

Abstract

Mankind is on the brink of a tragic era, in which the anarchic forces of the market and the incessant pressures upon natural resources on the verge of exhaustion will push sovereign states to increasingly dangerous rivalries. What will the role of research in higher education be, in response to the challenge of an active future contribution to human and social development? A good balance must be reached in the basic functions of research in order to avoid governance risks. While focusing only on the transformative function of research may pose dangers to the human dimension and development, unilateral concentration on responsible development aspects may generate reactive approaches and delay economic benefits. Disregarding the inclusiveness function may lead to slower development and even isolationism, and focusing on short-term issues is not good for long-term goals and future generations. We must reinforce research networks between 'Southern' and 'Northern', rich and poor, and developed and developing countries and institutions in order to bridge the gap between knowledge consumers and producers. This paper reviews aspects such as development, globalization and the inequality of nations; constraints and choices of the orthodox views of research; rethinking research and higher education to contribute to a better future; and knowledge integration for effective action.

INTRODUCTION

This is a time of renewed enthusiasm for higher education and research as the way forward to world development, with the establishment of millennium centres and science academies in Africa and other such initiatives in developing regions. Human and social development through higher education and research capabilities are appropriate themes in a report dedicated to the future role of higher education in an era of globalization. In this paper, however, I do not focus on the repeated promise that science, research and higher education are the surest routes to development. Instead, I argue that this can no longer be taken for granted and

concentrate on how international efforts in science and technology and higher education have missed the mark concerning unsolved issues and challenges in this domain, and on how research and higher education have grown in developing regions. I set out these ideas in this Introduction. In subsequent sections, I discuss and illustrate them and propose a rethinking of inherited perceptions with the aim of making science and technology relate more effectively and responsibly to society.

First, the intellectual rationale for science and research capacities being exclusively subordinated to the realization of practical ends as demanded by nation-states, and the universalistic approach that dismisses possible effects of national or other social and cultural dimensions upon the evolution of science, are both problematic, leading ultimately to undesirable if not tragic results. To a certain extent, this is a consequence of the prevailing ideology of scientists who, throughout the modern period, have resisted playing a political role in society. They refuse to see that, in practice, values other than the search for knowledge prevail. This corresponds to the form of education and professional training that excludes any link between the scientific endeavour and social concerns. This refusal by the scientific community to assume social responsibility can no longer be sustained because it has led to an out-of-control, conformist science without a conscience. Rethinking is overdue, given the current reality of the world and of certain countries in particular, if higher education and research are to bring about collective well-being and equity in society, (thereby improving the living conditions of most people, rather than just a small, better-off segment of the population), and salvage the Earth's environment.

Second, scientists have difficulty communicating across plural perspectives, conditioned as they are by a specialized and rather dogmatic scientific training. They generally feel uneasy about accepting and managing uncertainty, social variables and value commitments, and take comfort in reducing knowledge assessment to peer review of narrow technical issues. Basic science, however, is today recognized as

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THE ROLE OF RESEARCH IN HIGHER EDUCATION: IMPLICATIONS AND CHALLENGES FOR AN ACTIVE FUTURE CONTRIBUTION TO HUMAN AND SOCIAL DEVELOPMENT

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being only a part of a much richer whole, where criteria and tasks of quality assurance explicitly involve additional values and interests (Funtowicz and Ravetz, 1992). New forms of governance are emerging at the crossroads between science and society as useful and relevant experiences in a changing world that affect both scientists and the beneficiaries of science. In the common space where scientists and different audiences begin to meet, we can hope to find out what elements experts provide to formulate and implement policy decisions and how these elements are actually used; only this common space can help the development of socially robust knowledge.

Third, we must rethink researchers' education. Arguments for reforms aimed at creating socially responsible scientists have grown in recent years, based on the need to democratize expert knowledge and provide pluralistic expert advice to democratic institutions and to the citizenry more broadly, thereby increasing the capacity to discuss and eventually meet citizens' expectations. Since knowledge is a major asset that allows involvement in framing issues for policy attention and in designing options, the 'whats' and 'hows' of knowledge and expertise become paramount. We know by now that the growth of a higher educated stratum in society does not necessarily ensure that individual countries in today's globalized world economy will reduce social and economic inequality; higher education may be necessary, but it certainly cannot bring about a more equitable and fair society on its own.

