

Wu: When a developing country first enters a space research programme, it should avoid ambitious targets as going to the Moon or Mars. The best way is to start with a micro-satellite or cube-satellite programme. Only if a nation can master the basic technology, can it think about more ambitious programmes. ◘

FAROUK EL-BAZ: LESSONS FROM SPACE

After playing an historic role in the first Moon landings, Egyptian TWAS Fellow Farouk El-Baz has spent decades using space science to improve life on Earth.

by **Edward W. Lempinen**

As a hard-working young Egyptian geologist, Farouk El-Baz created his place in the history of space exploration with a leadership role in the NASA Apollo Moon missions in the 1960s and '70s. Though just a few years past his PhD research, he helped to select lunar landing sites. He instructed crewmembers in geological observations from orbit, and trained them in space photography.

When the Apollo lunar programme ended in 1972, El-Baz's career evolved: Instead of gazing at the Moon, he would use satellites to look back at Earth. If the new work had a lower profile, it was nonetheless pioneering and vitally important. And as an Egyptian, he had a natural interest in deserts, especially those in the Arab world.

Today, more than 40 years later, El-Baz is based in the United States as director of the Boston University Center for Remote Sensing, but he's still closely involved with Egypt and the developing world. "Water is life," he says in a recent video produced by the university. "We know that we will need more water as populations increase and the economy develops... There is no question in my mind that applying advanced science and technology would allow us to find more water for future use."

But he also has a parallel mission: to persuade Arab nations and other developing countries that a space programme can be enormously valuable, both for technological advancement and for inspiring a new generation. While advances have been uneven and great challenges remain, El-Baz continues to campaign for progress at high levels in education, policy and science diplomacy, across many countries.

"It is simplistic to think of a 'space programme' as shooting rockets into space," El-Baz said in an email interview with TWAS. "In reality, it is the upgrading of scientific research and the technological advancement of a whole generation of young people."

El-Baz was born in Zagazig, Egypt, about 70 kilometers northeast of Cairo. In 1958, at the age of 20, he received his bachelor's degree in chemistry and geology from Aim Shams University. He continued his education in the United States, earning his master's and PhD (1964) in the University of Missouri system. His PhD work included a year of research at MIT.

By 1967, he was working with NASA. But it was not an easy time to be a young Arab immigrant at such a high-powered science centre. "There were no other foreigners, not to mention Arabs, who had my responsibility," he recalled. "Because I had no training in astronautics, I knew that I had to work twice as hard as everyone else to be accepted. Then, the Six-Day War between Egypt and Israel began less than three months later.

▼ Farouk El-Baz, wearing a mask, gives a photography mission briefing in advance of the Apollo-Soyuz Test Project in 1975. The three American astronauts, from left, are: Thomas P. Stafford, Vance D. Brand and Donald K. Slayton. El-Baz wore the mask to protect the crewmen from possible exposure to disease before the launch. [Photo: NASA]

> I have hope in the younger generation. They don't seem to take the borders so seriously. *Farouk El-Baz*

▲ El-Baz with Boston University (BU) student Share-Leigh Bernard, who works as an assistant at the BU Center for Remote Sensing. [Photo: Emily Johnson, Boston University]

▼ Farouk El-Baz [Photo: Barbara Ross]

My having just immigrated from Egypt made it doubly difficult, as the US government supported Israel wholeheartedly. I knew that without being critically important to the programme, I would disappear in an eye-blink."

But with strong commitment and tireless work, he advanced to positions of influence and prominence. After the lunar programme ended, El-Baz moved through a series of successful assignments. NASA named him principle investigator for earth observation and photography on the first joint US-Soviet space mission, with a focus that included collecting images of the Sahara Desert. Soon he was creating networks between US and Chinese desert researchers. And in 1978, he was named science adviser to Egyptian President Anwar Sadat.

El-Baz was elected a TWAS Fellow in 1985, and a year later, he landed at Boston University, where he remains to this day.

One of the enduring lessons of his experience is the power of space science to lift entire nations. During the Apollo programme, he said, NASA had affiliated scientists at 126 educational institutions, which provided a systemic boost for US research culture. Space programmes have had similar effects in Japan, India and China.

Earth observation can be helpful in a range of development projects, but applications to agriculture are "particularly significant", El-Baz said. Space images can be used to evaluate crop health, find new fields and locate sources of groundwater in arid areas.

"India's first satellite in Earth orbit was dedicated to monitoring agriculture in the country," he said. "This allowed researchers to help farmers better plan seeding times and fertilizer use to increase production. Today, India feeds itself – an incredible accomplishment that was aided by observations from space."

El-Baz's work has helped discover groundwater reserves in Egypt, Oman, and the United Arab Emirates. He also discovered potentially massive reserves in the war-ravaged region of Darfur in Sudan, and he believes it could help to ease conflict.

Meanwhile, he continues to navigate the currents of Egyptian culture. He has long advocated an ambitious plan in which Egypt's urban development would be diverted from rich agricultural lands along the Nile and into adjacent desert areas. President Abdel Fattah el-Sisi has expressed interest, and appointed El-Baz to his Advisory Council of Scientists and Technologists.

El-Baz also has urged a pan-Arabic space agency, and though it hasn't happened yet, he remains hopeful. One positive sign is in the United Arab Emirates' plan to send a craft to study the atmosphere of Mars. He sees another in the young scientists of the region, who press ahead in a time of turmoil to pursue their dreams. Over the next 50 years, he predicts, they will drive new regional collaboration.

