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FEATURE

Worlds Apart Together

Mohamed Hassan

Science has advanced enormously over the past 25 years. Yet progress has been limited to a few countries. What can be done in developing countries to ensure that knowledge and development are shared by all?

There is little doubt that dramatic events over the past quarter century — political, economic and environmental — have shaped our world. Headline events tell the story: the collapse of apartheid in South Africa; the fall of the Berlin Wall; the birth of the Internet; the spread of new infectious diseases such as HIV/AIDS; growing concerns over global warming; the sequencing of the human genome; the Al Qaeda attacks of 11 September 2001; and the subsequent invasions of Afghanistan and Iraq.

Yet, the world has also experienced hidden undercurrents of change, with equally forceful, and perhaps even more enduring, impacts. These undercurrents often receive limited attention, until the impact becomes too visible to ignore.

One of the most profound trends of recent decades that largely went unnoticed until the past few years is the growth of frontier science, technology and innovation in a number of developing countries.

Until the late 1970s and early 1980s, China remained closed to the world. India was seen as a poor, rural nation where millions suffered from malnutrition. Brazil was a country of great inequality thwarted by a repressive military regime. South Korea's gross domestic product (GDP) was only just edging past Nigeria's. Singapore was regarded as a backwater 'island' port taking its first hesitant steps towards prosperity.

One key decision that each of these nations made to improve the lives of its citizens and its status within the global community was to take hold of science and technology (S&T) as tools for development. Since then, the countries following in their wake include Chile, Iran, Malaysia, Pakistan, Rwanda, South Africa and Vietnam. The result is that a bi-polar world of S&T (led by Europe and the USA) is gradually giving way to a multi-polar world with an increasing number of centres of science spreading across the North and the South.

NEW REALITY

Throughout his celebrated career, Abdus Salam, Nobel Laureate in physics (1979) and founding president of TWAS, the academy of sciences for the developing world, would often assert: "Science is the common heritage of humankind."

In doing so, he was gazing both backward and forward in time: back to when the cities of Baghdad and Alexandria were world centres of science, and forward to a future in which all of humanity would share in the fruits of S&T.

Twenty-five years after the creation of TWAS and a decade since his death, Salam's vision is beginning to be realized: scientific knowledge is becoming truly global in scope.

China, for example, has become a world leader in a number of technologies. Chinese scientists now publish more articles on nanotechnology in peer-reviewed international journals than any other nation, except the USA. Chinese scientists also participated as full partners in the Human Genome Project, and took the lead in identifying the genetic makeup of the severe acute respiratory syndrome (SARS) virus in 2003. Building on these efforts, China now occupies a prominent position in biotechnology and genetic engineering in the international scientific community.

India, meanwhile, has emerged as one of the world's foremost centres for information and communications technologies (ICT). The world has focused on India's 'back office' contributions to ICT — call centres and low-skilled programming work. Yet, increasingly, India's brightest minds are involved in high-end research and development (R&D) that requires world-class education and technical skills.

The Indian ICT company Infosys, which began in 1981 with seven people and US$250 in cash, now employs over 90,000 people and generates more than US$4 billion in revenues each year. Tata Consultancy, founded in 1968, is now one of Asia's largest ICT firms, with some 100,000 employees in 47 countries. Microsoft, Intel and Cisco have all opened research centres in India designed to draw on the country's well-trained and lower-cost workforce. These efforts are based, in part, on India's deeply rooted capacity in mathematics and physics, which is now finding expression not only in ICTs but also in such fields as biotechnology, pharmaceuticals and nanotechnology.

Brazil's efforts to increase agricultural yields have proved instrumental in the nation's successful biofuels initiatives. This success story is based largely on the nation's commitment to build its S&T capacity. In 1987, Brazil's universities graduated just 872 students with doctorate degrees. Today, they graduate over 7,000 students with PhDs and 25,000 with master's degrees each year.

China, India and Brazil undoubtedly lead the developing world in efforts to build national scientific and technological capacity. All three nations have recently crossed a significant threshold: each now spends at least 1% of its GDP on R&D. Each plans eventually to boost that percentage to 2–3% of GDP — a level comparable to that of a number of countries of the Organization for Economic Co-operation and Development (OECD), including Japan, South Korea, Sweden and the USA.

It should come as no surprise that unprecedented economic growth in each of these countries has been matched by dramatic growth in S&T. For example, the number of articles published in peer-reviewed international journals with at least one author from China rose from 828 in 1990 to more than 80,000 in 2007, according to *Science Watch*, a newsletter that tracks trends in global science. That represents a 100-fold increase over the past 15 years, and it now places China second only to the USA in scientific publications. Meanwhile, the number of articles with at least one author from India increased 45% between 2000 and 2005, from about 15,000 to 25,000 a year. Brazil's annual scientific output nearly tripled from 3,500 to roughly 11,000 articles between the mid-1990s and 2005.

China, India and Brazil, however, are not alone. Other developing nations are now eagerly pursuing strategies designed to promote science-based development. Malaysia, for example, is a leading exporter of high-technology products and also envisions itself as a regional knowledge hub — it is home to the new International Science, Technology and Science Centre for South–South Cooperation in Kuala Lumpur. The Arabic-speaking Gulf states are investing heavily in universities and research campuses designed eventually to transform their countries into world-class centres for S&T. Qatar, for example, has created the Science and Technology Park in Doha. ExxonMobil, Shell, Rolls Royce and the European Aeronautic Defence and Space Company (EADS) have all established offices there. The United Arab Emirates plans to build the International Academic City as an educational hub in Dubai, and the Plaza of Intelligence and Innovation City as an S&T hub in Abu Dhabi. Saudi Arabia is in the process of constructing the King Abdullah University of Science and Technology (KAUST) in Jeddah, which it will provide with a US$10 billion endowment.