Fourth, in weaker countries with inadequate capacities and the wrong basic infrastructure – that is, with ineffective and unstable political and social institutions – higher education, science and technology have not reduced social and economic disparities but rather increased social and economic differentials between the knowledgeable and the ignorant. Something similar may occur with the growth of domestic research capacity. Higher education and research capacities have repeatedly been shown to work better for the rich. In the developing world, particular individuals with more assets (better education, more contacts and so on) may, and in effect do, succeed in science and technology research, but their success too often leaves their society untouched or increases inequality. It has been argued that doctoral students, under today's training conditions, may become skilled specialists in finding solutions rather than thinking about the problems of society and going beyond the mere technical terms of one specialty or another (Salomon, 2006). Research groups, institutions and even countries in the developing world are often presented as success stories not because they signal lasting positive structural change, but because donors, governments and experts need success stories.

All this, however, does not imply that poor countries would have been better off without higher education, science and technology – only that research capacity per se, without social guidance or oversight and isolated from other essential components of social and moral responsibility, cannot fulfil its potential for improving people's lives.

DEVELOPMENT, GLOBALIZATION AND THE INEQUALITY OF NATIONS

The idea of development, with its renewed approaches to economic and social growth, took root in the newly born United Nations of the 1940s and 50s. This continued during the 1960s and 70s, although by then two opposing trends in development thinking had become recognizable. One consisted of widening the scope of the development strategies pursued by explicitly including social considerations such as education, health, nutrition, employment, income distribution, basic needs, poverty reduction, the environment and so on (Seers, 1972; Sábato, 1975; Herrera, 1971; Stewart, 1985; Ukoli, 1985; Hountondji, 2006). The other was represented by a return to neoclassical thinking (largely through the influence of Friedman, 1962, and Solow, 1957).

The Humboldtian principles of the university and academic science, further elaborated by the sociological contributions of Weberians and Mertonians until well into the 20th century, had constituted a coherent normative system, which was challenged by attempts to deal with the massification of education in the post-Second World War period. Like development and growth approaches, mass education became an object of analysis in the 1970s, inspiring the notion of the knowledge economy, the human capital school of economic growth, the concept of manpower planning and, somewhat later, an agenda of academic capitalism and managerialism. In particular, Bell (1973) made the strong point, drawn from the growth theory of economics of the 1950s and 60s, that the human capital factor played an increasingly important role in explaining the sum total of economic growth (Sörlin and Vessuri, 2007). Post-industrial society, as described and envisaged by Bell, seemed to be the material underpinning for the mass growth of education in new generations.

In the late 1970s, there was a strong move towards open-market policies that emphasized privatization and liberalization, with greater weight given to growth than to income distribution and social objectives. This was soon being followed in all countries of the Organization for Economic Co-operation and Development (OECD). It became the conventional wisdom of the West and later of practically the whole world, whether willingly or not.

Important exceptions were the East Asian countries that successfully took a different route to development, which differed significantly from the orthodox policy prescriptions then in fashion.

During the 1980s and 90s, a dominant view of growth based on ‘globalization’ and ‘free markets’ dismissed questions of ethnicity and culture and ignored the problems posed by nationalism, fundamentalism and terrorism. Science policy documents in many countries emphasized the economic benefits of science, along with strategic and security aspects. Public spending for higher education and research became a matter of debate, and most arguments turned on the issue of accountability and the need to reduce the size of the state. The connections between academic research and competitiveness in the first half of the 1990s, a growing literature on the ‘new social contract’ of science (Gibbons et al., 1994), and the continued expansion of undergraduate enrolment were part and parcel of a new understanding that wherever a large portion of the workforce had academic degrees, the rates of economic growth were persistently higher (OECD, 1996).

Within this climate of opinion, universities began to be perceived as prerequisites for the success of nations and, increasingly, of regions and cities. However, in order to deliver, they had to change their norms to become more flexible and readier to respond to social and economic demands. Knowledge increasingly came to be seen as a commodity, its practitioners became objects of trade, and higher education became a service industry included within the scope of the World Trade Organization (WTO).

Nevertheless, a different current of thought questioned this ‘economicist’ turn of knowledge. In the 1990s, the United Nations Development Programme (UNDP) launched the *Human Development Reports* series. These reports introduced the human development index, which tracks changes in people’s quality of life. In the late 1990s, Sen, a close collaborator of the UNDP series, provided the broadest possible conception of development as freedom: a process of expanding the real free-

doms that people enjoy for their economic well-being, social opportunities and political rights (Sen, 1999). Such freedoms were also perceived as being instrumental as the principal means of attaining development. Clearly, values are the leading dimension here. The question is whether society is good, fair and just, and if knowledge can improve it. The emphasis moved to attaining a higher level of public engagement in science, and widening participation in higher education among all social groups.