"Politically, there are a lot of differences between Arab countries," he recently told Al-Fanar Media. "But scientifically, we're the same people. We speak the same language, have similar aims and we could achieve so much more together... I have hope in the younger generation. They don't seem to take the borders so seriously. I see it here at Boston University: Students come here from all over the Arab world and they suddenly realize they're one people." ◘

ITALY & TWAS: A FRUITFUL PARTNERSHIP

TWAS and three other international science organizations based in Italy were the focus of a high-level presentation involving top officials of the Italian Parliament and the Ministry of Foreign Affairs.

by **Cristina Serra**

Science and technology are a common language that unifies people. Higher education shapes future generations and is critical for economic growth. Together they can build prosperity and help cross geographical and political borders, to act as a tool for global peace.

These feelings and beliefs were the core elements that characterized a public event held 10 June 2015 at the Italian Parliament, in the capital city of Rome, where TWAS and three other international institutes presented their work to Italian ministers, parliamentarians and scientists.

The Ministry of Foreign Affairs, with Undersecretary Mario Giro, organized the event that was hosted by the Chamber of Deputies, with the title: "The international science centres in Italy for the system of research and for the country".

TWAS was joined by two other Trieste-based centres – the Abdus Salam International Centre for Theoretical Physics (ICTP) and the International Centre of Genetic Engineering and Biotechnology (ICGEB), along with the International Center for Relativistic Astrophysics Network (ICRANet) based in Pescara.

"These four centres represent a major point of strength in the Italian plan that envisions the internationalization of 'Made in Italy'," said Giro, undersecretary for foreign affairs and international cooperation. He stressed that their presence and scientific activity in Italy have important, positive impacts on Italy's international image. In fact, they help shape the global agenda of Italian research and help Italy to establish and maintain strategic alliances.

Romain Murenzi, the executive director of TWAS, surveyed the Academy's successes in building a respected global academy that supports science in the developing world. This progress, he added, would not have been possible without Italy's "steadfast" support.

"Through every step, the government of Italy was a partner in our mission to build science in developing world," Murenzi said. "It is no exaggeration to say that, without Italy, none of our accomplishments would be possible."

Among the participants, representatives for the policy institutions were: Marina Sereni, vice president of the Chamber of Deputies; Stefania Giannini, minister of education, university and research; and Loredana Panariti, assessor of the

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▼ Nobel laureate Carlo Rubbia (standing, right). Seated, from left to right: Vincenzo D'Antuono, prefect of Pescara; Stefano Gresta, president, National Institute of Geophysics and Volcanology; Luciano Maiani, president of the ICTP scientific committee; Diassina Di Maggio, director, APRE (Agency for the European Promotion of Research). (Photo: Studio Luxardo, Rome)

◀ Opening of the event. From left to right: Loredana Panariti, Friuli Venezia Giulia assessor; Marina Sereni, vice president, Italian Chamber of Deputies; Undersecretary Mario Giro; Stefania Giannini, minister of education.

> "The Italian administration will continue to support these systems as a global resource."
>
> *Mario Giro*

▼ Marina Sereni, vice president Chamber of Deputies, and Mario Giro.

Friuli Venezia Giulia region in charge of employment, training, education, equal opportunities, youth policies, research and universities.

As Giro noted, Italy's annual investment of approximately 30 million euros in the science institutions generates an important return on investment, both in terms of production and employment, and in terms of collaborations with other organizations, countries and private entities such as the Bill and Melinda Gates Foundation. "The Italian administration will continue to support these systems as a global resources," Giro told the audience.

Presentations from the international research institutions were given by Fernando Quevedo, director of ICTP; Mauro Giacca, director general of ICGEB; and Remo Ruffini, director of ICRANet. Among the attendees at the Chamber was Nobel Prize winner Carlo Rubbia, a 1992 TWAS Fellow.

Speaking on the over 100,000 foreign scholars who visited ICTP since its founding in 1964, Quevedo said that many today consider themselves informal ambassadors of Italy in their home countries.

Giacca commented on the frontier research of its centre, including investigations into myocardial infarction and the identification of the site within the cell where the HIV virus hides. Ruffini, the director of ICRANet, presented some of the most recent discoveries in astrophysics.

These four centres, as Minister Giannini noted, have in common scientific excellence, international scope and focus on cooperation. And speaking on science at the Chamber of Deputies, to discuss the Italian frontier research, carries a strong political message.

In his concluding remarks, Murenzi highlighted how the TWAS network has grown over the past three decades to encompass the world. Today, TWAS has nearly 1,150 Fellows from 90 countries, and has three partners that operate under the Academy's umbrella: the Organization for Women in Science for the Developing World (OWSD); IAP, the global network of science academies; and the InterAcademy Medical Panel (IAMP), a network of the world's medical academies.

However, "our work is far from complete", he reminded the audience. "Eighty-one nations remain classified as lagging in science and technology. Of the world's 48 Least Developed Countries, 34 are in Africa. And indeed, Africa has only begun to tap its potential in science and engineering.

"Italy has provided life-giving contributions to our work, in good and bad times," he added. "This is why I say that, among scientists in the developing world, the beautiful city of Trieste is seen as a leader, and as a beacon of hope. When you talk about TWAS – and about the other international centres – our scientists inevitably think of Italy with admiration and with the deepest gratitude."

