Series on Science for Sustainable Development No. 11

INTERNATIONAL COUNCIL FOR SCIENCE

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Science and Technology at the World Summit on Sustainable Development

26 August
to 4 September 2002
Johannesburg, South Africa

WFEO/FMOI

ICSU Series on Science for Sustainable Development

The ICSU Series on Science for Sustainable Development is produced by the International Council for Science in connection with preparations for the 2002 World Summit on Sustainable Development (WSSD). The aim of WSSD is to bring together governments, United Nations agencies and other key stakeholders, including representatives of civil society and the Scientific and Technological Community, to build upon the 1992 United Nations Conference on Environment and Development (UNCED) and to enhance efforts toward the future of sustainable development. The Series includes a set of inter-disciplinary reports focusing on major issues that are relevant to science for sustainable development. The Series is meant to serve as a link between the scientific community and decision-makers, but the reports should also be useful to all others interested in the contribution of science to sustainable development. The Series highlights the fundamental role science has played and will play in finding solutions to the challenges of sustainable development. It examines experiences since UNCED and looks towards the future. It provides up-to-date knowledge, examines lessons learned, successes achieved, and difficulties encountered; while also outlining future research agendas and actions to enhance problem solving and good practices in sustainable development. The Series was made possible due to a generous grant provided by the David and Lucile Packard Foundation.

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Foreword

The Forum on Science, Technology, and Innovation for Sustainable Development, held in parallel to the World Summit on Sustainable Development (WSSD), was an event that I feel contributed to raising the exposure of–and drawing attention to–one of the most crucial legs of sustainable development.

As outlined in this report, to achieve sustainable development, we need major technological transformations in many areas. These transformations will require infrastructures, education, and enabling policy environments that put a premium on creativity and innovation. These will become crucial preconditions for harnessing science and technology for economic growth and sustainable development. The success of countries, corporations, and individuals around the world increasingly depends on their capacity to generate and access science, technology, and innovation.

The contribution of science, technology, and innovation must become more efficient in order to increase the understanding of the dynamics of sustainability as well as for finding solutions in the future. Cooperation and interdisciplinary integration will be necessary to take advantage of cutting edge science and technologies. The interface of science with policy will also be crucial for informed decision-making. Science can no longer be carried out in isolation; it must take its place as a driving force in sustainable development.

Science, technology, and innovation must be brought to bear on sustainable development and policy decisions in many of the areas discussed during WSSD. We need strong cooperation and partnerships in science and technology capacity building in order to achieve, for example, a new energy economy, a new water economy, and a new agricultural economy. This also holds true for efforts to address the health-environment links. Science is certainly needed to better manage risks and uncertainty in these areas.

Moreover, we need mechanisms in place to support the quantum leaps necessary in the areas of science, interdisciplinary research, and technological innovation. Increased cooperation amongst members of the scientific community and through partnerships with governments, business, and other stakeholders will also be needed.

We share the same planet, and true sustainability must be global. For this reason, we need to ensure access to new technologies as these technological transformations are under way. We must build capacity at the national level. We need to strengthen the capacity of developing countries to absorb, adapt, and utilise these technologies in their specific local settings.

The Forum on Science, Technology and Innovation at WSSD provided a vision of how science and technology, particularly the emerging and cutting-edge technologies, can contribute to sustainability.

NITIN DESAI

Secretary-General
World Summit on Sustainable Development

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Preface

Preparations for the World Summit on Sustainable Development, and the Summit itself, were a challenge for the scientific and technological (S&T) community in general and for ICSU in particular. At the request of the United Nations (UN), ICSU and the World Federation of Engineering Organizations (WFEO) accepted responsibility for soliciting input from the S&T community, which is one of the nine Major Groups identified in AGENDA 21.

When I joined ICSU in January 2002, the stage was already set for ICSU's intense involvement. My predecessor, Dr. Larry Kohler, had coordinated the development of a report to the UN, which focused on the achievements and failures of the S&T community since the UN Conference on Environment and Development (UNCED, Rio de Janeiro, 1992). Dr. Kohler had also taken the initiative to submit a proposal to the David and Lucile Packard Foundation. This generous grant made it possible for the S&T community to work together in developing a major input to the preparations for the Summit, and at the Summit itself. The collective efforts of many organizations and individuals contributed to the organization of nine major sessions during the Forum on Science, Technology and Innovation for Sustainable Development. We are all deeply indebted to Dr. Kohler for his dedicated commitment to the early development phase of this undertaking.

The S&T delegation's participation in the second and fourth meetings of the WSSD Preparatory Committee (New York and Bali, respectively) provided excellent opportunities for interaction with other Major Groups, which generated an atmosphere of trust and true commitment. Throughout the process, it was clear that societies will not automatically move forward toward a path of sustainable development. Rather, such a change of direction requires the involvement of all sectors of society. It goes without saying that the contacts developed amongst various groups during the WSSD preparations and at the Summit form an excellent platform for future collaboration. Personally, I look forward to strengthening interactions with our partners from civil society, as well as business and industry.

For the Stockholm Conference on the Human Environment in 1972, ICSU, through its Committee on Problems of the Environment (SCOPE), contributed a major report on global environmental monitoring at the request of the Maurice Strong, the Secretary-General of the Conference. For the UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, ICSU served as special science advisor to Maurice Strong. In preparation for the Summit, ICSU organized a conference on an "Agenda of Science for Environment and Development into the 21st Century" (ASCEND21). This helped focus the efforts of the science community on issues related to science and development, but ICSU did not have a formal role in the Rio de Janeiro Conference.

A major difference at the Johannesburg Summit was the true involvement of our community as well as that of the other Major Groups. WSSD Secretary-General Nitin Desai played a key role in ensuring that the Major Groups were involved to the fullest extent. He was also instrumental in the decision to arrange the Forum on Science, Technology, and Innovation for Sustainable Development, as part of the official Summit programme. Mr. Desai realizes the importance of science and technology for sustainable development, and we are very grateful to him for showing

such trust in our community. In addition, Zehra Aydin, Major Groups Coordinator at the United Nations Commission on Sustainable Development (UNCSD) Secretariat, was invaluable to the process. With unfailing kindness, she did everything in her power to ensure the planning and preparations advanced smoothly.

The Science Forum in South Africa was the brainchild of Nitin Desai and Dr. B. S. Ngubane, the South African Minister for Arts, Culture, Science and Technology. Minister Ngubane participated in several sessions of the science Forum and offered significant leadership. In addition, the Director-General of the Ministry, Rob Adam, and his staff, especially Daan du Toit, dedicated an extraordinary amount of energy to organize the entire Forum in less than two months.

ICSU and its partners also worked hard to transform this idea into a reality, and many scientists agreed to help organize sessions and agreed to participate in the Forum at very short notice. In addition to ICSU members, the S&T delegation consisted of representatives of our major partners, WFEO, as well as the Third World Academy of Sciences (TWAS), the InterAcademy Panel on International Issues (IAP) and the International Social Science Council (ISSC). Dato Lee (WFEO), Yves Quéré (IAP), Diego Malpede and Mohamed Hassan (TWAS) were very involved in both the preparatory work and the Summit itself. They and the other delegation members to PrepCom II and IV as well as the Summit deserve our gratitude.

ICSU's capacity to take the lead in the preparatory work could not have been carried out without additional contributors. Katie Hamilton worked very hard to help with the preparations for PrepCom II and IV; Lezsek Bialy took over this role for the Summit itself. Upon joining ICSU in April 2002 as Science Officer for Environment and Sustainable Development, Leah Goldfarb immediately applied herself to coordinating inputs from the S&T community both before and during the Summit. ICSU and its partners were also fortunate to recruit Gisbert Glaser as Senior Consultant for Sustainable Development. Formerly assistant director-general for Natural Sciences at UNESCO, Dr. Glaser's broad experience of working within the UN system and collaborating with the S&T community on environmental issues through UNESCO proved vital to the Forum's successful outcome.

Again, I would like to point out that none of this could have been achieved without the support from the Packard Foundation, and the tireless efforts of Helen Doyle, who served as a key link to the Foundation, offering valuable insight and support throughout the process. ICSU is also grateful for additional funding for the Science Forum, which was received from the United Nations Foundation and the Rockefeller Foundation.

The WSSD process was an exciting event. But we must realize that it was only the first step in a very long journey. I believe that science and technology have a great deal to contribute to the future of our planet. In fact, the S&T Community has already submitted a Type II proposal to the UN (see p.15), which outlines a number of initiatives designed to implement the commitments we made to each other and to society as a whole during the Summit. Together with TWAS and the international Initiative on Science and Technology for Sustainable Development (ISTS), ICSU has taken the initiative to establish a Consortium that will jointly promote the development of a science and education agenda for the next 10 years. It is my hope that through this initiative, and in collaboration with many other partners, we can truly contribute to policy-relevant science that supports sustainable development.

Professor THOMAS ROSSWALL

Executive Director
ICSU

Part I: Science and Technology as a Foundation for Sustainable Development

Summary by the Scientific and Technological Community for the Multi-Stakeholder Dialogue Segment of the WSSD Preparatory Committee IV Meeting [1]

Why is science and technology essential for sustainable development?

Sustainable development is probably the most daunting challenge that humanity has ever faced, and achieving it requires that the fundamental issues be addressed immediately at local, regional and global levels. At all scales, the role of science and technology is crucial; scientific knowledge and appropriate technologies are central to resolving the economic, social, and environmental problems that make current development paths unsustainable. Bridging the development gap between the North and the South, and alleviating poverty to provide a more equitable and sustainable future for all, requires novel integrated approaches that fully incorporate existing and new scientific knowledge. The scientific and technological (S&T) community can make a leading contribution to tackling major problems identified in Sections III and V of the Millennium Declaration[2] – "Freedom from want" and "Sustaining our future". These issues include: (i) fighting against disease; (ii) population growth and urbanization; (iii) the digital/information divide; (iv) coping with climate change; (v) confronting the water crisis; (vi) defending the soil; (vii) preserving forests, fisheries, and biodiversity, and (viii) building a new ethic of global stewardship. Whatever the cultural, geographical, socio-economic and environmental setting, a strong partnership between the S&T community and other members of civil society, the private sector, and governments is a fundamental prerequisite for sustainable development.

How can the various S&T communities improve their contributions to sustainable development?

Implementing Agenda 21 during the next decade and beyond will build on progress made during the past ten years in generating knowledge targeted to sustainable development objectives and in developing cleaner and more affordable technologies. However, enhancing the S&T community's capacity to contribute to sustainable development will require significant changes. The S&T community is committed to implementing necessary changes and developing appropriate partnerships. These changes include:

(a) *More policy-relevant science:* A much greater share of research must integrate problem-oriented and interdisciplinary research that addresses the social, economic, and environmental pillars of sustainable development. Good science is essential for good governance.

(b) *Broad-based, participatory approaches:* Traditional divides between the natural, social, economic, and engineering sciences and other major stakeholders must be bridged. Research agendas must be defined through broad-based, participatory approaches involving those in need of scientific information. The S&T community accepts its responsibility to improve cooperation with other parts of civil society, the private sector, governments, and intergovernmental bodies.

(c) *Promoting gender equality in science:* Historically women have been severely under-represented in science. The S&T community will actively promote gender equality in science and work with women and organizations (e.g. Third World Organization for Women in Science) to eliminate existing barriers.

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1. Prepared by the International Council for Science (ICSU) and the World Federation of Engineering Organizations (WFEO), who were invited by the WSSD Secretariat as the organizing partners for the Dialogue Segment for the Scientific and Technological Communities. This document has been prepared in consultation with the InterAcademy Panel (IAP), the Third World Academy of Sciences (TWAS) and the International Social Science Council (ISSC).

2. Kofi A. Annan. We the Peoples: The Role of the United Nations in the 21st Century, United Nations (2000).

New contract between S&T and society for sustainable development

The basic changes outlined above are essential for redirecting the present global S&T system towards the sustainable development challenge. However, it is now clearer than ever that this challenge has thus far outstripped the capacities both of the S&T community and of society to forge effective and comprehensive responses. Nothing less than a new contract between the S&T community and society is required.

The following are crucial components of such a new contract:

(a) *Improving education and capacity building.* Enhanced science teaching at both the primary and secondary levels is central to scientific and technological capacity building and to a better public understanding of sustainable development issues. A further target should be to increase the percentage of university level students enrolled in science, mathematics, and engineering. Current enrolments are decreasing in most developed and developing countries alike. Three core components are critical in enhancing capacity: skilled individuals, efficient institutions, and active networks. Capacity building at the international, regional, and sub-regional levels must be given increased attention, as it is often the most cost-efficient way to build a critical mass of S&T capacity.