The growth of knowledge-handling institutions in the current process of globalization is unprecedented. Global enrolment of students has multiplied, as has the number of Ph.Ds, institutions, scientific journals, scientists and academic staff. The increase is visible in other areas as well. A scientific background today is valuable to stock analysts, science publishers and government policy experts. This shows that scientific training can be put to good use away from the laboratory bench and away from academia. However, this expansion has until recently taken place within a restricted portion of the developed world. Despite decades of efforts to implant science and knowledge in the developing world, figures show that research and development (R&D) funds, scientists, doctoral degrees, scientific publications, patents and high-quality institutions continue to be sharply concentrated within the OECD area.

By contrast, in weaker countries, efforts to put science and technology at the service of human development have yielded dismal results. Globalization as we know it today is fundamentally asymmetric. In its benefits and risks, it works less well for poor countries and for the poor institutions within developing countries.

Enrolments and institutions in some developing countries are experiencing exponential growth, although they usually start from a base so low as to be totally insufficient. This might change during this century. China, India and Brazil, to mention just the most notable examples in terms of numbers, are telling. Estimates of growth in these countries are enormous, although the stakes are also unprecedented.

Box I.6.1 Quantifying asymmetry

There are only 94.3 scientific researchers per million people in the least developed countries (LDCs), against 313 in the other developing countries (ODCs) and 3,728 in rich countries (high-income OECD). Enrolment in university-level institutions (that is, tertiary school enrolment as a share of the corresponding age group) is only 3.5% in the LDCs, against 23% in ODCs and 69% in rich countries. LDC gov-

ernments are devoting only 0.3% of their gross domestic product (GDP) to research and development, against 0.8% in other developing countries and 2.4% in rich countries. Five LDCs – Haiti, Cape Verde, Samoa, Gambia and Somalia – have lost more than half of their university-educated professionals in recent years because they have moved to industrialized countries in search of better working and liv-

ing conditions. Asian LDCs received more than twice from workers’ remittances than from official development assistance (ODA) in 2005: \$7 billion in the former case versus \$3 billion in the latter. For all the LDCs, remittances amounted to some two thirds of the total ODA of \$18 billion received in the same year.

Source: UNCTAD, 2007.

Today, the paradigm of ‘modernity’ and the Western model of development are subject to criticism from many quarters. Nevertheless, a coherent and persuasive alternative has yet to be found. It took time to realize that education is not just a consumption good that can be afforded at a certain level of development, but also an investment in human capital that is a prerequisite for attaining that level of development. Higher education and research have finally been accepted as crucial elements in the global knowledge economy, after decades of ill-fated theories and approaches by the World Bank and other institutions in the developed world that did not see them as the right priorities for developing nations. However, the treatment of higher education ‘services’ as merchandise, as promoted in the WTO’s General Agreement on Trade in Services (GATS), does not seem the most adequate one for achieving the desired results. The lessons from the experience of science in developing countries have become embedded in both successes and failures, and are powerful reminders against non-transparent approaches that neglect the specificities of time and space. For the world to meet the challenges of the future, higher education and science must become more evenly distributed around the world and develop certain features that have largely been absent in the post-colonial and semi-colonial world.

ORTHODOX VIEW OF RESEARCH: CONSTRAINTS AND CHOICES IN THE DEVELOPED AND DEVELOPING WORLDS

One may extend to most regions in the world what Geuna (1999) describes as the governmental vision of the principal social goals for the university system in European nations. The first two goals – to reproduce the existing levels of knowledge and to improve the critical reasoning capabilities and specific skills of individuals, both as an input into their public and private work activity and into the development of a democratic, civilized, inclusive society – correspond to the traditional role of universities as institutions for the preservation and transmission through education of knowledge, culture and social values. The third social goal – to increase the knowledge base by pursuing knowledge for its own sake and for the creation of wealth – defines the action of universities in a broader sense. Scholarship and research should be pursued by universities, both for their inherent value and in order to produce a stock of useful knowledge that might be applied elsewhere for the benefit of society. This is not easily achievable in the developing world’s universities, although there may be some good research groups –

clearly a minority – that manage to work to solve local, regional or national problems and still be part of the international scientific community.

Unlike more mobile scientific communities in developed countries, where prestige is accumulated through the transit through various institutions, agencies and firms, successful individuals and groups in developing countries tend to spend their entire careers in a single institution, to which they show a very high degree of adherence and loyalty, despite often criticizing institutional dysfunction and inertia. Many successful research groups produce elaborate rhetoric about applied research for development but, like their less successful local colleagues, face difficulties in adapting and reconciling their discourse to the schemes of internal functioning, to national and institutional legislation, and to the explicit and tacit norms guiding careers in science. Countries besieged by corruption and inefficiency often exhibit rigid patterns of administrative control put in place at knowledge institutions as part of accountability processes, which interfere with the flexibility that scientific teams need to operate. Sources of support for applied research at the levels of investment required to push it forward significantly are also lacking. The absence or underdevelopment of local philanthropic structures is only partially remedied by the access for high-quality scientific groups to international funding (mainly from the United States and the European Union). As a result, the space for action and bargaining power is increasingly restricted and the possibility of attending to ‘local needs’ shrinks dramatically, since private actors clearly participate more actively in the developed countries that lead the international networks.