Speaking on Africa, a young continent with so much promise, Murenzi said it will take commitment to fully develop this potential. But TWAS, OWSD, IAP and IAMP, he maintained, are focused on building stronger African nations through science and science education. ◘

SOUTH AFRICA TO HOST REGIONAL OFFICE

Through a new association with the Academy of Science of South Africa, TWAS hopes to build its presence as a science and engineering leader across sub-Saharan Africa.

by **Sean Treacy**

TWAS's regional office in sub-Saharan Africa is being transferred to South Africa, in a move to strengthen TWAS's presence and advance its mission on the continent.

The TWAS Regional Office for sub-Saharan Africa, also known as TWAS-ROSSA, will be based at the Academy of Science of South Africa (ASSAf) headquarters in Pretoria.

"Because of South Africa's strong research and educational institutions and its globally influential science policy leadership, we believe it will be an excellent host for the regional office and very capable of guiding its transition to a science centre," said TWAS Executive Director Romain Murenzi.

"ASSAf is greatly honoured to be identified as the new host of the TWAS Regional Office," said TWAS Fellow Roseanne Diab, executive officer of ASSAf and coordinator of the office. "We shall commit our resources to further the objectives of TWAS. The hosting represents an opportunity to strengthen our mutual interests in promoting young scientists and creating opportunities for them to become global players."

ROSSA is one of five TWAS regional offices, each based in a different region of the developing world. It had previously been based at the African Academy of Sciences in Nairobi, Kenya. The TWAS Council approved the change 27 January 2015 and it became effective 5 March.

Murenzi said TWAS-ROSSA had been the only one among the five offices that was not directly connected to a national government. The TWAS Council was looking for that kind of relationship to help the office evolve into a regional science centre– and found it with South Africa.

"No other country in Africa has had the same commitment to TWAS," he said.

TWAS's 2009 General Meeting was hosted in Durban, South Africa. And in 2010, 2012, 2013, and 2014, South Africa sent either its science minister or another major policy leader to the meeting. South Africa's Ministry of Science and Technology has agreed to provide 70 PhD fellowships and 10 postdoctoral

▼ From left: Romain Murenzi, Naledi Pandor and Roseanne Diab.

▲ A new fellowship between the South African National Research Foundation and TWAS will benefit 240 early-career scientists. (Photo: Kate Holt/Africa Practice)

fellowships to TWAS through the South African National Research Foundation (NRF). ASSAf also hosts a national chapter of the Organization for Women in Science for the Developing World (OWSD) an international organization based in Trieste, Italy, that works in close association with TWAS.

Murenzi visited ASSAf offices 17-20 June 2015 to inaugurate the new regional office. He also met with Diab and South African Minister of Science and Technology Naledi Pandor, and officially exchanged the signed fellowship agreement with acting NRF CEO Beverley Damonse.

The fellowship will run from 2015 to 2018, benefitting up to 240 early-career scientists from Africa by the time the agreement has ended.

According to Stanley Maphosa, the international liaison manager for ASSAf, TWAS-ROSSA is already preparing for a young scientists' conference on women's empowerment in science, which will be held in Pretoria in September. They hope to organize several such conferences each year and host them in different countries throughout sub-Saharan Africa.

> "No other country in Africa has had the same commitment to TWAS."
>
> *Romain Murenzi*

It's also part of the office's duties to select TWAS Young Affiliates; winners of the annual TWAS Regional Prize; and young scientists to attend the annual life sciences forum Biovision.NXT in France.

ASSAf also plans to hire a web developer to shape the ROSSA website, to make it more user-friendly to those who might be interested in the office's news and announcements, said Maphosa.

"We want to make a website that's interactive and attractive," he explained, "so it becomes an appealing website to use, and also to have a social media presence." ◘

TODAY'S SCHOLARS, TOMORROW'S LEADERS

Five physicists and mathematicians, from Nigeria, Sudan and Vietnam, won the 2015 Elsevier Foundation Awards for Early Career Women Scientists.

Four physicists and a mathematician have been named winners of the 2015 Elsevier Foundation Awards for Early Career Women Scientists in the Developing World, in recognition of research that has strong potential social and economic benefits.

The winning scholars are from Nigeria, Sudan and Vietnam and were honoured for accomplishments in nanoparticle physics, atmospheric physics, medical physics and computational mathematics. The Elsevier Foundation awards are given in partnership with the Organization for Women in Science for the Developing World (OWSD) and TWAS. The women received their awards on 14 February at the American Association for the Advancement of Science (AAAS) Annual Meeting in San Jose, California.