(b) *Bridging the North-South divide in scientific and technological capacity.* While it is necessary to build and enhance strong scientific and technological capacity in all regions of the world, this need is particularly pressing in developing countries. The Organization for Economic Cooperation and Development (OECD) countries spend annually more on research and development (R&D) than the economic output of the world's 61 least developed countries. Developed countries employ 12 times more the *per capita* number of scientists and engineers in R&D than developing countries, where there is woefully weak institutional S&T capacity. Ten years after the Earth Summit (Rio de Janeiro, 1992), this challenge remains a major obstacle to sustainable development. Developing countries must address this problem and significantly enhance investment in higher education and S&T capacity. Developed countries must accept their responsibility for much improved knowledge and technology sharing. Bilateral donors and other funding mechanisms should substantially increase the funds they allocate to S&T for sustainable development, especially in the area of scientific and technological capacity building.

(c) *Clean technologies and sustainable production and consumption patterns.* The public and private funding of science and technology, in developed and developing countries alike, must focus on developing new clean technologies, and on supporting sustainable production systems and consumption patterns. There should also be improved international sharing and local adaptation of clean and/or traditional technologies. In many instances, traditional technologies offer viable solutions. Due emphasis should be placed, whenever appropriate on local, culturally adapted, and low-cost technologies.

(d) *Governance for sustainable development.* Governance systems for sustainable development at local, national, regional, and global levels must incorporate the best available scientific and technological knowledge. The link between the S&T community and decision making is poorly supported by current institutional structures. Existing governance institutions and institutional mechanisms need to be transformed in ways which ensure S&T input; if necessary, new mechanisms should be developed to meet this explicit goal. The tool of integrated scientific and technological assessments needs to be bolstered and enhanced at national, regional, and global levels. It is proposed that a formal link be established between the Commission on Sustainable Development (CSD) and the organising partners of the Dialogue Segment for the S&T community (ICSU and WFEO), for example through an S&T Advisory Panel. This would be a mechanism to ensure that the CSD can draw upon independent scientific and technological expertise and advice.

(e) *Long-term perspectives and data needs.* The S&T community has a responsibility to provide the knowledge and technologies that will enable a long-term sustainable future. To this end, a basic requisite will be to establish long-term monitoring systems for collecting reliable scientific, socio-economic, and other societal data. These systems

must permit the integration of all relevant data sets for addressing crucial sustainability issues. The global environmental observation systems need to be made fully operational, which requires governmental funding. Full and open access to scientific information data must be ensured.

(f) *Augmenting financial resources for S&T for sustainable development.* Current levels of investment in S&T for sustainable development are far too low in both developed and developing countries. This is true both with respect to the scope of the problems and with respect to the promising rate of return on S&T investments. Larger investments in S&T should be seen primarily as increased investment in a country's socio-economic development and in preserving natural life-support systems for the present and future generations, rather than simply as research expenditures. For this reason, public sector funding for S&T activities targeted on sustainable development goals should be augmented significantly in both the North and the South. The private sector should reorient its S&T investments in a manner, which integrates sustainable development objectives and should increase its S&T investments generally. Strategic partnerships should be forged between the public and private S&T sectors at national and regional levels.

Specific New Partnership Initiatives

The S&T community has taken the initiative to launch several new partnership initiatives geared towards implementing important recommendations in a number of Agenda 21 chapters. The participation of other partners is sought in these initiatives as appropriate.

- *Science and Technology for Sustainable Development:* The current global change programmes[3] provide an important platform for the development of scientific endeavours addressing key issues related to sustainable development. Within the next few years, initiatives will be launched that address all three pillars of sustainable development in a more integrated way. The aim is to develop such interdisciplinary science programmes addressing key sustainable development issues in a participatory fashion, engaging other dialogue partners as well as the engineering community.

- *International S&T Capacity Building:* Several capacity building programmes will be launched with various partners. Examples of specific initiatives include: (i) a capacity building programme for addressing crucial freshwater problems. Training activities will range from relevant basic sciences to training in interdisciplinary approaches including the social sciences. The lead partners are UNESCO, ICSU and TWAS; (ii) an initiative on mathematics and science teaching based on current ICSU – IAP collaboration. The involvement of Youth and Labour Unions Major Groups will be sought; (iii) "A Decadal Plan for Capacity Building for Global Change Science" (START/IFS/TWAS)[4] calling for support of a broad-based capacity building programme in global change research for developing countries.

- *The Role of Food Security in Sustainable Development:* Food security is an essential component of sustainable development, especially for developing countries. ICSU will launch a Global Environmental Change and Food Systems (GECAFS) Programme. Possible partners include IAP, FAO, as well as the Farmers and Women Major Groups.

- *Health as an integral component of sustainable development:* Major research initiatives are already underway to address the scourge of infectious diseases that is the major cause of morbidity and premature mortality in developing countries. The S&T community is fully committed to these initiatives. Further to this, the S&T community is committed to the integrating human health research with all three pillars of sustainable development. For example, ICSU's global change programmes are initiating a partnership with WHO and IAMP[5] focused on environment and health.

- *Blending traditional and scientific knowledge for sustainable development:* ICSU and UNESCO, in collaboration

3. DIVERSITAS (sponsored by ICSU and three of its subsidiary bodies plus UNESCO), International Geosphere-Biosphere Programme: A Study of Global Change (ICSU), the International Human Dimensions Programme on Global Environmental Change (ICSU and ISSC) and the World Climate Research Programme (ICSU, the Intergovernmental Oceanographic Commission and the World Meteorological Organisation).

4. The International START Secretariat [the Global Change System for Analysis, Research and Training of International Geosphere Biosphere Programme (IGBP)], the International Foundation for Science and the Third World Academy of Sciences.

5. WHO (World Health Organisation) and IAMP (Inter-Academy Medical Panel).

with the Indigenous People and Business & Industry Major Groups, will develop a new initiative for the conservation and sustainable use of natural resources based on traditional knowledge. TWAS activities on indigenous medicinal and food plants could provide additional links to S&T community in developing countries. Planning of activities and targets to be achieved will initially be for five years.

- *Demonstrating Applications of the Global Environmental Observing Systems:* ICSU, its relevant interdisciplinary programmes, UNESCO, and the other UN-system agencies are co-sponsoring the Global Observing System. The focus should now be on making this system operational and the applications of the Global Environmental Observing Systems for enhancing integrated approaches to sustainable natural resource management.

Part II: Scientific and Technological Community Contributions to WSSD

Summary of Activities Undertaken Prior to and During the Summit

Introduction

Historical overview

In the decade spanning the 1992 UN Conference on Environment and Development (UNCED, more commonly known as the Earth Summit, Rio de Janeiro) and the 2002 World Summit on Sustainable Development (WSSD, Johannesburg), the role of the scientific and technological (S&T) community in relation to such large-scale, UN-organized events has changed significantly. Whereas the official programme for the Earth Summit was exclusively reserved for government delegations, the S&T community was invited to take an active role in both the preparations and programme of WSSD. For the first time, the S&T community had direct input in developing a world summit agenda.

In fact, the S&T community represents just one of several global stakeholder groups that have begun to make major contributions to the process of international policy development in the field of sustainable development. The following paragraphs demonstrate the significance of this new approach.

AGENDA 21 AND THE IDENTIFICATION OF MAJOR GROUPS

With the adoption of Agenda 21 at the Earth Summit, governments from around the world effectively recognised the importance of nine so-called 'Major Groups', as described in nine chapters of the Agenda:

- Business and Industry
- Farmers
- Indigenous Peoples
- Local Authorities
- Non-Governmental Organisations (NGOs)
- Scientific and Technological Community
- Trade Unions
- Women
- Youth

Agenda 21 clearly stipulated that governments should collaborate with these Major Groups in pursuing the objectives of sustainable development.

Collectively, the Major Groups began to increase their impact following the Earth Summit, particularly when the UN General Assembly established the intergovernmental Commission on Sustainable Development (CSD). This Commission has a mandate, at the global level, to promote the implementation of Agenda 21, specifically to monitor progress and address difficulties encountered. At its annual meetings, the CSD began to organize concurrent, multi-stakeholder fora on specific topics, to which it invited representatives of the most closely aligned Major Groups. In fact, the objective of these fora was to solicit input from the Major Groups on the Commission's deliberations and, thus, to give Major Groups an opportunity to influence the CSD's decision-making process. Even though final decisions remained *de jure* a prerogative of governments only, this opportunity for interaction represented an important step forward.

Major Groups' contributions to WSSD preparations

In 2000, the UN General Assembly gave the CSD a mandate to act as the intergovernmental preparatory committee for WSSD. To this end, the CSD held one organizational and three substantive sessions (Preparatory Committees I – IV).

Following Preparatory Committee I (2001), the CSD invited the International Council for Science (ICSU) and the World Federation of Engineering Organizations (WFEO) to act as co-organising partners to collect input from the S&T community in preparation for WSSD. In order to ensure wide representation of the entire S&T community, ICSU and WFEO sought the collaboration of three other global organizations: the Inter-Academy Panel on International Issues (IAP), the International Social Science Council (ISSC), and the Third World Academy of Science (TWAS). ICSU also invited its members to nominate focal points to assist in the WSSD process.

At Preparatory Committees II and IV (New York - January/February 2002 and Bali - May/June 2002), the CSD organized multi-stakeholder dialogue sessions involving official delegations of all Major Groups, with the same objective as described above for the multi-stakeholder fora. In addition, each Major Group was invited to submit written reports with recommendations for consideration by all governments. At the request of the UN, the reports for Preparatory Committee II focused on lessons learned during the implementation of relevant Agenda 21 chapters following the Earth Summit and on the identification of priorities for future action. Reports for Preparatory Committee IV highlighted commitments by individual Major Groups on action to be developed following WSSD, as well as on the identification of partnership initiatives that could be implemented in cooperation with other Major Groups, governments, and intergovernmental organizations.[6] This set of 18 documents (nine reports prepared for each of the two substantive sessions) were recognised as official UN documents and submitted by Kofi Annan to the Preparatory Committee.

This detailed description of the gradual process leading up to the involvement of the S&T community in the work of CSD and to the preparation for WSSD is important for several reasons. First, there is no question that over the past decade, governments in the CSD have opened the intergovernmental dialogue on sustainable development to all Major Groups as representatives of civil society and of the private sector. Second, it highlights how this new spirit of dialogue and partnerships–the latter of which became a keyword for WSSD–led to the first incidence of Major Groups being invited to send official delegations to a world summit organized by the UN.

TOWARD A NEW CONTRACT BETWEEN SCIENCE AND SOCIETY

The WSSD process provided a timely opportunity to raise–at the international level–the inability of the current global science and technology system to meet the challenges of sustainable development. In this context, the S&T community used WSSD as a platform to call for transformations on three fronts:

- The redirection of a major portion of the present global S&T system toward science for sustainable development.
- Enhanced support for strengthening relevant S&T capacity in developing countries, and
- Developing new partnership initiatives to achieve these ends.

ICSU and its international partners, along with the S&T community, proposed to WSSD that nothing short of a new contract between the science and society is required. In addition, these groups set forth the crucial components of such a contract, as described under the next subheading.

In order to set this agenda in motion, ICSU has invited its own global change research programmes to examine their current initiatives and consider a re-orientation toward science that is more focused on sustainable development.

In addition, ICSU has established a close partnership with the international Initiative on Science and Technology for Sustainable Development (ISTS), another programme that has received generous support from the David and Lucile Packard Foundation. The activities of ISTS focus on establishing best practices and regional priorities for S&T, targeted on sustainable development. Both ISTS and ICSU coordinated additional events that were significant to the WSSD process:

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6. "Report of the Scientific and Technological Community to the World Summit on Sustainable Development", as submitted to PrepCom II, has been published as Report No. 1 in the ICSU *Series on Science for Sustainable Development*. The S&T Community's corresponding report for PrepCom IV, entitled "Science and Technology as a Foundation for Sustainable Development" is included as Part 1 of this document.