Geuna’s fourth social goal attributes a new role to universities – one which is promoted by international actors in connection with notions of academic capitalism and managerialism. Higher education institutions come to serve specific training needs and more general research-support needs of the knowledge-based economy at the local, regional and national levels, and are seen as direct participants in the process of economic development. Numerous studies of innovation dynamics have underlined the importance of the institutional context and how it has been changing in the current techno-economic transition of developed countries. This very process, however, poses a number of problems to many developing countries’ higher education institutions in their attempts to recreate themselves or to facilitate or curtail advancement towards sustainability. They do not normally cooperate with business as suppliers of applied knowledge that can be readily transformed into innovations that increase the competitiveness of national industries. This is the case

precisely because, in a particular country, innovative firms may be scarce or non-existent or, when present, most often solve their knowledge problems by resorting to international applied-knowledge providers through licensing, franchising or consulting.

There is little dispute over certain important points. In conventional terms, the world made enormous economic progress during the second half of the 20th century. Over the past 50 years, the world's GDP has multiplied almost twelvefold while per capita income has more than tripled. Growth has been impressive even in the developing world. In a world more interconnected than ever, globalization has opened the door to many benefits: innovation, entrepreneurship, wealth creation, better communications, and enhanced awareness of rights and identities. The notion of the universality of science – according to which national political aims, domestic economic concerns and national boundaries should not act as constraints – has provided an ideological justification for this. The argument is that science (in fact, technology) led to rapid industrialization and economic convergence in the world economy in the late 19th century and, in some cases, the 20th century.

The dark side of this, however, is that science and technology also contribute directly to the new problems societies face today: the challenges of nuclear, chemical and biological weapons; genetically modified organisms and human cloning; and nanotechnologies. Along the way, the self-proclaimed values of science as expressed by Merton – objectivity, generosity, universalism and communism – are increasingly abandoned as knowledge institutions and researchers are subordinated to the interests of powerful private stakeholders. As things stand, the resulting global knowledge divide today is almost a mirror image of the global poverty divide. Globalization has exacerbated the existence of two worlds co-existing in space yet far apart in well-being. Inequality and deprivation persist, and poverty is everywhere. Of course, these problems existed before, but globalization seems to have accentuated exclusion and deprivation, for it has dislocated traditional livelihoods and local communities. Reducing poverty requires that poor countries upgrade their technology, master and produce knowledge, and invest in innovation. However, this is easier said than done.

UNCTAD's *Least Developed Countries Report 2007* argues that the current flow of technology to least developed countries – through international trade, foreign direct investment and intellectual property licensing – does not contribute to narrowing the knowledge divide. Sustained economic growth and poverty reduction are not likely to take place in countries where viable economic

re-specialization would remain impossible in the absence of significant progress in technological learning and innovation capacity-building. The UNCTAD report suggests that national governments and development partners could meet this challenge, notably through greater attention to the following four key policy issues:

1. How science, technology and innovation policies geared towards technological catch-up can be integrated into the development and poverty-reduction strategies of LDCs.
2. How stringent intellectual property regimes internationally affect technological development processes in LDCs, and how appropriate policies could improve the learning environment in these countries.
3. How the massive loss of skilled human resources through emigration could be prevented.
4. How knowledge aid (as part of official development assistance) could be used to support learning and innovation in LDCs.

The promise for the world can no longer be that it will follow the historical trajectory of the rich West. We must reckon with the fragility of many global systems. Ravetz reminds us of that fragility, the prospects for failure and experiences of the large systems that are a common feature of the current world:

The fates of the systems of national defense are threatened by the spread of weapons of mass destruction. Those of the management of wastes are already compromised by insidious pollutants. Our systems of maintaining health are seriously threatened by biological pathogens created by the conditions of modern technology, be they in mass over-medication, mass travel or mass food. Even the systems of communication are vulnerable to 'malware'-pathogens of information which, it now seems, can at best be kept at bay and never wiped out ... Everywhere we look there are threats of failures of systems, many on a global scale. (Ravetz, 2006)

In the process of achieving sustainable, lasting development, we must solve various problems that we have never experienced in the past. Since the well-trodden paths prove increasingly unable to solve them, we must take a step into the unknown territory of creativity, discovery and invention. We must ask what mechanisms – in activities such as higher education and research, as obvious as they are resilient – block the effectiveness of science in contributing to human well-being and environmental sustainability.