The winners are:

- **Mojisola Oluwyemisi Adeniyi**, head of the Atmospheric Physics/ Meteorological Research Group, Department of Physics, University of Ibadan, Nigeria (lower-atmospheric physics). For her research using modeling to understand weather and climate, as well as atmospheric radioactivity, lightning and food security. Her research has shed light on when to best plant staple crops in Nigeria.
- **Nashwa Eassa**, assistant professor of physics, Al Neelain University, Khartoum, Sudan (nanoparticle physics). For her research on a type of high-speed semiconductor, focusing on how to lessen the film that accumulates on its surface and interferes with the flow of electrical current. She is also involved in a project developing methods for using solar radiation to treat water and for splitting water molecules so that hydrogen can be collected.
- **Dang Thi Oanh**, head of the Division of Science, Thai Nguyen University of Information and Communications Technology, Vietnam (computational mathematics). For developing algorithms that are used to solve problems that are normally too complicated for computers. Her work has helped to improve the accuracy of these methods, typically used for solving problems in fields such as artificial intelligence.
- **Rabia Salihu Sa'id**, deputy dean of student affairs, Bayero University, Nigeria

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http://twas.org/node/8676/

▼ The winners of the 2015 Elsevier Foundation Awards for Early Career Women Scientists in the Developing World, from left, Rabia Salihu Sa'id; Mojisola Usikalu; Nashwa Eassa; Mojisola Oluwyemisi Adeniyi; and Dang Thi Oanh. (Photo: The Elsevier Foundation)

INSPIRATION ON FILM

A short film by Nicole Leghissa of Trieste, Italy, captures the inspiring stories of five women scientists from the developing world who won the 2015 Elsevier Foundation awards. "When you receive an award, especially an international award, you are empowered, you are energized to do more," says Nigerian physicist Mojisola Usikalu.

See the new film at: www.tinyurl.com/ElsevierAwardees

(atmospheric physics). For research that seeks to solve Nigerian environmental challenges, such as decreasing deforestation, by turning carpenters' waste into briquettes to replace firewood. She is currently working on a project to gather atmospheric data, and is a mentor in science projects that encourage youth participation.

- **Mojisola Usikalu**, senior lecturer in physics, Covenant University, Nigeria (medical/radiation physics). For her research on how radiation affects health, finding that exposure to microwave radiation, for example, could increase anxiety and reduce sperm counts in animals. She also promotes physics in her home country through programmes that guide young women into studying university-level physics.

The 2015 Elsevier Foundation awards competition focused on physics and mathematics, and a selection a panel of eminent scholars and mathematicians selected each winner based on her achievements. The prize included USD5,000 and all-expenses-paid attendance at the 2015 AAAS Annual Meeting. Also, the Abdus Salam International Centre for Theoretical Physics (ICTP), based in Trieste, Italy, is offering each of the winners free attendance and accommodation at one its workshops or conferences.

"OWSD is very proud to have been a key partner in these awards over the last five years. Each year, five very talented women scientists have been selected from countries with challenging conditions for science in general and for women in particular," said Professor Fang Xin, president of OWSD. "Furthermore, this year's awards are in maths and physics, two fields that typically have a low take-up rate for women. The fact that the awards are presented during the AAAS Annual Meeting gives the awardees high visibility and they will make many important contacts here to further their research. I extend my full congratulations to this year's inspiring winners."

"TWAS is committed to reducing the gap between men and women in the science and engineering professions, so that we can better achieve sustainable development in all nations," said TWAS executive director Romain Murenzi. "The 2015 Elsevier Award winners, through their excellent research and commitment to education, represent the important progress we are making. Clearly, these young women will be leaders in their fields of research and in their countries."

> "This award will demonstrate how women can contribute to our society for the greater good." *Rabia Salihu Sa'id*

David Ruth, executive director of the Elsevier Foundation, said: "We are very honoured to be able to recognize these remarkable women who are working to overcome obstacles and make valuable contributions in their respective fields. These women are leaders and we are delighted to be able to celebrate them at this year's AAAS meeting."

Sa'id, a mother of six children, acknowledged the importance of winning such awards in encouraging girls to reach for the stars. "In some areas of our country, girls' education is struggling to be recognized," Sa'id said. "This award will demonstrate how women can contribute to our society for the greater good."

Eassa stressed the impact of the award. "The prize is very encouraging for Arab women", she said, "and will show girls in my country that they can achieve their career goals, too." ◘

◀ Jacob Palis, who served as president of TWAS from 2007 through 2012.

PALIS WINS ABDUS SALAM MEDAL

by **Edward W. Lempinen**

Former TWAS President Jacob Palis has long been an advocate for science in the developing world – first in Brazil, and then globally. The Abdus Salam Medal reflects his commitment to the vision and ideals of TWAS's founder.

Former TWAS President Jacob Palis has been named winner of the 2015 Abdus Salam Medal, a recognition of his years of leadership and global impact in building science and engineering for the advancement of the developing world.

Palis, an early leader in Brazil's embrace of science for development, was elected a TWAS Fellow in 1991, and he served as president from 2007 through 2012. He will receive the award at the 26th TWAS General Meeting, slated for 18-21 November in Vienna, Austria. The TWAS Council selected him as the medal winner during the TWAS 25th General Meeting in the Sultanate of Oman.

"Professor Palis is a brilliant mathematician and scientist," said current TWAS President Bai Chunli of China. "Academically, he is very well recognized and highly regarded. He has contributed hugely to the promotion of scientific collaboration and the cultivation of a young generation of scientists in developing countries. Both as president of TWAS and as a TWAS member, his work and contributions brought us to where we are today."

Palis has served as president of the Brazilian Academy of Sciences since 2007.

"Perhaps this most special honour was bestowed upon me in view of my great passion for TWAS, designed by Abdus Salam to carry on the building up of science all over the world, with focus on developing countries, to the benefit of their societies," Palis said.

The Abdus Salam Medal is one of TWAS's most prestigious awards. It is named for the eminent Pakistani physicist who founded the International Centre for Theoretical Physics (ICTP) in 1964, won the Nobel Prize in physics in 1979, and convened some of the most eminent scientists of the developing world to found TWAS in 1983. The medal was instituted in 1995, a year before Salam's death.

