SUSTAINABLE WELL-BEING IN AFRICA

MENTION AFRICA, AND DIVERSITY IS NOT THE FIRST WORD THAT COMES TO MIND. YET, AFRICA IS A LARGE AND DIVERSE CONTINENT THAT DEFIES SIMPLE DESCRIPTIONS.

People from outside Africa often see it as a place that lends itself to simple, straightforward and often unflattering characterizations. From the outside looking in, the only clear line of division in Africa lies between North Africa and sub-Saharan Africa. Otherwise, the continent is usually seen as one. The true portrait is quite different, however.

Africa consists of 53 countries. In contrast, South America has 12 countries, North America 23, Europe 47 and Asia 50. How similar are Sudan and South Africa? Liberia and Lesotho? Mauritania and Madagascar?

But it's not just geographical and political boundaries that reflect the continent's diversity. Africa's varied ecology and vast treasure trove of resources also speak to the continent's wide-ranging diversity. It has, for instance, 14 ecological zones ranging from dry desert to humid rain forest and it is rich in diamonds, oil, gold and copper.

THE POVERTY LINE

Yet Africa is also a continent that has been persistently overburdened by poverty.

Poverty, in fact, remains Africa's chronic affliction defying a broad range of remedies that have been pursued by governments at home and by funding agencies from abroad. According to the World Bank, no fewer than 43 of the continent's countries are low-income countries and, according to the UN Conference on Trade and Development (UNCTAD), no fewer than 35 of the continent's countries are least developed countries (LDCs).

Poverty, in short, is the characteristic that makes many observers conclude that Africa lacks diversity. In their eyes, Africa is simply poor and no more.

Aggregate statistics and global economic rankings, of course, are also mirrored in the low incomes and chronic social ills that afflict the people who live there. More than 70% of all Africans live on less than USD2 a day. More than 26 million Africans are infected with HIV and an estimated 2.5 million Africans die each year of AIDS. Nearly 1 million Africans fall victim to malaria. Over 40% of all Africans do not have access to safe drinking water.

WHAT HAPPENS IN AFRICA...

What happens in Africa is, no doubt, of consequence first and foremost to the people of Africa. Yet what happens to Africa is also of consequence to the rest of the world.

That's because Africa is home to nearly 1 billion people or nearly

15% of the world's population. The population is currently experiencing an annual growth rate of 2.5%, which makes it the world's fastest growing continent. Its population, in fact, could double by 2050.

Africa, moreover, is also comprised of a huge landmass covering more than 30 million hectares. Only Asia is larger. Indeed Africa's landmass is 2 million hectares larger than Europe, the USA and Australia combined.

CHALLENGES, CHALLENGES

Africa is not only economically challenged. Not surprisingly, it is also scientifically challenged. African countries spend on average just 0.3% of their gross domestic product (GDP) on research and development (R&D) compared to a global average of 1.7%. Africa has just 164 researchers per one million population compared to a global average of nearly 1,100 researchers per one million population.

Put another way, with nearly 15% of the world's population, Africa has just 2.2% of the world's researchers. Each year, not surprisingly, it produces just 1.5% of the peer-reviewed scientific publications.

When it comes to patents, the situation is even more troublesome. The World Intellectual Property Organization's 2008 *World Patent Report* noted that only 26 of Africa's 53 countries filed patents in 2007 and in 20 of those countries the number of patents filed was fewer than four.

Less than five decades ago, South Korea was an impoverished country with a per capita GDP of USD1,630 and it had virtually no scientific infrastructure. Today, South Korea has a per capita GDP that exceeds USD20,000. It spends 2.3% of GDP on research and development (with plans to spend 5% of GDP by 2012) and has more than 3,000 researchers per one million population. A country with only 50 million people, South Korea is far outdistancing every country in Africa – and indeed the continent in the aggregate – in both scientific capacity and economic growth.

ALL IS NOT BLEAK

Yet, while troubles abound, all is not bleak in Africa. In fact, some recent trends have been encouraging. For example, in the five years preceding the international financial meltdown in 2008, GDP in Africa grew at an annual rate of more than 5%, and over the past two years many countries in Africa have been able to weather the shockwaves of the global downturn better than many northern countries, including the United States.

Meanwhile, the number of African countries that have taken significant steps to strengthen their scientific capacity has continued to rise.

Nigeria, for example, has invested in space technology to improve its ability to monitor changes in its environment. South Africa, meanwhile, has invested significant resources in nanotechnology to enhance its capabilities in providing access to safe drinking water and to advance its efforts in promoting renewable energy.

IMPEDING PROGRESS

But a host of intractable issues continue to stand in the way of whatever progress has been made. Africa may be slowly moving ahead but strong headwinds continue to hold back the continent's efforts to embark on an enduring path for economic development.