The first limitation of the orthodox view of research is the unquestioned faith in unharnessed science and tech-

nology as the solution to the world's problems. There is no magic in science and research. For various reasons, the views that merely highlight the virtues of science may not hold. Countries vary greatly in their ability to absorb, diffuse, use, adapt and improve imported knowledge and in their capacity to generate original scientific and technological knowledge and innovations, although they require all three types of capacity. In Latin America, for example, nations such as Brazil, Mexico and Argentina have considerable science and technology capacity, particularly in certain industrial sectors and scientific fields. Other countries, such as Chile, Colombia and Venezuela, have a more limited, but still non-negligible, capacity in these areas. Others, such as certain small Caribbean islands and Central American countries, have little or no capacity to produce or disseminate science and technology. These particular countries in this region face various types of problems and challenges, and we need to advance our understanding of the nuances of political, cultural and social development.

Similar caveats hold for other regions and cultures. For instance, it has been argued that colonialism changed the practice of Islam such that only the pursuit of religious knowledge came to be seen as important in Islamic culture, and this led to the decline of science in Muslim society (Sardar, 2007). This could be redressed by rediscovering the spirit of scientific inquiry, reconstructing the open intellectual climate of the past and reinstating critical thinking. Clearly, the single Western canonical view of free-rein, unfettered research is not necessarily the most appropriate one. Reform measures exclusively focused on economic aspects respond to global capital interests and market needs and leave out crucial dimensions of cultural diversity. They also fail to recognize that issues of difference are closely linked to issues of power, opportunity and the specific history of groups, in addition to the experience of each individual. A great deal needs to be done in terms of cultural tolerance and mutual understanding. These changes must involve significant resources and a commitment to systemic change and education. Individual patterns of diversity might be woven together, allowing each pattern to maintain its unique character and helping them blend harmoniously to reflect the rich diversity of the whole. Meanwhile, university and research communities should concentrate on promoting debate on fundamental issues such as the future of society and the regeneration of the university mission, in favour of more inclusiveness and more openness to ideas and people.

RETHINKING RESEARCH AND HIGHER EDUCATION TO BUILD A BETTER FUTURE

Higher education and science must become more evenly distributed around the world if political tension is to be eased and the chances of economic and social development are to improve. The role of education and science in this process is taken as a given – a point of departure – and it is assumed that knowledge and skills will be at least as important for the future of the developing world in this century as they were for developed and industrialized countries in the past. Admittedly, the worldwide higher education landscape and research and knowledge production sectors are undergoing a profound transformation driven by unprecedented global social and economic forces and are embedded in an extremely complex reality, in which no self-evident choices are available and where actions have multiple effects in a dynamically interdependent environment. The size of the academic enterprise has grown tremendously in the past century. The figures for 2000 were worlds away from those for the year 1900, and the speed of change increased in the latter decades of the 20th century. Student enrolment has multiplied worldwide, as has the number of Ph.Ds. The number of institutions has multiplied twentyfold, and the number of scientific journals – not to mention the number of scientists and academic staff – has grown at a similar pace. The increase has been as rapid in industry as it has been in universities and other research organizations.

Still, this expansion has taken place within a fairly limited part of the world. Of the resources spent on science and universities in the year 2000, more than 80% were spent within the OECD area. Within the OECD, the clear majority of all activities occur in North America and Europe. If we expand this region to include the European Union with its new member states in Eastern and Central Europe, the dominance becomes even more overwhelming. A few indicators may suffice to establish the asymmetrical relationship. North America and Europe together account for 95% of the world's doctoral degrees and continue to outstrip the rest of the world combined in the production of new Ph.Ds by a rate of 10 to 1. North America and Europe are responsible for 75% of the world's scientific articles. The region is home to the great majority of the world's university faculty, as well as virtually all of the world's high-quality institutions (Sörlin and Vessuri, 2007).

In the coming century, however, this is likely to change dramatically, not just because the non-OECD world is much larger, with some 85% of the world's population, but because most projections hold that economic growth in these regions will make it possible for many countries

to make a sustained investment in higher education and science. It is hard to foresee how this will play out in detail. Various scenarios are possible. If we stick to current trends and limit our speculations to a 30–40 year period, it is obvious that the growth will be huge. The growth of enrolments and institutions in the developing world is exponential, despite the fact that it is far too small to meet the needs. Both China and India are growing rapidly and have the potential to become scientific superpowers – admittedly with very large populations and a fairly low rate of citations per paper. Some Southern countries, such as Brazil, Mexico, South Korea and India, have improved their scientific standing rapidly over the past two decades. Africa, at the other end of the scale, does not reach even 1% of total scientific article production, although individual universities have grown and improved their record of teaching and research (Dakar, Makerere/Kampala, Dar-es-Salaam and a few others). Research training in African universities is still very limited, with the aforementioned institutions and several South African universities being the only exceptions (OECD, 2005).