In a 2013 interview, Palis described meeting Salam shortly after he was elected a TWAS Fellow. Salam offered some brief but profound advice: "My son, think big!"

Palis took that advice to heart, becoming a guiding figure in his home country, a strong presence at ICTP, and then an energetic leader at TWAS. He served as TWAS secretary-general from 2001 through 2006. In 2010, he was awarded the prestigious Balzan Prize for mathematics.

Under Palis' direction, TWAS experienced significant growth: It opened five regional offices, created new prizes, and dramatically expanded its endowment fund. The number of research grants, PhD fellowships and postdoctoral fellowships available to scientists in the developing world all grew dramatically. ◘

Learn more:
www.twas.org/node/8623

R&D FOR A CARIBBEAN FUTURE

by **Edward W. Lempinen**

When TWAS joined top policy and science leaders in Grenada, they heard a pointed message: a better future for the Caribbean Basin requires the political will to support research and education.

Despite chronic poverty and public debt, Caribbean nations must increase investments in research and development and science education, top science and policy leaders said at high-level regional conference in Grenada.

Led by Grenada Prime Minister Keith Mitchell and joined by TWAS Council member Harold Ramkissoon and TWAS Executive Director Romain Murenzi, speakers at the conference urged nations of the Caribbean Community to summon the political will to support new investments. Without a sustained commitment, they suggested, the nations will struggle to address economic growth and science-related challenges such as climate change and disaster preparation and will continue to suffer from debilitating brain drain.

"Inadequate expenditure on R&D has been for too long our greatest obstacle to development in the region, and we must now make investment in R&D a top priority," said Mitchell, a PhD-level mathematician, in the keynote address "We have no choice, if we are going to ensure a secure future."

Mitchell is the prime minister in charge of science and technology for CARICOM, an organization of 15 Caribbean nations and dependencies that was founded in 1973. His remarks came during the 2nd High-Level CARICOM S&T Meeting, "Strengthening and Utilizing S&T in the Caribbean", that ran from 26-28 March 2015 in Grand Anse, Grenada. The meeting was organized by the CARICOM Science, Technology and Innovation Committee; CARISCIENCE; UNESCO; and the TWAS Regional Office for Latin America and the Caribbean (ROLAC).

The meeting was attended by science and education ministers and other top-level government officials from Antigua and Barbuda; the Bahamas; Barbados; the British Virgin Islands; Dominica; Grenada; Jamaica; Trinidad and Tobago. It also featured representatives of the private sector and the Caribbean diaspora.

In addition to Murenzi and Ramkissoon, speakers included TWAS Fellow Anthony K. Cheetham, vice-president and treasurer of the Royal Society, and Carlos Alberto Aragão de Carvalho Filho, former ROLAC chairman.

▼ Prime Minister Keith Mitchell of Grenada (right) met with TWAS Executive Director Romain Murenzi during the CARICOM High-level S&T Meeting.

▼ TWAS Council member Harold Ramkissoon.

Ramkissoon serves as the head of the CARICOM S&T committee and was the chief meeting organizer. Formerly an independent senator in the Trinidad and Tobago Parliament, he serves on the board of UNESCO's International Centre for South-South Cooperation and as a professor emeritus of mathematics at the University of the West Indies. In an email interview, he noted that no country in the region spends more than 0.2% of its gross domestic product on R&D.

The meeting endorsed the Grand Anse Declaration, which called on Caribbean nations to make a stronger, more coordinated commitment to economic development through science, technology and education. ◘

Learn more:
www.twas.org/node/11079/

A BIG STEP FOR SCIENCE IN ECUADOR

by **Cristina Serra**

With close ties to TWAS and a commitment to scientific strength, the Academy of Sciences of Ecuador inducted 25 scientists in its first class of elected members.

Ecuador is an emerging country with a thriving economy, abundant resources and a good educational system. But until recently it did not have a science academy to guide its research and drive its development.

Eugenia del Pino Veintimilla, a renowned biologist and Ecuador's first TWAS Fellow (1989), with a few colleagues committed herself to this goal and worked for several years to succeed. In March 2013, the *Academia de Ciencias del Ecuador* (ACE) came to life and on 19 February 2015 it welcomed 25 new members during an official ceremony held in the capital city of Quito. With the new scholars, ACE now counts 31 affiliates.

"Having such an academy is very important for Ecuador," ACE President Carlos A. Soria said in a recent interview. "It will serve to promote research and the development of science, creating a rich core of experts available to contribute to the development of the nation."

The road to the Academy's inception was marked by meetings among the founding members – TWAS Fellow Santiago Ron (2014); Katya Romoleroux; Tjitte de Vries; Jaime Costales; Soria; and del Pino – who examined the statutes of other science academies in South America.

After the founding of ACE, the leaders received an encouraging visit from TWAS President Bai Chunli, who also serves as president of the Chinese Academy of Sciences. The new academy "is an important milestone achievement", Bai said after returning from Ecuador. "It has the good potential to be a scientific think-tank for the country on major S&T and development issues."

As a TWAS Fellow, del Pino was aware that Ecuador could learn from TWAS's experience and benefit from the Academy's support in terms of visibility and international connections. She also credited IAP, the global network of science academies, with providing an important boost for ACE.