Event	Organized by	Date / Place
Led by ISTS		
Synthesis Workshop on Science and Technology for Sustainable Development[7]	Jointly organized by ISTS, ICSU and TWAS; hosted by the Autonomous University of Mexico (UNAM)	20 - 23 May 2002 Mexico City, Mexico
International Workshop on Mobilizing Science and Technology for Sustainable Development	ISTS, in cooperation with ICSU and TWAS	10 - 12 April 2002 Cambridge, MA, USA
International Workshop on Science, Technology and Sustainability: Harnessing Institutional Synergies	TWAS, under the auspices of ISTS, with ICSU as a participant	6 - 9 February 2002 Trieste, Italy
Led by ICSU		
International Workshop on Earth System Science and Sustainable Development	Global Change Research Programmes, with the support of ICSU	4 - 6 February 2002 Paris, France

WSSD Type II Partnership Proposal for Science and Technology for Sustainable Development

Early in the WSSD preparatory process, the intergovernmental Preparatory Committee encouraged and welcomed voluntary partnership proposals of international scope as one of the desired major outcomes of the Summit. The Preparatory Committee acknowledged that moving toward sustainable development requires not only political will and action by governments, but equal commitment from all sectors of the global society and all stakeholders in sustainable development.

The Committee also identified the need for broad partnerships between civil society–including the S&T community–governments, and business. Hence, the Committee agreed to work toward generating two outcomes of WSSD, known as Type I and Type II agreements. Type I represents intergovernmental agreements; Type II outcomes are built upon voluntary partnership commitments and proposals of international scope, which are under the leadership of non-state actors.

Based on consultations within the S&T community, and particularly on relevant discussions at the Synthesis Workshop in Mexico City, ICSU submitted a Type II proposal for a broad *Partnership on Science and Technology for Sustainable Development* to the United Nations in advance of WSSD. Once fully developed, the Partnership could involve many key players including the five S&T organizations involved in the WSSD Forum on Science, Technology and Innovation for Sustainable Development (ICSU, TWAS, WFEO, IAP, and ISSC) and ISTS. In addition, the Partnership would seek input from ICSU's global change research programmes and other ICSU bodies, from other non-governmental S&T institutions, from relevant UN system entities and other Major Groups, and from governments around the world.

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7. The timing of this workshop was such that its draft consensus report produced was available to the S&T delegation in advance of their interventions in the Multi-stakeholder Dialogue at PrepCom IV (Bali, Indonesia). In addition, the "Consensus Report and Background Document of the Mexico City Synthesis Workshop" was made available in printed form at WSSD, as Report No. 9 in *ICSU Series on Science for Sustainable Development*. The Report is also available on the ICSU web site: www.icsu.org.

The proposal outlined actions for the Partnership, focused on five key areas:

- identifying indicators of sustainable development
- establishing research networks
- creating a clearing house for clean and locally appropriate technologies
- providing scientific guidance for locally initiated sustainable development activities, and
- the development of virtual knowledge systems.

Major Groups become an active voice in WSSD deliberations

As a result of this close collaboration during the preparatory stages, WSSD became a truly unique event. The WSSD programme provided opportunities for all Major Groups to participate in all parts of the official summit–including the segment arranged for heads of state or government. As described below, delegates from the S&T community played key roles in five elements of the Summit: the Thematic Panel Sessions, the Plenary Sessions for Policy Statements, the Plenary Sessions for Policy Statements by Heads of State/Government, the Round Table Sessions, and the Multi-Stakeholder Event.

Thematic Panel Sessions

This initial segment of the Summit consisted of seven, half-day plenary sessions devoted to the five priority areas proposed by the UN Secretary General Kofi Annan: water and sanitation, energy, health and the environment, agricultural productivity, and biodiversity and ecosystem management (the so-called WEHAB areas). In addition, there was one session on 'cross-cutting' issues, which included science and technology, education, and capacity building, as well as a final session that focused on regional priorities. Each session began with a panel discussion moderated by Mr. Jan Pronk, Special Envoy of the UN Secretary General for WSSD. The plenary was then opened to interventions by government delegations.

The S&T community delegation, along with all other Major Groups, had the opportunity to designate one member of the delegation as a panelist in these plenary sessions. Hence, the S&T delegation intervened during the panel discussions through the following spokespersons:

Water	C.N.R. Rao, TWAS
Energy	Y. Quéré, IAP
Agriculture and Food	L. Lehutso-Phooko, ISSC
Biodiversity	T. Rosswall, ICSU
Cross-cutting Issues	G. Glaser, ICSU

Plenary Sessions for Policy Statements

This segment of the Summit provided an opportunity for intergovernmental organizations, such as UN system agencies, and non-governmental entities, to address the plenary. In this context, the S&T community delegation delivered two five-minute statements (see pages 17 and 18):

Capacity Building for Sustainable Development
M.H.A. Hassan, Executive Director, Third World Academy of Sciences (TWAS)

Appropriate and Environmentally Sound Technology for Sustainable Development
J. Medem Sanjuán, President, World Federation of Engineering Organizations (WFEO)

The Summit's third segment consisted of policy statements in plenary by heads of state/government or heads of government delegations.

Round Tables: Making it Happen

In parallel to the policy statements in plenary, four half-day closed Round Tables were organized–all around the same central theme: *Making it Happen.* Each government delegation was restricted to attending only one Round Table, and their participation was restricted to one person per delegation, apart from the heads of state/government who could attend accompanied by a second person. In addition, one high-level representative of each Major Group was invited to attend each Round Table, but without any assurance of being given the floor. In the end, the S&T community delegation was the only Major Group to be given the floor during all four Round Table sessions, during which brief statements

were delivered by M. Hassan (TWAS), Y.C. Lee (WFEO), T. Rosswall (ICSU) and H. Yoshikawa (ICSU).

Multi-Stakeholder Event

Major Groups delegations were invited to present their own policy statements during the Summit's final session on 4 September 2002. As president of ICSU, Prof. H. Yoshikawa made a statement on behalf of the entire S&T community (see page 19). This event took place immediately prior to the adoption of the Johannesburg Political Declaration, the Johannesburg Plan of Implementation, and the closing of the Summit.

Clearly, the stage has been set for increased involvement from all Major Groups, and for the S&T community in particular, to take active roles in setting the agenda, engaging in dialogue, and contributing to decision-making processes as governments and stakeholders around the globe take steps toward increasing their commitment to sustainable development.

* * *

Statements

Capacity Building for Sustainable Development

Statement by Professor Mohamed H.A. Hassan
Executive Director, Third World Academy of Sciences (TWAS)

Plenary Session for Policy Statements

Building and maintaining adequate scientific and technological capacities in all countries and harnessing these capacities to address critical economic, social, and environmental issues are essential prerequisites for the transition to sustainable development. Such capacities in science and technology can help nations better understand their current situation, as well as devise effective responses to meet future challenges. Scientific research may be global in scope but its applications work best when tailored to national and regional settings.

A worldwide shortage in scientific and technical skills and leadership, particularly in developing countries, calls for designing more effective regional, national, and international research and training programmes in science and technology at all levels. The necessary capacity building calls for fully utilizing the powerful tools of information and communication technologies.

Increased priority, moreover, should be given to promoting science and technolo gy educ ation and training for women. Women remain an under-utilised intellectual resource worldwide, particularly in science and technology.

Professional education programmes that include the goals of sustainable development are also needed for scientists and engineers throughout their professional careers. We must also develop a science-literate civil service capable of technology management and a civil society that understands these challenges and their importance to human welfare and sustainable development. All of this means that national and international organizations must invest in life-long learning programmes for their citizens–and that such programmes must weave together a broad understanding of science with knowledge of the social sciences and economics.

Because of the wide gap among countries and regions in their science and technology capacities, different priorities and strategies should be designed to address the needs for capacity by different regions.

In the North, where 85 per cent of the current science and technology knowledge is produced, capacity building is part of a larger effort to modify existing scientific agendas and institutions to address long-term sustainability issues.

In the South, meanwhile, capacity building must focus on nurturing home-grown research skills and building research and training institutions, including universities, to a level of excellence that would enable them to attract talent, curb the brain drain, and participate effectively in global efforts to harness science and technology for sustainable development.

One of the prime lessons we have learned is that capacity building efforts in the South have been too fragmented and uncoordinated to build the critical mass of scientific expertise that is necessary for many developing countries to take advantage of science and technology to accelerate their own sustainable development goals.

Coordinated efforts–through the strengthening of South-South and North-South institutional partnerships–would help foster the mobility of scientists and technologists as part of a larger strategy for promoting the exchange of knowledge and experiences to advance the transition towards sustainable development.

Responsibility for building and maintaining science and technology capacities for sustainable development resides first and foremost on the shoulders of national governments and must be guided by strategies and policies that are fully integrated into national development goals. It is critical, therefore, for governments worldwide to adopt sustainable development strategies that recognise the trade-offs between short- and long-term economic development strategies. Indeed this challenge is particularly critical for the North where consumption patterns place global efforts to promote a sustainable future at risk.

The S&T community calls on national governments and international funding agencies to recognise the central importance of capacity building for the transition toward sustainable development. Increasing the role of science and technology in sustainability initiatives should focus on:

- Expanded efforts to build and maintain institutional centres of scientific excellence, especially in the South, through additional investments in university departments and research institutes that have displayed research and training capabilities on a national and regional scale.
- Additional investments in programmes designed to assist women, especially in the developing world, to acquire the scientific and technical training that they need to participate in the global scientific community.
- Greater sensitivity and acknowledgement in the S&T community of the potential value of indigenous knowledge in addressing critical sustainability issues, especially in the developing world.
- Strengthening of South-North cooperative programmes that recognise the growing capabilities of science and technology in the South to forge partnerships that are truly equitable and global in scope.
- Better integration of scientific knowledge and skills with other sources of knowledge, including the social sciences and economics, as a prerequisite for devising multidisciplinary strategies to address sustainability issues.

The strategy boils down to this: the S&T community has called upon governments and funding agencies to provide sustained and reliable funding for science and technology initiatives, especially in the South. The S&T community, in turn, has pledged to focus a greater portion of its research agenda on issues of direct concern to the societies in which its scientists live and work. By agreeing to such shared responsibilities and commitments, we believe that both the S&T community and the larger society will be better able to advance their shared goals for a sustainable future.

* * *

Appropriate and Environmentally Sound Technology for Sustainable Development

Statement by Professor José Medem Sanjuán
President, World Federation of Engineering Organizations (WFEO)

PLENARY SESSIONS FOR POLICY STATEMENTS

Scientists and engineers are committed to contribute to sustainable development through knowledge and technology generation and diffusion. Addressing the basic needs in the area of water, food, health, housing, and energy consists essentially of the application of appropriate technologies.

Countries in both the developed and developing world contribute significantly to global risks, such as climate change, ozone depletion, degradation of biological resources, and loss or deterioration of arable land. The unsustainable production and consumption patterns of the developed world are largely responsible for the conditions in which the planet

now finds itself. Unfortunately, this energy- and materials-intensive model of economic development is viewed by many in the developing world as the path to prosperity.

Improving the economic well-being of lesser developed countries and reducing poverty of the third world is a pre-requisite for creating a stable sustainable world. Indira Gandhi's statement "poverty is the greatest polluter of all" is very important to the understanding of the problem. Urgent action is required to reverse the unsustainable production and consumption patterns by the adoption of appropriate and environmentally sound technology.

Concerning these technologies, the mindset of scientists and engineers must focus on affordability and accessibility, as much as on cutting edge technology. The conditions of the poor can be improved by using low-cost local materials, renewable energy, and local fabrication.

In order to strengthen the capability of developing countries to produce, adapt, and use knowledge, we must improve the dissemination of information and knowledge through networks and partnerships. Capacity building in science and engineering is key to enhancing the abilities of developing countries to moving towards sustainable development.

In view of the fast pace of development in science and technology, the developing world must also continue to keep pace with science and engineering research and development. Assistance from the developed world is required in building their capacity in this regard.

The S&T community commits itself to develop concrete partnerships with all the other stakeholders in moving to faster and more efficient implementation of Agenda 21. We also propose that the scientific and engineering professions become fully involved in all stages of decision making processes for sustainable development.

* * *

Science and Technology for Sustainable Development

Statement by Professor Hiroyuki Yoshikawa
President, International Council for Science (ICSU)

MULTI-STAKEHOLDER EVENT

The UN Secretary-General 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.

Science and technology are increasingly recognised to be central to Kofi Annan's three challenges. A vision for a sustainable future should be based on knowledge societies, in which the scientific and technological (S&T) community will have an important role to play, and it should accept the challenge to provide leadership based on its competencies. In response, the S&T community, under the leadership of the International Council for Science (ICSU) and the World Federation of Engineering Organizations (WFEO), launched a series of pre-Summit initiatives designed to devise new commitments and forge new partnerships for the advancement of sustainable development. The Third World Academy of Sciences (TWAS), the InterAcademy Panel (IAP) and the International Social Science Council (ISSC) worked closely with ICSU and WFEO on this effort, including the reports to PrepComm II and IV.