Among the compelling questions that Africa faces are these: Is the progress that has been made, however commendable and encouraging, commensurate with the scope of the problems? Are the measures sustainable? Will the advances ultimately be shared by all African countries or confined to the continent's larger and relatively more prosperous countries? Will Africa follow a path toward science-based sustainable development similar to the one that has recently unfolded in Asia, where China and India have led the way and where other countries in central and southern Asia have been buoyed by their success? Or, will it establish its own, uniquely African, paradigm for growth?

STEP BY STEP

Where should Africa start in its quest for sustainable economic development? In many ways, it already has. For nearly a decade, efforts to create a pathway for sustainable growth have focused on fundamental issues that were concisely articulated at the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa, in 2002. These challenges, presented under the acronym WEHAB, include water, energy, health, agriculture and biodiversity. Since then, climate change has been added to the list.

The key issues facing Africa, as it seeks to improve the economic and social well-being of its people, may be clear and straightforward. But how to best address these issues is not. In other words, identifying the issues, in many ways, has been the easy part, while effectively doing something about them has been another, more troublesome, matter.

That's because the challenges that Africa faces are complex and often interwoven. Answers, moreover, lie not only in science but also in a broad range of intractable social and economic challenges that must be addressed in the political arena as much as in the laboratory.

Take, for example, the issue of biodiversity. Experts in developed countries tend to view the issue of biodiversity as a question of species survival and landscape protection with long-term implications for economic and social well-being.

In Africa, however, biodiversity is a more immediate concern since so many people depend on their environment and nearby natural resources for their survival.

Put another way, in Africa, when it comes to biodiversity (and so many other issues), the focus is local and the timeframe immediate.

In terms of global warming, the international community tends to worry about questions concerning the ability of societies to adapt to warmer climates or the impact that rising sea levels and more intense storms will likely have on heavily populated coastal areas.

Again, for Africa, the impact is more immediate. Warming temperatures could pose critical risks to agricultural productivity and undermine efforts to promote food security. Indeed, according to most experts, Africa is the continent most vulnerable to climate change due to its fragile ecosystems and its lack of capacity to adapt to the changes that will accompany significant modifications in climate.

For example, as temperatures rise and rainfall decreases, the sandy soils found in Africa's dry and semi-dry regions are more likely to be transported from their current locations and carried away to distant places. Indeed soil experts have concluded that Africa currently exports 50 million tons of soil and dust particles each year.

Robbing Africa of its topsoil will have direct, on-the-ground consequences for Africa. However, as these soil and dust particles are carried air-borne to Europe and South America, they will also bring environmental problems to people living there. In today's world, distinctions between local and global impacts are becoming increasingly blurred.

A number of other fundamental societal challenges are also most acute in Africa, including access to safe drinking water and the ability to connect to reliable sources of energy.

All of these issues require indigenous capacities in science and technology if they are to be addressed effectively. Yet the continent's current levels of scientific knowledge and technical skills are exceedingly weak and its financial resources scarce.

Some 3 billion people worldwide use coal, charcoal, firewood, agricultural waste and dung to

cook – and over 20% of these people reside in Africa. More than 1.5 billion people worldwide live without access to electricity – nearly 40% of whom are in Africa.

The use of traditional energy sources poses risks to public health related to indoor air pollution and fire hazards. And a lack of access to electricity, of course, limits educational and economic opportunities – and places significant constraints on the quality of life.

GAP CLOSING

The 2010 UNESCO *World Science Report* concludes that the gap in scientific and technological capacity between the developed and the developing world is closing. For example, the developing world's share of articles in science, medicine and engineering rose from 30% in 2002 to 38% in 2010.

Nevertheless, as these percentages also suggest, the gap remains significant (three-quarters of the world's population continues to generate just one-quarter of its scientific knowledge). The gap, moreover, remains particularly acute in Africa, the world's most scientifically lagging continent.

Only four of the top 20 countries that the Institute for Scientific Information (ISI) lists as the preeminent producers of peer-reviewed articles in science and engineering are classified as developing or, more accurately, as countries with emerging economies. These countries are China, India, Brazil and Turkey. South Korea and Taiwan, which rank among the world's wealthiest and most scientifically capable countries, are also on the list. Indeed, the presence of the latter two countries, both of which were poor, countries until recently, illustrates just how quickly investments in science and technology can reduce poverty and propel efforts for sustainable economic development. The lessons conveyed by these countries offer hope for Africa.