TWAS Fellow Michael Clegg, co-chair of InterAmerican Network of Academies of Sciences (IANAS), was in Quito for the ceremony. "Science academies are critical institutions for every nation, like Ecuador, which aspires to develop its capacities in science and technology," he said.

ACE's new members, chosen through a merit-based evaluation and with an eye on gender equality, include mechanical engineers, microbiologists, environmental chemists, marine ecologists and immunologists.

"I think that ACE will have a fundamental role in fostering scientific research and becoming a bridge between the Ecuadorian scientific community and the Ecuadorian government and society in general," said Ron, a professor of evolutionary biology at *Pontificia Universidad Católica*. Ron was elected to TWAS last year.

▼ Founding members of the *Academia de Ciencias del Ecuador*, from left: Tjitte de Vries, Katya Romoleroux, Carlos Soria, Eugenia del Pino, Santiago Ron.

Learn more:
www.twas.org/node/8701

◀ A university is more than a collection of beautiful buildings, says Pakistani scholar Atta-ur-Rahman.

A BOLD VISION FOR ISLAMIC SCIENCE

by **Cristina Serra**

To boost economic growth and raise a new generation scientists, Islamic countries need stronger leadership and a commitment to research, says influential scholar Atta-ur-Rahman of Pakistan.

To fulfil their aspirations for economic development and scientific strength, Islamic nations should develop a long-term strategy and triple investments in science, says Atta-ur-Rahman, the influential Pakistani researcher and educator.

In a recent interview, Rahman warned that Islamic nations risk being left behind unless their leaders re-orient to improve education and focus on scientific research.

"The biggest challenge [in the Islamic world] is the lack of visionary leadership," he said.

Rahman has long advocated education as a critical component in building strength and resilience, and in the interview, he said that universities too often are seen as only a collection of beautiful buildings. Instead, he argued, they should be hubs for creative minds and centers of excellence in research and training for a new generation of scientists.

"The key to a high-quality university is having a world-class faculty that can carry out pioneering research," he said.

Rahman, a TWAS Fellow since 1985, was interviewed in Muscat, Oman, by TWAS and Omani journalists during the Academy's 25th General Meeting in October 2014. From 2000 to 2008, he served high-level ministerial appointments and guided ambitious reforms that have boosted Pakistani education at all levels. He was elected as Fellow of Royal Society (London) and awarded the UNESCO Science Prize in recognition of his research contributions in natural product chemistry.

With respect to higher education, Pakistan – and Rahman's initiatives there – offer a valuable lesson for developing countries.

In 2002, Pakistan was facing pressure from the Taliban, which opposed science culture. At that time, Rahman was serving as federal minister for science and technology under President Pervez Musharraf. Thanks to his commitment, Pakistan launched a five-step plan for scientific development, and propelled higher education reforms that produced considerable progress in science and technology.

His efforts gave Pakistan one of the best digital libraries in the world and the world's largest Fulbright Scholarship programme. For his contributions to seminal changes in the higher education sector in Pakistan, Rahman won the TWAS Prize for Institution Building in 2009.

Today, Pakistan is offering competitive training and creating an attractive environment to persuade diaspora scientists to return home.

"Our world is knowledge-driven," observes Rahman. "Developing a strong knowledge economy depends on dynamic interplay among three important partners: the government, the private sector, and the universities and research centres. Only through their interaction, aimed at developing a strong knowledge economy, can a nation make rapid progress." ◘

Learn more:
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PEOPLE, PLACES & EVENTS

TWAS FELLOWS SHARE TYLER PRIZE

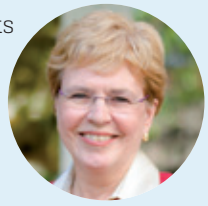
Madhav Gadgil, D.D. Kosambi visiting research professor of interdisciplinary studies at Goa University, and **Jane Lubchenco**, distinguished university professor in marine studies at Oregon State University, are the 2015 winners of the Tyler Prize for Environmental Achievement.

Both Gadgil and Lubchenco are TWAS Fellows (1991 and 2004 respectively). They received the prize for their commitment to the development of conservation and sustainability policies at local to international levels.

The Tyler Prize, established by John and Alice Tyler in 1973, acknowledges scientists who bring contributions to environmental science, environmental health and energy.

Madhav Gadgil is a retired professor of ecology at Indian Institute of Science. He promoted one of the first censuses of India's wild elephant populations, engaging in the study of long-term monitoring of forested regions. This led to a policy-level reduction of incentives to forest-based industries in the country.

He shaped India's National Biodiversity Act, and chaired the "Gadgil Committee" to provide guidelines on the protection of the Indian Western Ghats mountain range, a UNESCO World Heritage site.



Lubchenco served from 2009 to 2013 as undersecretary of commerce for oceans and atmosphere and administrator of the National Oceanic and Atmospheric Administration (NOAA). She currently serves as the first-ever science envoy for the ocean, an appointment with the US Department of State.

She made fundamental discoveries on the ecological and evolutionary relationships among living organisms in complex coastal systems and has been dedicated to finding solutions that enable sustainable use of the ocean.

AUTREY NAMED MAURITIUS CHANCELLOR

Louis Jean Claude Autrey, a 2004 TWAS Fellow, has been appointed Chancellor of the University of the Mauritius. The ceremony took place 20 April 2015, in the presence of the acting Mauritius President Monique Ohsan-Bellepeau, Prime Minister Anerood Jugnauth and other eminent personalities.