Harnessing science and technology to contribute to human and social well-being requires a strong push to advance focused scientific research. Developments and challenges in a growing number of cognitive fields force science to take into account further knowledge systems and, in so doing, revise its own standards of efficiency and efficacy. Fields from medicine to agriculture have begun to recognize that the modern world has paid a high price for rejecting traditional practices and the knowledge, however expressed, that underpins them. The need to include other knowledges and perspectives in the scientific endeavour poses important methodological challenges to science and technology for human and social development, as it implies adopting truth and quality criteria that are more sophisticated – and better able to incorporate complexity – than those conventionally accepted by the scientific community. These criteria must be no less solid and rigorous, or else the relevance and credibility of science could be gravely damaged (Rip, 2000). A point of contention has been that traditional knowledge is often contextual, partial and localized, and difficult to translate or integrate into a more scientifically manageable conceptual framework. To what degree, in which situations, and in what type and form extra-scientific types of knowledge will need to be incorporated into the sustainable development research agenda remain open issues (Gallopini and Vessuri, 2006). Uncritically grouping together all ‘non-scientific’ forms of knowledge and knowledge holders into a single category and separating them from their context only invites oversimplification.

Such unhelpful generalizations jeopardize the potentially unique and worthy contributions that various social actors can make to science.

The science experience, particularly during the second half of the 20th century, provides useful lessons for redesigning strategies based on past mistakes and failures. The nature and use of scientific data and information, the conditions under which they are produced, distributed and managed, and the roles of scientists and other actors in these processes have been changing rapidly. We need a coordinated global approach that ensures equitable access to quality data and information for research, education and informed decision-making. Improved monitoring of the Earth system will allow us to detect, attribute and understand change and the future implications of change. But not only that – the international scientific community must be actively engaged in the production of socially robust knowledge within an extended participation framework.

Many people are proposing a more pluralistic view of relevant knowledge and are concerned about the fate of education and science, subordinated as they are to commercial interests. In certain regions, this situation requires immediate and profound review. The current debate about universities in sub-Saharan Africa, for example, had powerful precedents in the post-independence period of the 1960s, when most of the modernizing groups hailed the idea of the ‘developmental university’ as a key component of the new nation-state.

The enormous scale of human struggle with poverty, disease, drought, famine, civil war, political authoritarianism, and decades of weakening structural adjustment programs provides obvious ground for social engagement by universities that represent resources of infrastructure, knowledge, information, expertise, agency, and activism, no matter how meager or impoverished they themselves might be. (Singh, 2007)

Today, there are attempts at university regeneration and reform in many sub-Saharan African countries (Manuh et al., 2003; Singh, 2007). But it remains to be seen to what extent these universities can develop appropriate policies and practices for engagement that do not become hostage to exclusively entrepreneurial rationales and drivers in situations of extreme paucity of funds and resource constraints. Moreover, universities are called upon to seize the opportunity to build a foundation of civic and democratic values and skills that may inspire social cohesion and purpose and enable future leaders to overcome racial and ethnic tensions, dogmatism and

religious extremism. We must urgently attend to cultural diversity in higher education and research within the framework of globalization. This does not mean simply increasing the percentage of particular under-represented social groups in a campus population. Rather, diversity encompasses a network of values, policies, practices, traditions and resources that provide coping mechanisms for students and faculty from relegated or excluded groups, thus serving as a sounding board for the wider society. By their attempts to embrace the growing diversity of society and to build cross-cultural bridges with counterparts all over the globe, universities may come to reflect a basic social, institutional and scholarly commitment to freedom, democracy and justice.

Because we live in an increasingly interconnected world, we must rediscover a path that was abandoned decades ago for the sake of increasing specialization. Today's challenges require fresh generalizing capacities and an education that goes beyond the strictly technical culture of the specialist. This step opens up new windows of opportunity for science and for the world. Quality itself has to be rethought in terms of richer and more diverse forms of evaluation. Disciplines, types of research activity, research aims and objectives differ in how they decide what is good and how good something is. Many of the world's governmental agencies and universities have established undesirable administrative evaluation routines that follow criteria that are appropriate for certain research areas and institutional setups but not for others. The inclusion of under-represented groups permits higher education institutions to benefit from under-utilized pools of human talent and experience. As the global market forces industrial economies to evolve towards a knowledge-based economy, people and knowledge constitute sources of new wealth. Countries race to build well-educated and highly trained labour forces in order to acquire a competitive edge in the global economy. Higher education plays a key role in making use of the contribution of all citizens. The combination of the exploration of problems at different scales from the local to the global – starting from a strategic position to have an impact on national and international research agendas with relative autonomy – may help reorient much knowledge production and evaluation towards local needs of cohesion and social equity.