In the report of the Secretary-General on Implementing Agenda 21, Mr. Annan states that "Ten years after UNCED, a major obstacle to sustainable development for much of the world remains the lack of scientific and technical capacity. ... The resources that have been made available for capacity building, however, have been relatively meagre in relation to the growing requirements of developing countries. More resources are needed to support international efforts at capacity building". Also the UN Millennium report recommends as a priority for the 21st century the need for more accurate scientific data. The S&T community shares these views, but at the same time we are proud of many of the achievements over the past ten years. The global change programmes of ICSU and its partners are one example of an unprecedented international effort to reduce scientific

uncertainties in relation to global change, and the results of the programmes have been highly policy relevant feeding directly into the Intergovernmental Panel on Climate Change (IPCC) and, thus, into the negotiations on the Framework Convention on Climate Change.

Sustainable development must be based on scientific and technological knowledge, which is often costly to create, and that is why much of it is created in industrial countries. The OECD countries spend more on research and development (R&D) than the economic output of the world's 61 poorest nations. High-income countries have twelve times the *per capita* number of scientists and engineers working in R&D and they publish 25 times more journal articles than low-income countries. This imbalance is a threat to sustainable development and capacity building for science and technology, including all levels of education, must be an essential component of the action plan from Johannesburg.

The S&T community accepts its responsibility to address issues of sustainable development in a holistic and integrated manner through education, training, research and technological innovation. Scientists and engineers will address the need for knowledge by civil society, the private sector and governments in order to help develop solutions and options for sustainable development. We will focus on enhanced dialogue with decision makers at all levels, from local to global, so that relevant issues can be addressed in a timely manner. In order to ensure policy relevance, we will implement research that integrates the three pillars of sustainable development.

The S&T community has launched a Type II partnership for "Science and Technology for Sustainable Development" involving many partners and seeking further involvement of the other Major Groups of the WSSD process. This initiative will focus on the interdependencies and interactions between ecosystems and social systems. Through this initiative, we will bridge the conventional divide between natural, social, economic and engineering sciences. This initiative is highly policy relevant and addresses the priority issues of the WSSD.

Efforts must focus on local and regional contributions to – and consequences of – global changes. New research initiatives will focus on the local and regional contexts integrating the three pillars. This can only be successful if there is better public understanding of the strengths and limitations of S&T and an involvement of civil society. Also, technology transfer, the local adaptation of appropriate technologies or development of community specific ones based on traditions and ingenuity of local peoples will equally be central to such efforts.

The agenda for such a bold new undertaking must be developed in partnership with other stakeholders in a truly participatory manner. This will necessitate a new approach to defining research questions, implementing research programmes and communicating the results. An S&T initiative for sustainable development will only be successful if its agenda and priorities are agreed upon in partnership with major stakeholders.

The S&T community has taken many other initiatives to support the WSSD process. One additional example is the proposed establishment of four ICSU regional offices for developing countries in Africa, the Arab States, Asia and Latin America. This recent initiative will help strengthen the involvement of the science communities of developing countries in the global scientific enterprise. We call on governments in these regions to help establish these important offices.

The priority of the World Federation of Engineering Organizations (WFEO) has been capacity building of national institutions/societies of engineers and technologists in developing countries, particularly in Africa, and promotion of the mobility of engineers and technologists between developing countries. While ICSU and WFEO have been the lead partners for the S&T community in the WSSD process, we have also worked closely with three other bodies that bring additional strength and expertise to this vital undertaking. The Third World Academy of Science has taken steps to advance a number of important initiatives related to research grants, fellowships and institutional networking, and will continue to be a motor for science in developing countries. The InterAcademy Panel has brought together the world's science academies in an effort to make these institutions a more effective force in advancing science-based development. The International Social Science Council brings the necessary social sciences expertise to the table, and it will be essential for the natural and social sciences, economics and humanities to work together in order to ensure

that the implementation of the Type II partnership will be truly successful as judged by the relevance that its results will have for both the public and private sector.

Good governance needs good science, but the link between the S&T community and decision making is poorly supported by current institutional structures. Governance systems and mechanisms for sustainable development at local, national, regional and global levels must incorporate best available scientific and technological knowledge. Existing governance institutions and institutional mechanisms need to be transformed in ways which will ensure input from the S&T community.

To strengthen the scientific contributions to sustainable development, our community has suggested that a formal link be established between the UN Commission for Sustainable Development (CSD) and the S&T community through a CSD Advisory Panel on Science and Technology. This would be a mechanism to ensure that the CSD can draw upon independent scientific and technological expertise and advice.

Good governance also requires an informed and educated population. Through capacity building, education and improved science communication, we will empower a new generation of citizens with the knowledge they need to better understand and address sustainability issues. Capacity building is also necessary to bridge the wide scientific divide between the North and the South.

Governments and all stakeholders need to be able to assess success in developments towards sustainable societies. Commonly accepted indicators should be developed and used. It is necessary with internationally agreed upon indicators, and the S&T community is willing to assist in the development of such a set.

Kofi Annan has outlined five areas, where concrete results are both essential and achievable; water and sanitation, energy, health and the environment, agricultural productivity, and biodiversity and ecosystem management. These are all areas where the S&T community has much to offer. We pledge our commitments to address these issues in relation to the social, economic and environmental pillars. We challenge the governments to support this new and bold venture. Only by working jointly can we succeed in addressing the challenge of sustainable development.

Part III: WSSD Forum on Science, Technology, and Innovation for Sustainable Development

Summary Report of Sessions Organized by ICSU, TWAS, and WFEO, in Cooperation with Other Partners

Introduction

In conjunction with the World Summit on Sustainable Development (WSSD), the Ministry of Culture, Arts, Science and Technology of the Government of South Africa organized a Forum on Science, Technology, and Innovation for Sustainable Development. In fact, the idea for such an event was originally put forward by Mr. Nitin Desai, UN Under-Secretary-General, who served in the capacity of Secretary-General for WSSD. The Forum was held at the Ubuntu Village (Johannesburg, South Africa) from 27 August to 4 September 2002.

The full Forum programme comprised two events that extended over a number of days, as well as a number of shorter, topical sessions. A two-day programme organized jointly by the South African Ministry of Arts, Culture, Science and Technology and the European Commission, sought to demonstrate–to the world and to developing nations in particular–the openness of the European Union's Sixth Framework Programme for Research. Various other non-governmental and intergovernmental scientific organizations hosted sessions that addressed specific subject areas.

This report focuses on the second major event presented during the first week of WSSD, a series of sessions which were organized by the International Council for Science (ICSU), the Third World Academy of Sciences (TWAS), and the World Federation of Engineering Organizations (WFEO), with cooperation from various other partners as indicated in the following pages. The programme addressed most of the five priority areas identified by UN Secretary-General Mr. Kofi Annan: water and sanitation, energy, health and the environment, agricultural productivity, and biodiversity and ecosystem management. The agenda also reflected the priorities officially put forward by the S&T community during the second and fourth meetings of the intergovernmental Preparatory Committee in advance of WSSD.

The sessions organized by ICSU, TWAS, and WFEO represented a very successful parallel event to the official WSSD programme. The presentations and discussions provided an opportunity to share knowledge, exchange ideas, and develop proposals for action in the domain of S&T for sustainable development following WSSD. Overall, the sessions were well attended. On average, 100 to 120 participants attended each session, most of whom represented the S&T community, the NGO sector, other Major Groups, indigenous peoples, or business and industry. Some session topics attracted crowds of up to 300 people. Participation by official government delegates was weaker than hoped, but satisfactory given the sheer magnitude of the Summit itself.

The following pages provide the full programme for each ICSU-TWAS-WFEO session, as well a summary report of the presentations and ensuing discussions. The format of these sessions generated excellent interventions from the floor: the open and frank discussions contributed significantly to the success of the Forum events.

Session 1

Harnessing Science for Sustainable Development

ORGANIZED BY:

International Council for Science (ICSU)
Third World Academy of Sciences (TWAS)

CHAIR

W.R. Erdelen, Assistant Director-General for Natural Sciences, UNESCO

TOPICS / PANELISTS

Introductory comments concerning harnessing science for sustainable development
W.R. Erdelen, Assistant Director-General for Natural Sciences, UNESCO

The policy challenge of science and technology for sustainable development
J. Sachs, Director, Earth Institute, Columbia University, USA

A science agenda from an African perspective
HE T.T. Isoun, Minister of Science and Technology, Nigeria

The future of global change science and a platform for science for sustainable development
B. Moore III, University of New Hampshire, USA

Vulnerabilities to climate change: An African perspective
C. Magadza, University of Zimbabwe, Zimbabwe

Resilience of ecosystems and social systems: A management challenge
J. Rockström, International Institute for Infrastructural, Hydraulic and Environmental Engineering (IHE)

Indicators and sustainable development
B. Moldan, Charles University, Czech Republic

Science and technology for sustainable development
J. Jäger, Executive Director, International Human Dimensions Programme on Global Environmental Change (IHDP)

INTRODUCTION

This session built upon the activities of the five official partners representing the S&T community in the WSSD process: ICSU and WFEO in collaboration with IAP, ISSC and TWAS. It also advanced the many workshops organized by the Initiative on Science and Technology for Sustainability (ISTS), including a synthesis workshop organized by ISTS, TWAS, and ICSU, which was held in Mexico City in May 2002.

Following 10 years of research efforts centred on global issues while also addressing regional aspects, this session focused on finding ways to link the global with the local. It also emphasized the need to integrate the three pillars of sustainable development–environment, society and economics–to enable science to meet the challenge of connecting local and global concerns while also interlinking bottom-up and top-down approaches to issues.

There is no question that science has had a complicated relationship with sustainable development. While some scientific discoveries have contributed to environmental degradation, others have provided substantial contributions to environmental, social and economic well-being. To successfully address the challenges of sustainable development, scientists must harness science and redirect research goals to more fully address societal needs. This will entail a 'new social contract' as proposed by Professor Jane Lubchenco during her tenure as president of the American Association for the Advancement of Science (*Science,* 277:494-499, 1998). Within that context, this session analysed the current situation and proposed possible ways forward.

PRESENTATIONS

Sustainability depends on knowledge. However, as Dr. Erdelen forcefully pointed out in his opening remarks, the S&T community must apply its knowledge more holistically. It also needs to address several worrying trends, especially in the area of science and technology education. For example, many young people in higher education today are turning away from science and technology; thus, it will become increasingly difficult to train enough scientists and engineers for the future. The under-representation of women in science, especially in physics and chemistry, persists as another impor-

tant problem to be tackled. In order to address the development gap in resources and in access to science and technology, the S&T community must collectively seek to increase capacity building.

Professor Sachs, a development economist and advisor to UN Secretary General Kofi Annan for the Millennium Goals, addressed the issue of science and technology from an economic perspective. He argued that while science and technology have been the prime drivers of long-term economic growth, the existing science and technology structure is worsening the divide between rich and poor nations. Science and technology outputs are now increasing returns of scale functions (i.e. innovation tends to take place in large cities). In addition, the substantial costs associated with new technology necessitate that research and development activities take place in areas that can provide large markets.

Scientists, said Prof. Sachs, need to associate and collaborate with other scientists. But the fact that most major scientific centres are currently in the North–95 per cent of advanced research and development centres are in the developed countries–further exacerbates the problem of brain drain in the South. And, while technological advances that originate primarily in the North do spread across the globe over time, substantial geographical and economic boundaries still exist. Yet Prof. Sachs admits that there is no easy solution. One can not simply transfer research centres to developing countries. Science is a reflection of complex social institutions, and much of the necessary infrastructure does not currently exist in developing countries.

The policy perspective of this vital question of harnessing science for sustainable development was presented by HE T. T. Isoun. Historically, he said, Africa has predominately been a user of science and technology, rather than an equal participant in the creation of knowledge. Nigeria is seeking to rectify this situation by creating world-class research centres in several strategic areas: information and communications technology, biotechnology, nuclear physics, and space science. These centres will be staffed by Nigerian scientists who have been trained in the North and will become the foci of international intellectual exchange in the near future. To accomplish this, the Nigerian government is developing partnerships with small- and medium-sized enterprises, as well as with other national research centres in the South and North. The key to the success of this programme will be a combination of integrated capacity building and political will.

Scientific evidence indicates that humans are significantly influencing the Earth's environment in ways–and at rates–never before experienced. Professor Moore provided an overview of various concurrent events now taking place in the atmosphere, on land, and in the oceans that have resulted in a situation in which we are outstripping the carrying capacity of the Earth. Each year, humans generate six billion tonnes of CO_2: five tonnes per person in the US versus 0.5 tonnes in China. At the same time, more nitrogen is being fixed by anthropogenic methods than by the ecosystem, and more than 60 per cent of the world's fisheries are over-exploited.