Autrey, a world-renowned authority on sugar cane research and development, earned a first degree in botany from the University of London, a master's degree in phytopathology and a doctorate in virology from the University of Exeter, UK. He was awarded the doctor of science degree by the University of Exeter.

He retired as director of the Mauritius Sugar Industry Research Institute in 2007, after 40 years of service. Today, he is the president of the Mauritius Academy of Sciences and Technology, the general secretary of the International Society of Sugar Cane Technologists, the Science & Technology coordinator of Omnicane Group and he chairs the ACP Scientific Committee on Sugar, the ACP Scientific Advisory Group and the Research & Development Committee of the Mauritius Cane Industry Authority.

Autrey has authored 150 scientific papers and carried out consultancies in more than 25 countries.

SHARMA NEW INDIAN S&T SECRETARY

Ashutosh Sharma, a professor at the Indian Institute of Technology (IIT) and a 2010 TWAS Fellow, has been appointed secretary of India's Department of Science and Technology.

The January 2015 appointment has a five-year term.

He has a broad international experience built in academic institutions and has also served on the governing boards and councils of over 15 prominent scientific institutions in India.

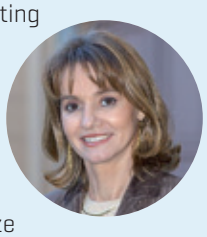
His scientific interests include nanotechnology, biomaterials and biosurfaces, nanocomposites in energy, health and environment. He is the recipient of many awards, including the TWAS Prize for scientific excellence in engineering, the Bhatnagar Prize and the Infosys Prize in Engineering and Computer Science.

Sharma obtained his MS from Pennsylvania State University (1984) and his PhD from the State University of New York, Buffalo (1988). He is currently Institute Chair Professor & C.V. Seshadri Chair Professor at IIT.

FELLOW WINS L'ORÉAL-UNESCO AWARD

Brazilian physicist and astronomer **Thaisa Storchi Bergmann**, a 2011

TWAS Fellow, is among the five winners of the 17th Annual L'Oréal-UNESCO for Women in Science Awards. By choosing five outstanding women for their scientific accomplishments, the prize aims at promoting gender balance in science, proving that women can make a difference. This year the L'Oréal-UNESCO prize has acknowledged scientific excellence in the physical sciences. In addition to Storchi Bergmann, the winners are: Rajaâ Cherkaoui El Moursli from Morocco, Yi Xie from China, Dame Carol Robinson from the United Kingdom and Molly S. Shoichet from Canada.



Storchi Bergmann is a professor at the Physics Institute of the Federal University of Rio Grande do Sul, Porto Alegre, Brazil, where she is the head of the Astrophysics Research Group. She also coordinates a project for the development of astrophysics in the south of Brazil. Her research focuses mainly on the study of supermassive black holes in the center of galaxies and how they influence the evolution of the universe. Storchi Bergmann is a member of the Brazilian Academy of Sciences and participates as Brazilian representative in the board of the Gemini Observatory, an international partnership that includes the United States, Canada, Brazil, Argentina, Australia and Chile.

IAP: CURRICULUM OF 'BIG IDEAS'

Science education should emphasize a small number of powerful ideas instead of overloading teachers and students with a curriculum obsessed with details, says a new publication issued by IAP, the global network of science academies.

"Working with Big Ideas of Science Education" was developed by an international team of expert scientists, and follows a previous document called "Principles and Big Ideas of Science Education" (2010).

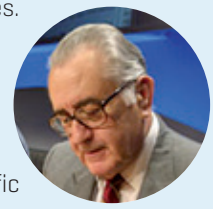
A few big, powerful ideas – which explain a range of related phenomena and events – are best suited to convey to students the fundamentals of science, the authors conclude.

And they suggest, in parallel, that curriculum content, teachers' professional training and teaching methods should be rejuvenated. In addition, reshaping small ideas to build bigger ones would propel students' creative thinking and the recognition that science and other subjects are intimately connected.

This book addresses all the professional figures concerned with improving science education: from teachers and managers, to curriculum developers and policy-makers.

IN MEMORIAM: RAIMUNDO VILLEGAS

Raimundo Villegas, the founder of the *Instituto de Estudios Avanzados* (IDEA, 1979) in Caracas, Venezuela, passed away 21 October 2014. Villegas, a 1985 TWAS Fellow and a renowned neuroscientist, was the founder and chancellor of the Latin American Academy of Sciences.



From 1969 to 1974 he served as the director at the Venezuelan Institute for Scientific Research, or *Instituto Venezolano de Investigaciones Cientificas* (IVIC). In 1970 he founded the Center for Advanced Studies (CEA-IVIC). From 1979 to 1983 he served as Venezuela's minister for science and technology.

Villegas helped to drive advances in the structure and function of the nervous system. In the field of biotechnology, he developed new techniques to ease the production of easily accessible food for the poorest. He authored more than 80 scientific papers, most of them in international peer-reviewed journals.

IN MEMORIAM: GUSTAVO RIVAS-MIJARES

Gustavo Rivas-Mijares, a professor emeritus at *Universidad Central de Venezuela* (Central University of Venezuela, or UCV), and a 1988 TWAS Fellow, passed away 30 November 2014. Rivas-Mijares earned his MSc in sanitary engineering (1950) from the University of Michigan and his DSc from the University of California (1962). He served as director of the department of sanitary engineering at UCV from 1958-62, 1964-69 and in 1972.