When discussing the democratization of expert knowledge, let us not forget the strong influence of international organizations. We need to better understand the realities of multilateralism and the obstacles and difficulties that new scientific and technological knowledge pose to delegates from developing countries in multilateral regimes and treaties such as those of the WTO, the United Nations System, the International Financial Institutions,

the European Union, the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, the Framework Convention on Climate Change and so on. Delegates are increasingly forced to debate very complex issues that require sophisticated mastery of the intricacies of technology and the global market economy in order to negotiate on their country's behalf. Decision-makers in Southern countries also face growing problems with applications, due to an inadequate grasp of scientific literature, and in situations in which governmental representatives cannot tell the difference between crucial and merely interesting or banal data.

Another lesson is that prudent macro guidance and management of scientific research at the national level is both necessary and desirable. Within developed countries, there is widespread consensus that government policies should support R&D activities, whether in the public or the private sector. The associated political outcomes stem largely from business pressures, which are becoming globalized. In developing countries, government policies are even more necessary, but the process of globalization reduces the government's autonomy in formulating policies aimed at development. Like Stewart (2007), one may wonder whether the fragile democracies of developing countries, confronted by such powerful forces, can be expected to do better. The current strict international regime for the protection of intellectual property rights could pre-empt or stifle the development of domestic technological capabilities in weaker countries. Taken together, the rules and conditions of the new international agenda are bound to curb the use of industrial policy, technology policy, trade policy and financial policy as strategic forms of intervention to foster industrialization in developing countries (Nayyar, 2006). Public science policies, while secondary to the aforementioned policies, could help foster the domestic R&D activities needed to build a comprehensive national scientific and technological capacity. Under current conditions, however, it is difficult to fulfil the mission of these policies, and economic and social innovations suffer accordingly.

Any rethinking of scientific R&D must involve a balanced view of the significance of state intervention, institutions and politics in science and the critical role of good governance. Initial conditions can and should be changed to foster development. This is an unambiguous lesson that emerges from the social history of science. In countries that are latecomers to industrialization, state intervention can create conditions for the development of industrial capitalism through the spread of education in society, the development of physical infrastructure and the introduction of institutional change. This role has always been rec-

ognized. A further lesson to emerge from experience, however, is that inappropriate and excessive state intervention is counterproductive. The key issue, then, is not whether states should intervene in policy issues related to education and science, but rather what kind of interventions and policies are appropriate in different countries and circumstances. The nature, speed and sequence of change matter, and change should follow the priorities set by the particular country or society.

Another important – if less recognized – aspect is building managerial capabilities in individuals and technological capabilities in firms, for it determines technical efficiency in the short run and competitiveness in the long run. Many developing countries still have a limited understanding of the role of the productive sector in promoting innovation. This may lead to contradictory policy measures; for example, a government may make efforts to strengthen links between universities and companies without at the same time taking complementary steps to strengthen the demand for knowledge in the productive sector. Several former socialist countries underwent rapid and extensive political and economic reform in the 1990s and at the beginning of the new millennium. This involved new challenges. Mongolia, for example, had a strong competitive science base embedded in public-sector institutional structures and a weak market-driven base for adding value and applying this resource. The government currently faces the difficult task of creating favourable conditions to maximize the benefits and minimize the costs of integration with the world economy (Turpin and Bulgaa, 2004).

KNOWLEDGE INTEGRATION FOR EFFECTIVE ACTION

There is broad agreement that mankind faces three main challenges in these early years of the 21st century: freedom from want, freedom from fear and the freedom of future generations to sustain their lives on this planet. Science, technology and innovation are central both to the origins of these three millennium challenges and to the prospects for handling them successfully (Annan, 2000). They are important forces in the positive and negative trends of development. While science, technology and innovation are traditionally associated with the improvement of health, life expectancy and living standards, as well as greater opportunities for information sharing and environmental remediation in many places around the globe, they are also increasingly perceived as linked in complex ways to the current unsustainable development trajectories. Why is it so difficult to change course?