Further evidence is available in ice core data, which clearly shows that atmospheric CO_2 is now outside the natural variations that occurred over the past 1000 years. Unless greenhouse gas emissions are greatly reduced, scientists predict that this increase will lead to a global temperature rise of 1.4 to 5.8 -C over this century. Moreover, even if CO_2 emissions are drastically reduced in the very near future, it would still take several hundred years for the Earth to return to a state of equilibrium. Any attempt to dispute this situation is an artificial uncertainty–which is usually politically motivated–to distort scientific certainty, said Prof. Moore. In order to address this situation, scientists must enter a new era of global change science in which the research agenda is set by a 'new social contract'. In closing, Prof. Moore suggested that one of the most difficult challenges in fulfilling this contract will be finding ways to link local and global issues.

The effects of such global climate change on the regional scale, and more specifically on African agriculture, was then addressed by Professor Magadza. Essentially, increases in global air temperatures will increase evaporation, and while precipitation changes will be geographically dependant, the overall effect will be one of water stress. Modeling projects of agricultural futures in Africa predict negative crop yield changes for nearly the entire continent. While global food production has been +3 per cent in recent years, Africa has experienced consistent declines. In fact, the rate of under-nourishment increased over the period 1996-1997, according to the Intergovernmental Panel on Climate Change (IPCC).

In Africa, multiple compounding factors make a sustainable solution difficult to develop and implement, said Prof. Magadza. For example, Africa needs to pay out 67.5 per cent of its Gross Domestic Product (GDP) to repay its debts. In addition, the ravaging effect of military conflicts account for more deaths annually than natural or epidemic events. In order to address the big issues induced by climate change, Prof. Magadza said Africa must find ways to uplift rural agriculture, encourage the cessation of unnecessary conflicts, create business/technical partnerships to address agricultural needs, and develop sound water policies.

The next issue covered was resilience, which is defined as the economic and social capacity of a system to absorb shocks. The term is also used to describe the degree to which a system can self-organize. In Africa, the frequency of shocks is increasing and the impact of these events is becoming more severe. The net result is a more fragile state that ultimately crumbles on both levels as erosion of ecological resilience often triggers loss of social resilience. According to Professor Rockström, the importance of the interconnectivity and dynamic states of social and ecological systems should not be underestimated.

Citing the need for a six-fold increase in water availability to meet the food challenge in Africa, Prof. Rockström underscored the determinant role of water. In order to increase resilience, he said, nations must look for ways to reduce risk. One such example occurred in India, where the last Green Revolution occurred. At the time, India was experiencing a state of high ecological and social resilience. By contrast, in Africa–where the New Green Revolution is now needed–there is low ecological and social resilience. Thus, even small shocks can turn into disasters.

Increasingly, scientists are using indicators to quantify risks and changes to a system, one of which is GDP, said Professor Moldan. Current projections suggest that by 2040, global GDP will increase by a factor of four. Such descriptive indicators are extremely helpful, especially when communicating with non-specialists. However, Prof. Moldan also pointed out that for the environment, there are currently more proposed environmental indictors than there are input data. The need to develop several accepted indictors, especially for resilience and other fields that include critical thresholds, is extremely pressing. But in order to tackle the need for legitimate, reliable, and credible indicators, scientists must engage in broad-based consultation with all concerned stakeholders.

Discussion and Summary

Prof. Sachs' suggestion that geography is a limiting factor for economic growth and that people in the tropics are 'stuck', drew dissension from several members of the audience. They quickly reminded participants that many Northern pharmaceutical companies are actually benefiting from the rich biodiversity of the tropics, while returning only a small portion of their profits to the countries of origin–in some cases, as little as 0.0001 per cent. However, there was general agreement that science for sustainability will not be self-organising, that business as usual will no longer suffice, and that widespread education is an essential step toward sustainability.

To conclude the session, Dr. Jäger summarised the efforts of the Initiative on Science and Technology for Sustainability (ISTS), as well as those of several other institutions, notably TWAS and ICSU. The overriding goal of these efforts is to advance fundamental human and social needs while protecting the Earth's life support system and biological diversity. To do this, the S&T community will need to re-focus knowledge on social-ecological systems, place-based learning, and system complexities–all of which require cross-scale linkages and will be subject to uncertainties and time-lags.

In closing, participants agreed that to be broadly accepted, this knowledge will need to be credible, salient, and legitimate. They then identified several possible agenda items for this new contract including:

- managing for resilience/adaptiveness and understanding vulnerability
- promoting sustainable consumption and production patterns, and
- establishing spanning institutions that link scientists and decision makers.

Report prepared by Leah Goldfarb

Session 2

Engineering and Technology Innovations for Sustainable Development

ORGANIZED BY:

World Federation of Engineering Organizations (WFEO)
Engineering Council of South Africa (ESCA)

CO-CHAIRS

T. Ridley, President, Commonwealth Engineers' Council
Dato Ir. Yee-Cheong Lee, President-Elect, World Federation of Engineering Organizations (WFEO)

TOPICS / PANELISTS

Welcome
J. Medem Sanjuán, President, World Federation of Engineering Organizations (WFEO)

Science and technology policy formulation and engineering and technology in Mozambique
HE L.M.R.A. Brito, Minister of Higher Education, Science and Technology, Mozambique

Building Engineering Ability in Mozambique (BEAM)
D. Hood, David A. Hood & Associates Pty Ltd., Australia

ECSA's Role in sustainable development in South Africa
R.A. Pullen, President, Engineering Council for South Africa (ESCA), South Africa
P. Roux, CEO, Engineering Council for South Africa (ESCA), South Africa

ECSA's Access to 'World Best Practice' and potential benefits for Africa
A.J. Hay, Chair, International Committee, Engineering Council for South Africa (ECSA), South Africa

The future of hydrogen as an energy carrier
A. Falanga, CEO, Atomic Energy Agency of France, France

Fuel cell technology for transportation
J. Schlaiss, Corporate Representative Office, Chrysler/Daimler, South Africa

Renewable energy for African development
J. Wakhungu, African Centre for Technology Studies (ACTS), Kenya

Megacities: A major challenge for sustainable development
G. Glaser, International Council for Engineering and Technology (ICET)

Technology capacity development
C. Juma, Professor, John F. Kennedy School of Government, Harvard University, USA

Bridging the gap through transformation
T. Goba, President, South African Institute of Civil Engineering (SAICE), South Africa

Sustainable engineering as a pre-requisite for sustainable development
D. Botha, Executive Director, South African Institute of Civil Engineering (SAICE), South Africa

Building sustainability
A. Gilham, Royal Institution of Chartered Surveyors (RICS) Foundation / Global Alliance for Building Sustainability (GABS)

Engineering and technology for poverty alleviation: A UNESCO initiative
T. Marjoram, Program Specialist, Engineering and Technology Division Science Sector, UNESCO
W. Erdelen, Assistant Director-General for Natural Sciences, UNESCO

APEC engineer register: A possible model for mobility of science, engineering, and technology professionals
J.A. Karim, Secretary, Board of Engineers, Malaysia

Telecommunications and information technology innovations for sustainable development
M.-J. Prieto-Laffargue, President, Engineering Institute of Spain, Spain

Economics of innovative knowledge
S. Raut, Chief Operations Officer, International Young Professionals Foundation (IYPF)

The natural edge: Sustainable development as an engine for technological innovation
J. Moody, President, International Young Professionals Foundation (IYPF)

Engineering sustainability in the Commonwealth
T. Ridley, President, Commonwealth Engineers' Council

INTRODUCTION

The main objective of this session was to highlight the crucial role of engineering and engineers in tackling sustainable development and poverty alleviation. Indeed, at the Opening of the Science, Technology and Innovation (STI) Forum on 27 August 2002, Nitin Desai, UN Secretary-General for WSSD, acknowledged the valuable input of WFEO to the Earth Summit (Rio de Janeiro, 1992) and the subsequent WFEO initiative in 1993 that led to the formation of the World Engineering Partnership for Sustainable Development.

Implementing Agenda 21 after WSSD will be based on political will, practical steps, and partnerships with time-bound actions. The means of implementation are through finance, trade, transfer of environmentally sound technology, and science and capacity building. The engineering profession has considerable experience in practical implementation of projects and programmes within time and cost budgets, and is therefore well-equipped to play a key role in setting and implementing the agenda for the future.

The WFEO Session focused on policy relevant science (with a strong emphasis on its engineering implementation), long-term perspectives, capacity building, and global concerns (with appropriate emphasis on Africa). Whilst giving more preference to South Africa and Africa, speakers were selected with due consideration of geographical spread, gender, and generation balance.

PRESENTATIONS

HE Dr. Brito opened the session by talking about science and technology policy formulation, as well as engineering and technology, in Mozambique. The urgent need to build up engineering and technological capacity was emphasized in the companion paper on *BEAM-Building Engineering Ability in Mozambique,* an initiative of Mozambique government and industry, with assistance from engineering institutions of Australia, South Africa and Great Britain. BEAM is working with, and will enhance, the recently proclaimed *Ordem dos Enginheiros de Mozambique,* the newest national institution of engineers in the world.

Representing UNESCO, Drs. Marjoram and Erdelen highlighted the role of engineering and technology for poverty eradication. They argued that access to knowledge and resources that address basic needs should be considered a basic human right, as well as a central component of a rights-based approach to poverty eradication. They also described Technology and Poverty Eradication (TAPE), a UNESCO programme to promote technology for sustainable development that has interdisciplinary components across UNESCO's areas of mandate, and specific geographic and social dimensions relating to particular regions and issues. The focus of the TAPE project is on providing technology to address basic needs, and on access to knowledge and resources to promote sustainable livelihood development. The strategy is to support and encourage local responses to diverse basic needs, using a variety of media.

As an example of long-term technological development, two papers focused on the coming 'hydrogen economy'. Dr. Falanga focused on the future of hydrogen as an energy carrier, while Mr. Schlaiss highlighted the potential of fuel cell technology for transportation. Both corporate representatives were 'out-of-the-box' invitees of Nitin Desai, Secretary-General of WSSD.

The next presentation by Dr. Prieto-Laffargue addressed the role of telecommunications and information technology in sustainable development. She spoke on the relationship between social and economic progress and telecommunications services, as well as telecommunications' contribution to improving education and health care in southern Africa.

Dr. Wakhungu focused on renewable energy techniques for Africa's sustainable development and described progress since the 1981 UN Conference on New and Renewable Energy

(Nairobi, Kenya). Although there have been successes, results have not lived up to expectations, and the unsustainable use of biomass energy continues to dominate in many areas of Africa. Dr. Wakhungu concluded by presenting a basis for a sustainable, renewable energy strategy.

In the first of several presentations that highlighted technology capacity building, Professor Juma suggested that perceived lack of progress since the Earth Summit is due to inadequate science and technology investment as much as to the lack of political will. He said that geographic information systems (GIS) are central to addressing Agenda 21 actions, particularly in that they can be used to understand and integrate social, economic and environmental issues, as well as relationships between these factors at local, regional, national, and global scales. These systems have also demonstrated excellent benefits when used in early warning systems for natural disasters, human and livestock health, crop production and yields, and for monitoring soil erosion, rainfall and biodiversity.

Speaking on behalf of SAICE, Mr. Goba emphasized that his organization has seized the opportunity of the 'new' South Africa, and has a drive to become a leading player in sustainable development initiatives. With the New Partnership for Africa's Development (NEPAD), SAICE will contribute significantly to alleviating poverty and improving the quality of life both inside and outside South Africa. Mr. Goba argued that, because modern society relies heavily on the availability of well-developed and well-maintained infrastructures, sustainable engineering is a prerequisite for sustainable development. Thus African science and technology capacity and skills must match the standards of international best practices.

Mr. Pullen then outlined ESCA's role in ensuring compliance with high standards for the engineering profession–always keeping the interests, safety, and health of the public in mind. Long-established standards and procedures for regulating the profession have been transformed, he said, to meet the evolving needs dictated by the political, social, and economic changes in South Africa. As a follow-up, Dr. Roux discussed how ESCA's links with international engineering bodies help promote engineering best practices. He also highlighted ways in which ECSA can help bring best practices to other countries in Africa.

Mr. Karim responded by presenting the Asia Pacific Economic Cooperation (APEC) Engineer Register as a possible model for promoting South-South mobility of professionals in science, engineering, and technology. Such a network, he said, could help address the critical problems of brain drain in developing countries.