IN AFRICA

All of this activity is for the good. Yet, while overall investment trends in S&T are encouraging, indicators for economic development in the poorest developing countries remain troubling.

Africa remains the most troubled region of all, although signs of progress can be found in some countries. For example, South Africa now spends about 1% of its GDP on R&D and has built strong research communities in astronomy, biotechnology and nanotechnology. Rwanda, which has placed S&T at the heart of its economic development efforts, currently invests 1.6% of its GDP on R&D. Similar trends are unfolding, to varying extents, in Kenya, Senegal, Tanzania and Uganda. Yet, deep economic problems and deficiencies in vital R&D infrastructure persist throughout. Too many countries on the continent have shown too little progress in either building their S&T capacity or improving their economic and social well-being.

Thirty-five of the world's 49 least developed countries (LDCs) are located in Africa. Nearly 70% of Africa's people live on less than US$2 a day. More than 26 million are afflicted with HIV/AIDS, a disease that claims the lives of 2.5 million each year. Nearly 1 million die each year of malaria. More than 40% do not have access to safe drinking water, and over 70% lack access to electricity. Education on the continent, while recently enjoying some signs of resurgence, continues to be inadequate, and reliable health-care continues to be out of reach for most.

Amid all of these difficulties lies a deficit that few international development agencies have acknowledged until recently: Africa simply does not have the S&T capacity to effectively address the challenges that it confronts. To make matters worse, the continent lacks sufficient infrastructure for the knowledge creation and innovation that is so badly needed.

Poverty reduction, food and energy security, adequate health-care, adaptation to climate change, environmental degradation and sustainable development are all complex issues that demand their own set of responses if they are to be successfully addressed. Yet what all of these problems have in common is a need for a critical mass of indigenous S&T expertise.

Helping Africa's most marginalized societies requires investments in the continent's most productive citizens. A balanced strategy that addresses immediate social and economic needs while simultaneously building Africa's capacities in S&T is the key. It will not be easy. But there is no alternative. Africa will not succeed over the long term unless it finds a way to do both at the same time.

IN ASIA

Asia, as outlined above, tells a different story. While economic progress has been undeniable, the progress that Asia has experienced has not been cost-free.

There is good news. China's annual GDP, for example, has grown by more than 10% over the past 5 years and India's by 8–9%. More than

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500 million people in China have been lifted out of poverty over the past quarter century, marking the largest and most rapid escape from poverty in history. Other Asian countries have experienced similar success, although not as spectacular. Vietnam's GDP, for example, has grown more than 8% a year for the past 3 years and Malaysia's has grown at 5–6%. In 1970, Malaysia's poverty rate stood at 50%; today, by some estimates, it is less than 5%. In 1993, Vietnam's poverty was nearly 60%; it is now under 20%. Economists project that if current trends continue, Asia's portion of global GDP will rise from 30% today to 50% by 2040.

However, alongside rapid economic growth, Asia faces major environmental and energy challenges. The continent is projected to lose 75% of its forests and 40% of its biodiversity over the current century. Between 1992 and 2005, per capita energy consumption in Asia grew by 70% and is still just two-thirds of the global average. Energy use in China and India is set to double. Other Asian countries have hopes of matching these growth rates as part of their ambitious plans to reach the same level of prosperity as developed countries.

Over the past quarter century, Asia has lost one-half of its forests, degraded one-third of its agricultural land and become home to 13 of the world's 15 most polluted cities, according to the Institute of Global Environmental Strategies in Japan.

India has more arable land than any other country except for the USA. Yet, over the past few years, as the impact of the green revolution has slowed and the country's growing middle class has increased in numbers and wealth, India's rising demand for foodstuffs has outpaced its ability to grow rice and wheat. Similar trends are taking place in Indonesia and the Philippines.

CHALLENGES AHEAD

Our world, especially the developing world, has indeed changed since TWAS was created 25 years ago. Significant advances in S&T have taken place. Sustained economic growth, moreover, has generated a sense of hope and optimism in countries that had fewer reasons for confidence a quarter century ago.

Scientific and industrial success in Europe and North America came at a price. Biodiversity loss and climate change have both resulted from agricultural intensification and greenhouse-gas emissions. Moreover, it now seems that much of the developing world will be following in these well-trodden footsteps.

What this means is that equity and sustainable development must be at the centre of the global agenda for S&T in the decades ahead. This dual agenda will be necessary if we are to avoid a worsening of economic conditions for the world's poorest and most marginalized people, on the one hand, and the degradation of both local and global environmental conditions, on the other.

These are the global challenges that are likely to shape TWAS's agenda for years to come. Efforts to address these challenges not only reflect the enduring value of TWAS but also serve as a fitting tribute to the principles that it was founded upon. As was true 25 years ago when the academy was launched, indigenous capacity in S&T will largely determine the level of social and economic well-being in the future, and will also play a fundamental role in whether we succeed in creating a sustainable future for ourselves and our world. ■

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