

Research Systems for a Transition Toward Sustainability

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Sustainability concerns have occupied a place on the global agenda since at least the Brundtland Commission's 1987 report "Our Common Future." (1,2). The prominence of that place has been rising, however. UN Secretary General Kofi Annan reflected a growing consensus when he wrote in his Millennium Report to the General Assembly that "Freedom from want, freedom from fear, and the freedom of future generations to sustain their lives on this planet" are the three grand challenges facing the international community at the dawn of the 21st century (3). Sustainability has become a "high table" issue in international affairs.

Science and technology are increasingly recognised to be central to both the origins of Secretary General Annan's three challenges, and to the prospects for successfully dealing with them (4,5,6). But there is a great imbalance in the resources and attention devoted to harnessing science and technology in the service of these three transcendent goals. Efforts to achieve "freedom from fear" are supported by a mature, well-funded, problem-driven R&D system based in the world's military establishments. Efforts to achieve "freedom from want" have created and been supported by several effective R&D systems, for example those engaged in international agricultural research and in certain global disease campaigns. In contrast, efforts to achieve sustainability are relatively new because, in the words of the Secretary General, the "founders of the UN could not imagine that we would be capable of threatening the very foundations for our existence." (3) As a result, efforts to harness science and technology for sustainability have largely had to draw on R&D systems built for other purposes – begging monitoring data from the world's military establishment, piggy-backing on the already over-extended international agricultural research system, and borrowing insights gained from basic research programs on global environmental change. With a few important but relatively small and under-funded exceptions, efforts to "sustain the lives of future generations on this planet" still lack dedicated, problem-driven R&D systems of anything like the scale or maturity of those devoted to security and development.

The World Summit on Sustainable Development, scheduled for September of 2002 in Johannesburg, South Africa, represents the best opportunity in a decade to construct a global R&D system tailored to the particular needs and magnitude of the sustainability challenge. Seizing that opportunity will require a strategic approach that transcends the interests of individual nations, policy initiatives and research programs. Fortunately, important elements of the foundation for such a strategy have been laid out over the last several years through a rapidly expanding discourse on the relationships among science, technology and sustainability.

Many of the earliest and most thoughtful contributions to this discourse have come from the developing world through the work of individual scholars and of institutions such as the Third World Network of Scientific Organizations (TWNISO), the Commission on Science and Technology for Sustainable Development in the South (COMSATS), the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), and the South Center (7).

European thinking of the late 1990s is exemplified in Schellnhuber and Wenzel's *Earth systems analysis: Integrating science for sustainability* and the European Union's *Fifth Framework Programme* (8,9). A synthesis of US views from the same period is given in the National Research Council's *Our common journey: A transition toward sustainability* (10). Initial efforts to capture an international cross-section of perspectives include the special issue on *Sustainability Science* published by the International Journal of Sustainable Development in 1999, and the World Academies of Science report on a *Transition to sustainability in the 21st century* (11, 12). In addition, international environmental assessments are increasingly reaching out to connect with sustainability issues, as are research planning efforts for global environmental change programs at both national and international levels (13, 14, 15). A number of academies of science have also recently addressed the links between sustainability and global change (16, 17, but see also 18 and 19). Most recently, the ad-hoc International Initiative on Science and Technology for Sustainability has been sponsoring a series of workshops around the world to help regionalize the discourse on core questions, research strategies, action priorities and institutional needs for mobilising knowledge in the service of sustainable development (20).

This widening discourse on science, technology and sustainability has revealed profound differences in perspectives and priorities between rich and poor people, northern and southern regions and public and private sectors (20). But it has also demonstrated broad agreement on a number of characteristics that effective R&D systems for sustainability might be expected to exhibit.

First and foremost, effective R&D systems for promoting sustainability will need to be structured so that they are driven by the most pressing problems of sustainable development as defined by stakeholders in those problems. This will almost certainly result in a much different agenda than would be obtained by continuing to allow priorities to reflect primarily the most interesting problems in science and technology as defined by stakeholders in research and innovation. But while the specific character of those "most pressing problems" of sustainability will need to be assessed on a regional and even local basis, a general consensus is emerging that they involve discovering and inventing ways of simultaneously meeting human needs with special attention to the reduction of hunger and poverty while protecting the earth's essential life support systems and biodiversity.

There is also general agreement that to accomplish these goals, R&D systems for sustainability will have to be extraordinarily integrative, encompassing the communities engaged in promoting not only environmental conservation, but also human health and economic development. They will need to entrain formal expertise from the public and private sectors, the natural and social sciences, and engineering. Perhaps most challenging, they will need to find ways of identifying, utilising and honouring the vast resources of informal expertise derived from practical experience in grappling with particular sustainability problems in particular social and ecological settings (21).

As implied above, much of the knowledge needed for advancing sustainability goals involves making sense of how multiple environmental stresses, social institutions and ecological conditions interact in particular places. This means that R&D systems for sustainability will

need to give special emphasis to integration at intermediate or regional scales (22). From this base, they will need to be structured to facilitate “vertical” connections between the best research anywhere in the world and practical experience in particular field situations. At the same time they will need to foster “horizontal” connections among regional research and application centres that might learn from one another (23).

Finally, effective R&D systems for sustainability will need to bridge the artificial but pernicious divide between “basic” and “applied” research (24). Progress on some of the most urgent problems of sustainability will almost certainly require fundamental improvements in our understanding of nature-society interactions: sustainability science needs to be fundamental research. But on other issues the requirement is less for new knowledge than for learning how to apply what is already known in an experimental, problem-solving mode: sustainability science needs to be learning-by-doing. More generally, promoting sustainability needs integrated *knowledge systems* that connect what have too often been the “island empires” of research, monitoring, assessment and operational decision support.

With these widely shared criteria for effective sustainability R&D systems in mind, an initial set of goals for the World Summit to pursue with regard to science and technology might include the following:

- Secure continued support for the core disciplinary and integrative R&D programs on which sustainability science and technology must build;
- Launch focused, action initiatives in priority problem areas (e.g. sustainable urban growth, carbon management) where we know enough to complement learning-by-studying with learning-by-doing;
- Initiate focused R&D efforts on fundamental scientific questions (e.g. determinants of the vulnerability of nature-society systems) arising from attempts to resolve priority problems of sustainability;
- Increase the world’s capacity for regionally-based, problem-driven, integrated R&D in support of a sustainability transition.

Effective R&D systems to mobilise science and technology for sustainable development should not be impossible to design and implement. Some relatively successful international programs exhibiting many of the characteristics outlined here have already been developed to address problems ranging from increasing agricultural productivity, to combating human disease, to protecting the earth’s ozone layer. Likewise, there already exist efforts such as START’s South East Asia Regional Center that have made a good beginning in implementing integrated, problem-driven, place-based research and applications programs in support of sustainability (25). To date, however, these successes reflect idiosyncratic, if invaluable, exceptions rather than general rules.

Needed over the period leading up to the World Summit is a systematic and critical effort to learn from both successes *and* failures of the past lessons that have most to offer the design of effective R&D systems for promoting a transition toward sustainability. Such learning will in turn require a determination to move beyond advocacy of existing programs that have been built for other (often excellent) reasons, toward a critical dialogue about the science and technology

strategies most needed to support sustainable development per se. Above all, it will demand a unified campaign by the scientific, engineering, and development communities to build the political support needed to implement -- at a scale worthy of the challenges before us -- an R&D system for sustainability.

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