A presentation by Mr. Gilham focused on the Global Alliance for Building Sustainability (GABS), a Type II initiative made up of more than 40 organizations working to accelerate the achievement of sustainable development in the land, property, construction, and development sectors. The overriding aim, said Mr. Gilham, is to close the gap between policy and practice, thereby making sustainable development a reality for practitioners working in government, business, community, and environmental projects.

Economic development is crucially dependent on an understanding of new, innovative knowledge, said Ms. Raut. In future, she said, societies will be knowledge societies with knowledge markets, and will bring together environment, ecology, economics, equity, and ethics. Her colleague from the IYPF, Mr. Moody, took that idea a step further, arguing that sustainability can–and should–be used as a driver for innovation and success in the knowledge economy of the 21st century. Businesses, communities, and governments that move to sustainable development have three distinct advantages: They create more wealth and employment, they protect and enhance natural and human capital, and they increase profit and competitive advantage.

In his presentation on megacities, defined as those with populations greater than 10 million, Dr. Glaser opened with current statistics and a glimpse of the future. By 2030, experts predict the world will have some 35 megacities, 30 of which will be in developing countries. Dr. Glaser went on to highlight major problems that must be addressed in these environments, such as

- finding ways to cope with massive development of shanty towns
- reducing health risks and improving sanitation
- decoupling enhanced urban mobility from increased pollution and greenhouse gas emissions
- enhancing prevention of human-induced and natural disasters

- improving governance systems, social insertion, and security, and
- addressing the social, economic, cultural, and political 'footprints' of megacities at the global, regional and national levels.

All of these issues must be considered with a view to also assessing how megacities affect the Earth system. Admittedly, said Dr. Glaser, megacities are extremely complex systems and, therefore, solutions to these major problems require a holistic and integrated approach.

In closing the session, Prof. Medem Sanjuán summarised WFEO's proactive participation in the World Summit on Information Society (WSIS), which will be held over two sessions in Geneva (2003) and Tunis (2005). He also invited all participants to the World Engineering Convention in Shanghai (November, 2004), the theme of which is *Engineers Shape the Sustainable Future.*

Discussion and Summary

This session clearly demonstrated WFEO's contention that engineering provides a highly necessary, though not totally sufficient, input for sustainable development and, indeed, for poverty alleviation. The variety of papers illustrated the contribution that engineering is making and/or will make in future, whether technologically, in capacity building, or in other areas.

Several key outcomes from the session are noteworthy:

- WFEO pledged its full support for the BEAM programme in Mozambique, as did the Spanish Institute of Engineers.
- WFEO invited Atomic Energy France and DaimlerChrysler to develop a joint, international workshop to discuss how hydrogen might/will be developed as an energy carrier for transport and as a power supply that will be accessible to and affordable by the poor. Nitin Desai's office has been asked to support this initiative.
- With financial support from the Department of Arts, Culture, Science, and Technology of South Africa, SAICE has been instrumental in setting up an Africa Engineers Forum. The Forum's protocol is founded on the philosophy that sustainable development can only be achieved if there are viable, indigenous engineering professionals with internationally accepted technical expertise and skills working in Africa. WFEO offered the assistance of its national and international members outside Africa to HE Dr. Ngubani, the Minister of Arts, Culture, Science and Technology of South Africa.

Report prepared by Tom Ridley and Dato Ir. Yee-Cheong Lee

Session 3

Capacity Building in Science and Technology

ORGANIZED BY:

Third World Academy of Sciences (TWAS)
International Council for Science (ICSU)

IN COLLABORATION WITH:

International Foundation for Science (IFS)
Leadership for Environment and Development International (LEAD)

CHAIR

C. N. R. Rao, President, Third World Academy of Sciences (TWAS)

TOPICS / PANELISTS

Partnerships for capacity building in science and technology
M. H. A. Hassan, President, African Academy of Sciences (AAS), Kenya

Supporting the emergence of a new generation of scientists in Africa: An urgent priority
J. Gaillard, Deputy Director, International Foundation for Science (IFS)

Networking of scientists
HE L.M.R.A. Brito, Minister of Higher Education, Science and Technology, Mozambique

The case of LEAD
J. Marton-Lefèvre, Executive Director, Leadership for Environment and Development International (LEAD)

The case of the ICGEB
A. Falaschi, Trieste Molecular Biology Group Leader, International Centre for Genetic Engineering and Biotechnology (ICGEB)

Educational model network for a global seminar on the environment and sustainability
H.D. Sutphin, Director of Academic Programs, College of Agriculture and Life Sciences, Cornell University, USA

Information technology and education: Tapping the potentials of IT for education programmes in urban and rural areas in developing countries
R. Reddy, School of Computer Science, Carnegie Mellon University, USA
V.S. Arunachalam, Carnegie Mellon University, USA

INTRODUCTION

Scientific capacity building, especially in the developing world, is a critical element for sustainable development. Issues related to capacity building were highlighted during the WSSD preparatory process, as well as at the Summit itself, where the panel session on capacity building was organized by the Third World Academy of Sciences.

PRESENTATIONS

Professor Hassan opened the session on capacity building by describing current efforts in developing countries, which, he said, must be perceived in the framework of the enormous disparities between the North and the South. That is, these efforts are taking place in an environment where 80 per cent of humanity lives but only 10 per cent of scientific publications are produced, 10 per cent of expenditures for scientific research are spent, and a mere two per cent of world patents are granted.

The big challenge, said Prof. Hassan, is to make a strong case for scientific and technological development in developing countries. This can only be done by convincing the public and private sectors of the value of science for economic and social development, and by bringing scientists together in North-South and South-South partnerships.

Therefore, political and institutional decisions must be translated into fellowships for highly qualified education, programmes for young scientists, and sharing of innovative experiences. Prof. Hassan also advocated for the creation of networks of institutions of excellence and clusters of centres of excellence (such as the current US cooperation with India), as well as increased efforts to solve practical development problems, establish international programmes, and strengthen national academies. In addition to all this, capacity building requires a concentrated effort to push political action in intergovernmental bodies.

Finally, said Prof. Hassan, there is a need for a strategy to demonstrate success stories and case studies to politicians–to show them what other countries are doing and how countries can learn from each other. In Africa, some countries are devoting important resources to science and technology: their example should be seen by others and followed.

Ten years after the Earth Summit, Dr. Gaillard said the lack of critical science and technology remains one of the major obstacles to sustainable development, particularly in Africa. He pointed out several factors that explain this, including:

- disparities in salaries that produce dissatisfaction among African scientists
- dependence on outside donors
- lack of scientific equipment
- lack of access to post-graduate education, scientific literature, and the Internet
- reduced opportunities to participate in international conferences
- decreased public funding and tight budgets
- very low participation of women, and
- aging of academic staff and lack of new recruits.

All of these factors must be considered within the context of three overriding issues: a) globalization and privatization have affected science development and expanded NGOs, while at the same time reducing university activities; b) the brain drain process that has arisen from these factors; and, c) the fact that the needs are far greater in median Africa.

What is needed, said Dr. Gaillard, is a new generation of scientists, particularly interested in sustainability needs and willing to adopt a more holistic approach using transdisciplinary resources. Seeking input from, and collaboration with, diasporas or repatriating scientists are possible solutions, but nothing replaces the need to develop a strong, home-based scientific capacity. The NEPAD programme is a positive step, but more is needed, especially in countries in Central Africa. For instance, to build capacity in these regions, it will be necessary to develop new programmes for PhD training geared specifically to the unique needs of sustainable development and a comprehensive programme of competitive research grants. Dr. Gaillard closed by emphasising that it is very important not to forget young scientists.

The following presentation focused on the development of networks of scientists as one of the most important means of tackling the issue of capacity building. Dr. Brito outlined how such networks help scientists exchange scientific knowledge, identify common interests, understand impacts, disseminate and gather information, and provide mutual support through the sharing of facilities.

However, said Dr. Brito, these networks should also aim to go one essential step further–to create 'institutional networks'. Institutionalization, she said, brings more than sharing. It is a process that leads toward a common research agenda, increased human capacity, increased resources, and vital synergies that support institutional growth.

Moving from the broad to the specific, Dr. Brito then discussed the important role of centres of excellence, which have distinct identities but are integrated within solid institutional networks. These centres are catalysts of research that provide key opportunities for capacity building and peer revision. Such institutional networks, said Dr. Brito, must focus on sustainable development and must strive to develop a culture of science that encourages individual participation to ensure they address local realities and work toward the common good. In addition to being embedded in the society, these networks must also form partnerships with governments, with the production sector, and with the civil society. The objectives of such networks should be to develop the social contract between science and society, thereby supporting endogenous capacities and applying diversity to sustain development.

The three following session speakers presented various models for scientific networks and centres of excellence. Dr. Falaschi began by describing *The Trieste Model,* an idea that was put forward by Abdus Salam and supported by UNESCO and the International Atomic Energy Association (IAEA). This network brings together the work of the International Centre for Theoretical Physics (ICTP), the International Centre of Genetic Engineering and Biotechnology (ICGEB), and the Third World Academy of Sciences (TWAS) and represents a model of international capacity building. It supports capacity building in the broadest sense by helping scientists return to their home countries and facilitating the transfer of know-how and technologies. *The Trieste Model* is an excellent example of North-South and South-South cooperation.

LEAD International (Leadership for Environment and Development) is another example of international capacity building, not only on science but on all aspects of sustainable development. As described by Ms. Marton-Lefèvre, LEAD's mission is to create, strengthen, and support networks of people and institutions promoting change toward sustainable development. They achieve this by training and networking talented, mid-career individuals in the fields of academia, government, non-governmental organizations (NGOs), media, and business. The LEAD network is composed of 1500 people, all of whom have completed training and are identified as LEAD Fellows. Thirty per cent of the Fellows come from the scientific community. LEAD carries out its objectives through close collaboration with NGOs in countries around the globe.

Professor Sutphin provided an overview of a third model, that being the *Educational Model Network for a Global Seminar on the Environment.* Organized as a global network of universities–with Cornell University as the hub and satellite members at other institutes in the USA, the Netherlands, Sweden, Australia, India and Costa Rica–this is a new paradigm of education for sustainable development. The programme uses videoconferencing, multi-conferencing, and satellite communication systems to focus on specific problems, with the objective of transforming institutions and empowering global citizens to cooperatively sustain human, environmental, and food systems. Working together with faculty, undergraduates and graduate students in this global seminar form a 'learning network' based on concepts and theory, then develop practical, holistic solutions using literature from education and social sciences. The model incorporates constructivist learning concepts and theories, experiential learning, and cognitive psychology. Subject areas include global warming, biodiversity, food security and supply, water, and population.

In the final presentation of the day, Drs. Reddy and Arunachalam focused on a significant change that has occurred in the past 10 years. At the Earth Summit, information and communication technologies (ICT) were not on the scene: the international community was largely unaware that the world was about to experience a technological revolution. In 2002, connectivity, technology, speed, and capacity are growing very rapidly, and ICT products have become tools that are very close to people. More and more, ICT is the means through which individuals obtain knowledge and information. The application of ICT for sustainable development can be enormous. The technologies themselves are a 'democratiser' in that they provide information and knowledge to everyone, everywhere.

Both Drs. Reddy and Arunachalam agreed that satellite and Internet education can never substitute for the presence of a teacher, but ICT can help greatly. For instance, these technologies can cut salary costs. Moreover, because the costs of the technologies themselves are decreasing, developing countries now have the ability to launch satellites of their own. Another advantage is that the newest technologies are also wireless, requiring less expenditure on infrastructures.

While science and technology are global, their applications can be very local and relevant. ICT can be used to meet diverse targets such as reducing illiteracy and eradicating malaria. Technology will not solve all the problems, but it is an effective tool that can support job creation, increase access to goods and services, reduce mortality rates, improve management to enhance access to safe water, facilitate financial transactions, provide logistic support for disaster recoveries, etc.

In order to meet it full potential, ICT must be sustainable, accessible, and affordable. If people cannot afford it, there are no benefits. The technology tools should also be easy to use and reliable. But, at the same time, ICT cannot be a charity–the technologies are most useful in the hands of people who desire them. In addition, multilingual software, support for local entrepreneurs, gridless power development, and wide-band infrastructures are greatly needed.

The S&T community should contribute to enhancing the desirability of ICT by disseminating information to the networks and institutions in developing countries and providing incentives. For example, an organization such as TWAS could introduce copyright schemes that charge small royalties for providing information. Intellectual property rights could also produce win-win situations and concrete solutions.