Water was his field of investigation and his lifetime commitment. He addressed several issues linked to the efficient use of water, including wastewater treatment, water consumption for domestic use and origin of turbidity in natural surface waters.

He authored three important textbooks on water treatment, as well as another eight books and 136 scientific papers. He was a member of the National Academy of Sciences, Venezuela, where he served as president from 1981-85; the National Academy of Engineering, USA; and the Royal Academy of Sciences, Spain.

BE A CONTRIBUTOR

Do you have news for People, Places & Events?

Please send an email to Cristina Serra (cserra@twas.org) with a brief explanation, links to more details, and contact information.

LIFE OUTSIDE THE COMFORT ZONE

Almas Taj Awan's path in science has been unique. She has quickly travelled from hosting radio and television programmes in her home country of Pakistan to becoming a promising biotechnology researcher with international experience. Her PhD research on using the waste from orange juice production as a source of bioethanol has recently led to her being a finalist in the 2015 GIST (Global Innovation through Science and Technology) Tech-I Competition.

And her career has just begun. Now, she tells her story of what it's like to be a Pakistani scientist in Brazil, and how a PhD fellowship with TWAS enriched her life and made her scientific career possible.

"Really, are you from Pakistan? So where is your burka?"

It's a question I often hear from Brazilian people. Yes, I am Almas, a Pakistani lady; I breathe, I work, I earn an income and I am a significant member of the community where I live, whether it is Pakistan or Brazil. Unfortunately, the shifting paradigms of the emerging urban Pakistani woman are not highlighted in the media.

Passing all my teenage years as a thoughtful little girl, I finally broke my silence and started sharing my thoughts at university and joined literary societies. My passion for letting myself be heard took me to a Pakistani radio station where I started my career as a radio show host. I loved my job, and during two to three hours of live shows, it was just me and my voice flying on the FM air waves. In 2007, I got the chance to host shows on the national TV channel, PTV.

These activities were actually hobbies that went alongside with my studies. One of my university professors suggested that I apply for TWAS-CNPq fellowships. I did, and after getting approval by TWAS, I stepped into the country of football, Brazil.

It is said that when you travel you change and will never be the same again. During my PhD programme with the TWAS-CNPq fellowship and later in my post-doc, I presented my scientific work by travelling to 12 countries on five different continents. It proved to be a journey of self-discovery.

That is how I learned to appreciate life, to appreciate different cultures, to be patient with others, to move outside of my comfort zone, to make quick decisions independently, to be a risk taker, and try to live life to the fullest.

My journey from being a media person to a young woman researcher in science from a developing country was a real shift. Nonetheless, with time, I discovered that I can connect them together for community awareness.

It is because of the TWAS fellowship programme that I was able to think outside of the box and develop a much brighter vision. Currently, I am a post-doctoral researcher and I am looking for opportunities to use my skills by working on green scientific technologies and resolving environmental issues. I strongly believe in hope and struggle. Keeping that in mind, life goes on in a better way. ◘

Science diplomacy – a bridge to the future

To solve regional and global challenges, the world needs partnerships between scientists, policymakers and diplomats. They come together at **TWAS workshops and courses**.

Photo: Tartarin2009/flickr

www.twas.org/science-diplomacy

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The World Academy of Sciences for the advancement of science in developing countries – TWAS – works to advance sustainable prosperity through research, education, policy and diplomacy.

TWAS was founded in 1983 by a distinguished group of scientists from the developing world, under the leadership of Abdus Salam, the Pakistani physicist and Nobel Prize winner. Today, TWAS has nearly 1,150 elected Fellows from some 90 countries; 15 of them are Nobel laureates. It is based in Trieste, Italy, on the campus of the **Abdus Salam International Centre for Theoretical Physics (ICTP)**.

Through more than three decades, TWAS's mission has remained consistent:

- Recognize, support and promote excellence in scientific research in the developing world;
- Respond to the needs of young scientists in countries that are lagging in science and technology;
- Promote South-South and South-North cooperation in science, technology and innovation;
- Encourage scientific and engineering research and sharing of experiences in solving major problems facing developing countries.

TWAS and its partners offer nearly 500 fellowships per year to scientists in the developing world for PhD studies and post-doctoral research. TWAS prizes and awards are among the most prestigious given for scientific work in the developing world. The Academy distributes USD1.9 million in research grants every year to individual scientists and research groups. It supports visiting scientists and provides funding for regional and international science meetings.

TWAS hosts and works in association with three allied organizations on the ICTP campus:

The Organization for Women in Science for the Developing World (OWSD). At its founding in 1989, OWSD was the first international forum uniting women scientists from the developing and developed worlds. Today, OWSD has more than 4,000 members. Their objective is to strengthen the role of women in the development process and promote their representation in scientific and technological leadership.

IAP, the global network of science academies. Established in 1993 as the 'InterAcademy Panel on international issues', IAP unites more than 100 science academies worldwide. It provides high-quality independent information and advice on science and development to policymakers and the public; supports programmes on scientific capacity-building, education and communication; and leads efforts to expand international science cooperation.

The InterAcademy Medical Panel (IAMP). IAMP is a network of the world's medical academies and medical sections of academies of science and engineering. It is committed to improving human health worldwide through the coordinated global action of its 73 members.

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