The economic drivers and financial constraints of sci-

ence are huge. Despite the importance of sustainability and the centrality of science and technology in the strategies for achieving it, there is a great imbalance in the resources and attention devoted to applying research in the quest for sustainable development. So far, efforts to harness research for sustainability have had to be supported to a large extent by R&D systems built for other purposes. Financial support of science has traditionally been related to the expectations that scientific research would help achieve aims that society considered important. This basic role remains the same, but the needs and visions of very complex and heterogeneous societies have changed dramatically. Besides, visions of the future often emphasize only the opportunities for new applications of science and technology without giving due consideration to potential side effects.

The difficult adjustment and radical changes needed are illustrated by what has come to be called ‘the stalemate in the energy debate’ (NCEP, 2004). The inescapable linkages between energy production and use and the environment result in a vastly complicated overall picture. The risk of global climate change due to emissions released by fossil fuel combustion will exert a profound influence on the world’s energy options over the decades ahead. Almost every study in recent years has concluded that current efforts in both the public and private sectors are not commensurate in scope, scale or direction with the challenges, opportunities and stakes. The gap between current efforts in energy-technology innovation and the level and quality of effort required to meet extant and looming energy challenges is very large indeed. This applies to both publicly and privately funded efforts, and it is true for the entire world, not just for the United States or Europe.

Economics is not the only thing standing in the way of much-needed change. As recently put by Ravetz (2006), reflecting on Kuhn’s insight in his theory of scientific revolutions, ‘the inertia of those intellectual structures that define and regulate our thoughts – be they called paradigms, frameworks or mental models – must be recognized by whoever would wish to change them’. If science is to address sustainability problems, it must be produced in a way that allows it to be linked more easily and rapidly to action communities. It is very likely that it will be reformulated and even transformed through multiple dialogues and interactions among the individuals, groups and institutions that generate and ultimately apply new scientific and technological knowledge. The implementation of new knowledge and technical capacities by different social actors – including governments, natural resource managers, industry and society in general – should not be a final phase in a research programme but

rather an integral part of it, from the very early definition of the problem.

Moreover, we must insist on the critical importance of linking the various scales of interaction. Locally focused studies and actions often have limited value if they do not account for the higher-level forces affecting the immediate local dynamic. Development specialists often mention this limited understanding of multi-scale interactions as one of the main obstacles to progress. Advances in the modelling of complex systems and new integrated assessment methodologies afford new opportunities to overcome traditional disciplinary compartmentalization and to aid in decision-making under conditions of persistent uncertainty. New organizational models of international inter- and transdisciplinary assessments – such as those by the Intergovernmental Panel on Climate Change (IPCC, 2007), the Millennium Ecosystem Assessment (2005) and the Arctic Council (2004) – open up new possibilities for integrating knowledge through a wide range of disciplines and development experiences with the involvement of an extensive set of stakeholders.

These approaches are anchored in the objectives of reducing poverty, improving the human condition and conserving the systems that support life on earth. They integrate various disciplines and action communities by assuming dynamic interactions between nature and society and seeking to empower people through active participation. Emphasis is placed on the translation of knowledge into action and a focus on regionally and locally oriented solutions. These approaches encompass both basic and applied science and build upon existing initiatives. Special attention is given to ‘slow’ variables associated with thresholds, and to the study of vulnerability and resilience. Within an interactive framework, the creation of new scientific knowledge and technical capacities is seen as part of an experimental social process in which the producers and consumers of knowledge interact to identify R&D priorities and to translate knowledge into real actions.

In every society, economy and polity are closely intertwined. The interaction of economics and politics shapes outcomes for people. There is, however, a tendency to ‘isolate’ certain policy areas from the normal political processes and transfer power to special interests. Science has been assumed to be largely foreign to both economic and political concerns, although, contrary to Weber’s (1919) reasoning, the results cannot be separated from the authors. In the short term, technocratic governance without politics may improve policy implementation in certain areas. In the longer term, however, it is not likely to provide a real solution, for it will induce a decline in social cohesion and generate a ‘confidence gap’ between

political office holders and citizens. The practice of democracy in the world today has tended to distance citizens from professionalized political instances. Excessive reliance on experts’ opinions contributes to depoliticization and further removes citizens from political participation. Scientific knowledge and expertise are more crucial than ever in democracy. However, it is also true that the ‘knowledge problem’ has emerged as one of today’s four major governance challenges, in terms of the difficulty in understanding and correctly assessing complex societal issues, as well as the causal linkages between resources and objectives. Scientists have opened Pandora’s box and the powers unleashed require deft guidance and societal control to prevent irreparable damage and ensure welcome benefits to mankind. A new politics of knowledge is emerging in which political goals and economic interests have to come to terms with universal norms and values.

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