Discussion and summary

Session 3 focused on the critical role that capacity building plays in sustainable development. It also made a strong case that scientific and technological development in developing

countries will take root (1) on the domestic front, only if the public and private sectors are convinced of the value of science for economic and social development, and (2) on the international front, only if scientists work together through North-South and South-South partnerships. Therefore, rhetorical support for science-based sustainable development must find concrete expression through adequate financial support for research fellowships and exchange programmes, and educational and research training initiatives for young scientists. In addition, strategies must be created to support the sharing of innovative experiences and the development of networks of institutions of excellence. Moreover, true change requires increased efforts to solve practical economic development problems, to strengthen national academies, and to develop international programmes in which Southern scientists participate as full and equal partners.

Many factors affect scientific capacity in developing countries: disparities in salaries that fuel dissatisfaction among scientists; over-reliance on foreign donors; limited access to scientific equipment, the most current scientific literature, and post-graduate education; lack of opportunity to participate in international conferences; inadequate and inconsistent funding; low participation of women; aging of academic staff; and lack of new recruits.

Session speakers presented various models for the development of centres of excellence and scientific networks. LEAD (Leadership for Environment and Development) and the Trieste System were cited as potential models for future capacity building efforts that could successfully be applied to North-South and South-South partnerships to improve scientific expertise in the developing world.

Session participants also pointed to information and communication technologies as enabling technologies that have played–and will continue to play–a central role in efforts to promote science-based development. Therefore, participants highlighted the need to promote information and communication technologies, especially in least developed countries, as the centrepiece of a larger strategy to reduce the growing North-South disparities in scientific expertise. To realise this potential, participants concluded that access to information and communication technologies must be made affordable and that the scientific community should play a key role in convincing national governments and international funding agencies of the critical importance of this issue.

Finally, session participants agreed that capacity building must also focus on nurturing home-grown research skills. They felt that the best way to advance this goal may be to raise research and training institutions, including universities, to a level of excellence enabling them to attract talent, curb the brain drain, and participate effectively in local and global efforts to harness S&T for sustainable development.

Responsibility for building and maintaining S&T capacities for sustainable development resides, first and foremost, on the shoulders of national governments and must be guided by strategies and policies that are fully integrated into national development goals. It is critical, therefore, for governments worldwide to adopt sustainable development strategies that recognise the trade-offs between short- and long-term, economic development strategies.

Report prepared by Diego Malpede

Session 4

Linking Traditional and Scientific Knowledge for Sustainable Development

ORGANIZED BY:

UNESCO – Local and Indigenous Knowledge Systems Project (LINKS)
International Council for Science (ICSU)
Tebtebba Foundation

IN COOPERATION WITH:

International Chamber of Commerce (ICC)

TOPICS / PANELISTS

Opening Session

Opening by Indigenous Spokesperson
P. Settee, Director, Indigenous Peoples Programme, University of Saskatchewan, Canada

W. Erdelen, Assistant Director-General for Natural Sciences, UNESCO
V. Tauli-Corpuz, Executive Director, Tebtebba Foundation
T. Rosswall, Executive Director, International Council for Science (ICSU)

Introduction to the Theme
J. Fenstad, International Council for Science (ICSU)
J. Carino, Tebtebba Foundation
D. Nakashima, Head, Local and Indigenous Knowledge Systems Project (LINKS), UNESCO

Sub-theme A
Local and Indigenous Knowledge for Environmental Assessment

Chair: J. Carino, Tebtebba Foundation

Farmers' meteorological knowledge in Gujarat, India
P. Kanani, Associate Professor, Gujarat Agricultural University, India

Cree knowledge for comprehensive environmental, social, and cultural impact assessment: A partnership in James Bay (Québec, Canada)
R. Saganash, Grand Council of the Crees, Canada

Indigenous knowledge and foresight: A Cree elder's environmental impact assessment
M. Roué, Research Director, Centre National de la Recherche Scientifique (CNRS/MNHN), France

Sub-theme B
Countering the erosion of knowledge, revitalising transmission

Chair: V. Chinapah, Education Sector, UNESCO

Recognizing, promoting, protecting, and integrating IKS into the mainstream
C. Odora-Hoppers, University of Pretoria, South Africa

The endogenisation of education in South Africa
O. Ntsoane, University of the Northwest, South Africa

Culturally appropriate curricula and strategies for working with indigenous children and youth
S. Saenmi, Executive Director, Inter Mountain Peoples Education & Culture in Thailand Association (IMPECT), Thailand

Strengthening indigenous knowledge and traditional resource management through schools
R. Nari, Department of Environment and Conservation, Vanuatu

Sub-theme C
Keepers of traditional knowledge: Issues of protection and sharing

Chair: G. Glaser, International Council for Science (ICSU)

On traditional medicine and medicinal plants
M. Addy, University of Ghana, Ghana
Te Kete a Tini Rauhanga: Investigation of the native medicinal flora used by Tuhoe Maori
H. Kereopa, Te Kapu a Rangi Trust, New Zealand
M. Leach, Waikato University, New Zealand

INTRODUCTION

The topic of traditional knowledge is experiencing resurgence on the international agenda, as is the need to develop stronger links between these forms of indigenous expertise and scientific discovery. This full day of presentations and lively debate involving indigenous knowledge holders and scientists (including indigenous scientists) from a wide range of natural and social science disciplines attracted a large audience and generated active discussion regarding a number of challenging issues. The event also provided the opportunity to launch the ICSU/UNESCO report entitled *Science, Traditional Knowledge and Sustainable Development.*[8]

PRESENTATIONS

Opening Session

The event was launched with guiding words from Ms. Settee of the Cree First Nation of Canada. Subsequent opening speakers highlighted the urgent need for scientists and indigenous peoples to establish strong and equitable working relationships in order to move together toward sustainable development. They also detailed important progress on this issue following debates that arose at the 1999 ICSU General Assembly regarding linking scientific and traditional knowledge, as was recommended at World Conference on Science (Budapest 1999), co-organized by UNESCO and ICSU. This debate led to the formation of a special Study Group with a mandate to distinguish among traditional knowledge, science, and pseudoscience. The joint ICSU/UNESCO report on *Science, Traditional Knowledge and Sustainable Development* contains the conclusions of this Study Group.

Underlining the dominance of science in contemporary society, Ms. Carino recalled Einstein's warning about 'worshipping the tool and profaning the sacred.' She emphasized that scientists bear a particular responsibility to pave the way for broader acceptance of indigenous knowledge. Similarly, Dr. Nakashima welcomed the growing recognition of traditional knowledge, but warned against the dangers of tokenism. As the roots of indigenous knowledge run deep and touch all aspects of people's lives, he stressed the need for comprehensive approaches to understanding traditional knowledge in all of its complexity.

Sub-theme A
Local and indigenous knowledge for environmental assessment

The session on how local and indigenous knowledge is applied to environmental assessment began with a presentation on the meteorological knowledge used by farmers in northern India. Professor Kanani stressed that official weather forecasts in India are either too imprecise or too short-range to be of use to farmers. As a result, farmers rely upon traditional knowledge and beliefs to take important decisions such as crop choice and cropping patterns. Presenting results from 11 years of interaction with an informal network of local knowledge holders, Prof. Kanani highlighted how traditional assessments of key weather events, such as the onset and nature of the monsoon, have proved to be both reliable and useful. In addition to providing a valuable service, this network has restored people's confidence in traditional knowledge and skills.

Anthropologist Dr. Roué examined the contribution of indigenous knowledge to assessing environmental impacts that will result from large-scale development projects. Through the detailed testimony provided by R. Saganash, an indigenous elder from sub-Arctic Canada, Dr. Roué demonstrated that the Cree accumulate ecological knowledge in a methodical, empirical, and analytical manner that bears many similarities to science. However, said Dr. Roué, unlike science, Cree knowledge is holistic. Thus, by inter-relating numerous elements (material, social, spiritual, etc.) in a complex web of relationships, this approach surpasses science's as yet faltering efforts to mobilise interdisciplinary cooperation to deal with complexity.

Sub-theme B
Countering knowledge erosion through revitalizing transmission

Professor Odora-Hoppers opened this session with a resounding condemnation of the role science has played in the

8. *Science, Traditional Knowledge and Sustainable Development.* International Council for Science and UNESCO. © ICSU 2002. ICSU Series on Science for Sustainable Development No. 4 (24 pp.). ISSN 1683-3686.

cognitive subjugation of indigenous knowledge and world views. Citing the Budapest Science Agenda as a 'monument of hope', she called for a decolonisation of the mind to create cognitive space for all knowledge heritages.

Mr. Ntsoane then described the institutional resistance he encountered when introducing studies in indigenous knowledge into the curriculum at the University of the North West. Sharing his experiences in the classroom, he said that the students themselves–many of whom are conditioned to compartmentalised western modes of learning and thinking–provided the most difficult, but also most rewarding, challenge. By guiding them in the re-discovery of Afro-centric epistemologies and other sources of knowledge, such as elders from their own communities, he bolstered confidence in their own languages, knowledge, and traditions.

Concluding the session on education, Mr. Saenmi described the impact of formal education on indigenous children in the mountainous areas of northern Thailand. Obliged to use Thai language and learn formal subjects with no indigenous content, school has become a vehicle for assimilation. Mr. Saenmi outlined IMPECT's efforts to join forces with cultural experts, such as community elders and religious leaders, to establish alternative cultural education using local curriculum materials.

Sub-theme C
Keepers of traditional knowledge: Issues of protection and sharing

The third and final session on issues of traditional knowledge verification, protection, and sharing confronted two quite different perspectives on the relationship between science and traditional knowledge. Recognising that the majority of sub-Saharan Africa relies upon traditional practitioners for health care, Professor Addy called for scientific validation of traditional practice for reasons of efficacy, safety, and quality control. She argued that such a process of verification, standardisation, and regulation of medicinal herbs is an essential step for traditional knowledge to contribute productively to Africa's future.

In contrast, H. Kereopa, a Maori tohunga (traditional healer) offered quite a different view. Presenting jointly with Dr. Leach, a Maori biochemist, they described a collaborative study of Maori practices of healing and medicine, that 'brings together the baskets of knowledge from science and tradition.' Both presenters agreed that validation is not the primary goal of this project. However, the study does use biochemical analysis to identify the bioactive ingredients from medicinal plants and includes a remarkable revenue-sharing agreement that could provide economic benefits by allowing the Maori to retain full intellectual property rights. However, as H. Kereopa masterfully illustrated, traditional medical practice cannot be reduced to chemical formulae. It brings into play the full environment, including the social and spiritual. In many cases, he said, the actions and processes that are part of the healing act may be as important–if not more important–then the actual plants administered.

Discussion and Summary

Questions from the floor after each set of presentations touched upon a wide range of topics, only a few of which can be reported upon here. Some called for more exhaustive scientific verification, such as statistical analyses for traditional meteorological predictions, while others questioned the validity of science, which in today's market-dominated world has increasingly become a subset of economics. In the education domain, indigenous spokespersons questioned whether attempts to 'endogenise' education might at times amount to little more than a 'translation' of Western ways and values. The need to develop appropriate and effective methods for recording, protecting, and revitalising indigenous knowledge was also a key concern.

Finally, participants recognised that both traditional knowledge systems and science, whether in the domains of environmental conservation, education, or medical practice, each had their place and that continuing their respectful coexistence, encouraging open dialogue, and strengthening synergies are mutually beneficial goals.

Report prepared by Jonathan Breaker and Douglas Nakashima

Session 5

Emerging Diseases and Their Effect on Sustainable Development

ORGANIZED BY:

International Union of Microbiological Societies (IUMS)

CO-CHAIRS

K. Klugman, Department of International Health, Rollins School of Public Health, Emory University, USA and Respiratory and Meningeal Pathogens Research Unit, South Africa

B. Schoub, Executive Director, National Institute for Communicable Diseases, South Africa

TOPICS / PANELISTS

Global issues of antimicrobial resistance
K. Klugman, Department of International Health, Rollins School of Public Health, Emory University, USA and Respiratory and Meningeal Pathogens Research Unit, South Africa

Pandemic influenza: A global problem
B. Schoub, Executive Director, National Institute for Communicable Diseases, South Africa

Mother-to-child transmission of HIV
G. Gray, Director of the Perinatal HIV Research Unit, Department of Paediatrics and Child Health, University of the Witwatersrand, South Africa

Emerging haemorrhagic fevers in South Africa
R. Swanepoel, Deputy-Director and Head, Special Pathogens Division, National Institute of Virology, South Africa

Genomics and technology transfer in the diagnosis and control of infectious diseases
L. Zhang, President, World High Tech Society, China

Re-emergence of tuberculosis: A new global problem of antibiotic resistance
P. van Helden, Director, MRC/US Centre for Molecular and Cellular Biology, University of Stellenbosch, South Africa

INTRODUCTION

A healthy population is an absolute prerequisite for sustainable development; the individual, societal, and economic consequences of infectious diseases seriously inhibit development in many countries. This is most dramatically illustrated by the HIV/AIDS pandemic and its effects on many African countries, and increasingly on Asia and Eastern Europe. Despite several recent international initiatives to tackle the major diseases of poverty–AIDS, tuberculosis (TB), and malaria–many other infectious diseases are prevalent in developing countries. In addition, there is a constant danger that new diseases will emerge in a similar way to AIDS.