Yet, at the same time, it could be argued that the gap in science and technology is not only widening between African countries and developed countries, but that it is also widening between African countries and other developing countries. Advances in scientific and technological capacity in the South are being led – indeed, in many ways, monopolized – by just a few countries, including China, India, Brazil, South Africa and Turkey as well as Argentina, Chile, Mexico and Malaysia.

In 1994, China produced some 1% of the articles published in peer-reviewed international journals – a third less than Switzerland, which had just 7 million people (compared to 1.2 billion people in China). Yet, by 2007, China accounted for more than 7.5% of the world's articles published in international peer-reviewed scientific journals. That moved China into second place behind only the United States, which produced nearly 26% of the world's peer-reviewed articles in 2007.

Meanwhile, Africa was producing just 1.5% of the world's scientific publications in 2007. South Africa, the continent's indisputable leader in science, accounted for more than one-quarter of this small percentage and nearly half of all the scientific publications in sub-Saharan Africa. Egypt, which ranked second in publications in Africa, accounted for nearly one-fifth of the continent's scientific articles.

The sad truth is that 30 of Africa's 53 countries were together responsible for just 0.08% of the global output of peer-reviewed scientific publications – a paltry amount confirming that most African countries had virtually no presence in the global scientific community.

STEMMING BRAIN DRAIN

While Africa has not been entirely left out of the positive economic trends that have taken place among developing countries over the past decade, it has nonetheless not kept pace with developments in science and technology in Asia and South America (or, for that matter and not surprisingly, economic growth rates in either of these two continents).

Brain drain remains a more serious problem in Africa than anywhere else both because of the small size of its S&T workforce and the willingness – indeed eagerness – of its scientists and other educated professionals to move out of Africa for better pay and working conditions.

The continent, in short, continues to lose its top scientists and engineers, whose presence and contributions it needs most to provide science- and technology-based so-



lutions to its most fundamental social and economic challenges.

Six of the top ten countries with the highest percentage of emigrated educated citizens are in Africa. More medical doctors of Ethiopian origin practice medicine in Chicago, Illinois, USA, than in Ethiopia itself. There are more Malawian medical doctors living and working in Manchester, UK, than in all of Malawi. According to a recent survey, 60% of all African postgraduate students currently attending school in the UK have no intention of returning to Africa.

REVERSAL IN FORTUNES

So, what is to be done?

Commitments must be fulfilled both by the governments in Africa and governments and international aid agencies outside of Africa.

Calls for African countries to spend at least 1% of their gross domestic product (GDP) on research and development date back to the Vienna Programme of Action in 1979. Since then, the same calls have been echoed repeatedly at conferences focusing on science and economic development in Africa, most recently at the AU summit in 2007. Nevertheless, only Rwanda and Tanzania currently meet the 1% threshold figure and both have attained this level of investment in the past few years. South Africa, despite being the continent's scientific powerhouse, spends just 0.92%. The average expenditure across the continent is just 0.3% of GDP.

In 2005, the Group of 8, a network of the world's richest countries, which has recently expanded to the Group of 20 (as a reflection of the changed world in which we live), agreed to grant USD8 billion to strengthen universities and research centres in Africa over 10 years. Yet, only a fraction of that money – less than USD200 million – has been spent.

While domestic investments in research and development continue to be short-changed and international commitments to assist Africa's own efforts to build scientific and technological capacity remain unfulfilled, the continent spends an estimated USD4 billion each year to hire foreign consultants.

Clearly, training an indigenous workforce skilled in science and technology and providing opportunities for them to address critical societal problems would have multiple benefits for the continent.

KNOWLEDGE GOES GLOBAL

We live in a global knowledge society. Therefore it stands to reason that countries with acute shortages of knowledge workers will find themselves marginalized – and impoverished – in today's world.

Broad comprehensive efforts must be undertaken at both the national and continental levels to improve the conditions of Africa's universities and research facilities.

Equally important, comparable efforts must be made to curb the 'brain drain' phenomenon. This will require dramatic increases in investments in science and technology on the part of Africa's government as well as such pan-African organizations as the African Union (AU).

Indeed the AU's efforts to develop a pan-African university system deserve encouragement and support. Yet, the regional approach at the heart of the initiative has faced difficult challenges for cooperation that have yet to be overcome. Will the host countries where the hubs of the system are



to be located be willing to fully share their facilities with other countries? Conversely, what level of resources will other countries be willing to invest in a system driven by hubs that lie beyond their borders?

External funding can also aid in Africa's efforts to rebuild its universities and research facilities. For example, the Regional Initiative in Science and Education (RISE), based at the Princeton Institute for Advanced Study in the US and supported by the Carnegie Corporation of New York, is nurturing African-based research networks for both faculty and students alike in such fields as material science, engineering, biochemistry, natural products, access to safe drinking water and coastal and marine resources.

Regional and international cooperation can undoubtedly help raise the quality of education and research in African countries. The effort, moreover, can play a critical role in enabling Africa's scientists to acquire the knowledge and skills they need to advance the Millennium Development Goals (MDGs). It can also serve as a platform that helps to integrate Africa's scientists into the global scientific community.

Yet, whether such collaborative efforts achieve the level of funding and organization that is required to meet the scope of the problem remains to be seen.

OPPORTUNITIES TO TAP

As stated earlier, Africa is not without assets and opportunities.

It is a continent that is rich in natural resources. It has a vast storehouse of biodiversity. It has a broad base of indigenous knowledge of the local ecology and natural resources. Governments in a growing number of African countries have become increasingly democratic. And it has a large diaspora that has increasingly expressed interest in working with their colleagues in Africa.

There are, moreover, several specific fields with vast economic potential where Africa has a distinct advantage over other regions of the world. With sufficient scientific capacity, these areas could become models of success that both governments and scientists throughout Africa could point to as examples of how science and technology can help boost sustainable economic development across the continent.

Take, for instance, the prospects for solar energy. By some estimates, less than 1% of the world's deserts could produce enough electricity to meet current levels of world consumption. Energy experts, moreover, estimate that there are sufficient supplies of solar energy in North Africa and the Middle East to generate 500 gigawatts (GW) of electricity, enough power meet 15% of Europe's current power needs.

The Desertec Foundation, which is being assisted by a consortium of public-private interests that includes such multinational giants as Deutsche Bank, Siemens and Munich Re, is developing a business plan that is designed to supply solar-powered electricity to both North Africa and Europe, perhaps beginning as early as 2015. The plan will call for blanketing large swatches of desert lands – up to 17,000 square hectares – with solar collectors and wind turbines that will be linked together with thousands of kilometres of power cables, including cables stretching underneath the Mediterranean Sea from North Africa to Southern Eu-

rope. In November 2009, Morocco announced its first contribution to Desertec would consist of a USD9 billion, decade-long initiative that would ultimately generate two gigawatts of power.

Meanwhile, both Nigeria and South Africa are investing in space science and technology initiatives that are designed to monitor environmental change and the changing state of natural resources. Such efforts could help South Africa assess the risk posed by forest fires and to pursue strategies that would seek to minimize that risk in the most fire-prone areas. Similarly, it could help Nigeria monitor the levels of water pollution in waterways, especially those in urban areas and in mining and mineral districts.

Biotechnology is another frontier technology that holds great promise for improving the social well-being of poor people, especially in its potential for raising agricultural productivity and improving public health. The same is true of nanoscience and nanotechnology, which focuses on manipulating matter at the atomic scale.

Nanotechnology, for example, has the potential to provide inexpensive water filters that could vastly increase access to safe drinking water in Africa. Researchers at North-West University in South Africa have constructed a pilot water treatment plant in Madibogo, a village in the remote arid region of North West Province. Nanostructured membranes are serving as the basis of state-of-the-art nanofilters for the low-cost purification of water. The initiative also sponsors community-wide classes and workshops to increase the public's ability to maintain the plant in the future, thus ensuring that safe drinking water will be available after the researchers depart.

PEOPLE FIRST

Africa's most important resource has – and always will be – its people. More than 40% of its population is under the age of fourteen.

Indeed the future of Africa lies with its youth who await the education and training they will need to compete in the global knowledge-based economy of the 21st century.

As the populations of Europe and the United States age, and as China seeks ways to overcome the consequences of its one-child policy, Africa's demographic profile holds great promise to be its strategic advantage in the years ahead (perhaps only India has a comparable advantage).

But demography is not destiny. It will take enormous investments in education, starting with primary school and continuing through postgraduate studies, to fulfil the promise of its younger citizens. It will take increased funding for building classrooms and laboratories where students can learn. It will take adequate salaries and career-long training for teachers to help guarantee that instructors have the incentives and skills to do a good job. It will take continued investments in information and communication technologies to ensure that the information and data that researchers need to succeed are easily accessible. It will take targeted aid from external sources that helps to supplement the investments of Africa's governments and pan-African institutions. And it will take a long-term view of a better future, bolstered by political stability and efficient and innovative administration that puts the people's welfare first.

Yes, we live in a time of unprecedented change where knowledge is king. But we also live in a time when principles that have been the hallmarks of successful societies for centuries remain critical elements of progress.

That is Africa's challenge: to embrace the 21st century with a determination that enables it to take advantage of the unprecedented opportunities that advances in science and technology provide. Yet, to do so in ways that will allow it to meet the critical social and economic needs of its people to not only improve their lives in the near term but also to give them hope for an even better future for their children. ■

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