Thus far, the medical and health science research community have tended to approach these diseases in isolation, rather than considering them as an integral part of the sustainable development agenda. This must change: health issues must be given a central position on the agenda for sustainable development. The social, environmental and economic pillars of sustainable development are inextricably linked, and health has an effect on–and is a function of–all three.

PRESENTATIONS

Professor Klugman opened the session by offering a broad perspective on global issues of antimicrobial resistance. At present, acute respiratory infections are the leading infectious cause of death in both adults and children. This is true globally, but the burden of disease in children is in developing countries. Antibiotic resistance can increasingly be associated with clinical failures in the management of pneumonia. Several risk factors for resistance are evident including young age, previous hospitalization, and HIV infection. There is also a strong association between previous antibiotic exposure and resistance, which can be made at the level of antibiotic use by country, by county, and by individual. Prof. Klugman cited recent evidence indicating that antibiotics given at high

dose for a short duration may select for less resistance than the same antibiotics given in lower dose for a longer duration. He also presented evidence that therapy with fansidar (sulfadoxine and pyrimethamine tablets) can select for bacterial resistance to cotrimoxazole (a sulfa drug used to treat or prevent bacterial infections).

In the case of *Streptococcus pneumoniae,* evidence from Africa and elsewhere illustrates increased resistance to antibiotics amongst individuals living in urban areas and children who attend daycare. The emergence of resistance in the pneumococcus is clonal, which means that a small number of discrete strains have now disseminated globally. In Africa, co-existing HIV infection is an additional major risk factor. Such clonal spread of antibiotic-resistant strains in pneumococcus–and the associated increased healthcare costs of treating infections caused by these strains–present an immediate threat to development. In Hong Kong, the recent emergence of fluoroquinolone resistance is also a major concern.

In both cases, the distribution of resistance is largely related to access to antibiotics. Attempts to use widespread antibiotic prophylaxis to treat HIV-infected individuals will fuel resistance in developing countries. However, it has recently been shown that conjugate pneumococcal vaccine interrupts the transmission of antibiotic-resistant pneumococci. Therefore, strategies for introducing this vaccine into developing countries are urgently needed.

Influenza has been defined as the prototype of an emerging infectious disease. Dr. Schoub reported that influenza epidemics occur every winter, due to the emergence of new strains with relatively subtle antigenic changes that result from mutations in the gene coding for the superficial haemagglutinin antigen. This process is called *antigenic drift.* Fortunately, more dramatic, severe and acute pandemics occur more rarely–about once every 10 to 40 years. These devastating outbreaks are usually due to the re-assortment of genes derived from the reservoir in aquatic birds. While some examples of direct avian-to-human viral transmissions do exist (e.g. the small but virulent 1997 Hong Kong chicken flu outbreak), for the most part the mixing of viruses from human and avian sources that leads to yearly epidemics occurs in the swine population, which is susceptible to viruses from both sources.

Scientific opinion is unanimous that the next pandemic of influenza is inevitable and probably imminent. Thus, the World Health Organization is calling for all countries to draw up pandemic preparedness contingency plans. Surveillance to detect antigenic drift, as well as for early warning of the arrival of the next pandemic, is a key element of pandemic preparedness and regular influenza management. There is a growing international awareness that in addition to being a very significant cause of morbidity and mortality, influenza has a major economic impact worldwide. Without question, the effect of the influenza is considerably greater in the developing world, where much of the illness and economic burden of influenza can be effectively reduced through vaccination.

Dr. Gray spoke on mother-to-child transmission of HIV, describing efforts in developing countries to address the issue of vertical transmission in a cost-effective way. She described the struggle in South Africa to persuade policy makers of the importance of this intervention and the urgent need for antiretroviral drug access in sub-Saharan Africa.

Viral haemorrhagic fevers, as epitomised by the related Marburg and Ebola diseases, are characterised by a propensity for human-to-human spread and high death rates. Despite their notoriety, however, the total number of victims claimed by these diseases pales into insignificance when compared to the ravages of the more common, vaccine-preventable diseases such as poliomyelitis, measles, meningitis, and influenza. Dr. Swanepoel addressed the effect of emerging haemorrhagic fevers on sustainable development.

To date, Ebola fever is known to have killed a total of less than 1500 people, and Marburg less than 200. Hence, it is sometimes asked whether the resources dedicated to the control of haemorrhagic fevers are not disproportionately large. However, one of the notable features of viral haemorrhagic fevers is that many of the victims are medical personnel who become infected while attending patients in hospital. Consequently, many past outbreaks of these diseases effectively paralyzed medical services in impoverished rural communities. For example, during the 1995 epidemic in Kikwit (Zaire) 70 members of the hospital staff succumbed to Ebola fever before medical services collapsed entirely.

Moreover, the outbreak of an acutely fatal disease in a community imposes an urgency of its own; there is no choice but to respond with a suitably skilled and equipped outbreak control team of international volunteers. To a large extent, these epidemics are caused by lack of availability of simple protective clothing for medical personnel (e.g. surgical gloves) and inadequate supplies of injection equipment, resulting in the re-use of contaminated, disposable syringes and needles. Thus, in the long term, the solution lies in socio-economic development of communities with particular emphasis on better funding for medical services.

Professor Zhang discussed how technological advances and genomic research will revolutionize the fight against infectious diseases. Specifically, genomic targets will be used to screen for drugs with novel mechanisms of action. This is possible because these new technologies screen for high affinity binders–even for unknown function protein targets. In some cases, potential drug leads for therapeutic targets can be isolated and characterised in as little as two to three weeks.

These advances offer unprecedented potential for investigating the molecules or compounds that come from the world's master chemist, nature. It is estimated that there are more than 10^{60} compounds in the natural Universe. To date, less than one per cent of these compounds have been explored as pharmaceutical products, yet more than 40 per cent of the drugs on the market today originated from natural sources. Because they exist in biological systems, natural products make good drugs: they offer unmatched diversity, and provide many unique and patentable chemical structures.

The technologies now available effectively create a natural product factory that unlocks this reservoir of chemical diversity and generates opportunities for altering the physiology, environment, or genetics of microbes to produce desired results. At present, the availability of microbe samples is a limitation for some specific diseases. For example, Prof. Zhang believes a cure or antidote for HIV/AIDS may exist in some microbial extract and has already developed drug targets for HIV/AIDS screening. However, although more than 20 per cent of the South African population is currently infected with the disease, Prof. Zhang's laboratory has few microbe samples from this region. He believes collaboration and technology transfer to build scientific capacity in developing countries is essential to addressing emerging diseases on local and global scales.

Tuberculosis (TB) has plagued mankind with successive epidemic wars for thousands of years. In fact, Professor Van Helden refers to TB as 'an ancient and modern scourge.' The most well-known TB epidemics are those of Western Europe around the 18th and 19th centuries. A current epidemic is now gripping the developing world.

TB requires three essential elements: the causative organism *Mycobacterium tuberculosis,* genetic or immunological susceptibility, and environmental stress. Several environmental stress factors that increase susceptibility are already well known including alcohol abuse, HIV infection, poverty and poor housing. The association between environmental conditions and TB outbreaks is evident on both local and global scales. There is a very strong association between TB incidence and political or civil unrest, which usually goes hand-in-hand with poverty.

The WHO *Directly Observed Treatment, Short-course* (DOTS) strategy, which combines technical and managerial components, is an excellent and cost-effective means of addressing active cases of TB. However, at present, the strategy has numerous problems that limit its potential to have a real impact on the epidemic. In order to improve outcomes, global efforts must be coordinated to:

- diagnose active and latent TB cases as early as possible and treat them appropriately;
- deliver appropriate drugs;
- develop new drugs and protect the rights of developers to ensure a reasonable return; and
- fast track trials of new TB drugs.

Failure to diagnose TB at an early stage perpetuates the epidemic, particularly in drug resistant cases. On a broader scale, it is likely that TB will follow the classical course of an epidemic–that is, it will wane naturally. However, in order to avoid millions of deaths, along with the associated high costs

for morbidity and mortality, sustained global action is critical. Again, Prof. Van Helden emphasized the need to consider all three pillars for sustainable development–environment, sociology and economy–in order to address underlying factors such as poverty, unemployment, and barriers to development such as trade regulations and restrictions, etc. He also suggested several positive factors that could stimulate action such as income tax reductions for new drug developers and differential drug pricing. Such measures could effectively accelerate the anticipated natural decline of the TB epidemic, thereby improving the overall health and well-being of developing nations.

Discussion and Summary

The session speakers described the significant impact of infectious diseases on development. Deficiencies exist in the implementation of strategies for disease control at many levels. Poor health is an important barrier to development. Infectious agents are not constrained by geographic boundaries and the conditions needed for their dissemination are widely present in developing countries. In a global economy, it is in the national interest of all countries to increase the capacity of developing nations to diagnose, treat, and prevent the spread of infectious diseases.

Report prepared by Keith Klugman and Barry Schoub

Session 6

Food Security in Africa: The Role of Research

ORGANIZED BY:

Global Environmental Change and Food Systems (GECAFS)
International Council for Science (ICSU)

CHAIR

J. Jäger, Executive Director, International Human Dimensions Programme on Global Environmental Change (IHDP)

TOPICS / PANELISTS

Introductory comments on the current and anticipated food situation in Africa
B. Njobe-Mbuli, Director General, Department of Agriculture, South Africa

Consultative process on the role of agricultural science and technology in sustainable development: An overview
R. Watson, Chief Scientist and Director, Environment Department, World Bank

Research opportunities and constraints in national agricultural research systems in Africa
M. Jones, Executive Secretary, Forum on Agriculture Research in Africa, Ghana

Agricultural research for sustainable development: The importance of donor support
F. Reifschneider, Director, Consultative Group on International Agricultural Research (CGIAR)

The role of biotechnology in food production
R. Kiome, Director, Kenyan Agricultural Research Institute, Kenya

Organic farming in developing countries and implications for household food security
M.S. Swaminathan, M.S. Swaminathan Foundation, India

Food provision and global environmental change: The role of interdisciplinary research
J. Ingram, Executive Officer, Global Environmental Change and Food Systems (GECAFS)

The role of social and economic sciences in managing complex emergencies
C. Vogel, Department of Geography & Environmental Studies, University of Witwatersrand, South Africa

The role of partnerships and participatory research in agricultural development
A.M. Izac, Director of Research, International Centre for Research in Agroforestry (ICRAF)

INTRODUCTION

Food security is a key issue for sustainable development, not least in Africa, and several, major international initiatives investigating the issues have recently been launched. These include, *inter alia,* the InterAcademy Panel's *Food Security in Africa* (a strategic plan for increasing agricultural productivity in Africa, initiated at the request of Kofi Annan); the *Task Force on Hunger* (a component of the UN Millennium Development Project); and the Global Environmental Change and Food Systems (GECAFS), a research project that brings the international global change research community together with the Consultative Group on International Agricultural Research (CGIAR), the UN Food and Agriculture Organization (FAO), the World Meteorological Organization (WMO) and other international research bodies.

The purpose of the session was to attract the attention of WSSD delegations to the key roles science and technology transfer play in sustainable development, especially in the area of food security, and thereby help increase momentum in these, and other international and national research initiatives.

PRESENTATIONS

Food security issues in Africa are highly complex and misunderstandings in terminology often further complicate the debate. To help clarify discussions Ms. Njobe-Mbuli suggested definitions for key terms:

- **Famine**: wide-spread and extreme hunger that impacts on the individual and community;
- **Hunger**: the condition resulting from an individual's inability to reach sufficient food for a healthy and active life;
- **Undernutrition**: measurable nutrient deficiencies in a diet that lead to illness or premature death.

She also noted that the food security situation is further complicated by changes in international trade and in reforms in land tenure.

Mr. Jones made a strong case for the need for more scientifically prudent methodologies, capacities, and systems to ensure data collection, analysis, and predictions on the availability of food. He underlined that this will require adequate investments in public and private sector research capital and systems, and an articulation of strategic research challenges that will effectively address the situation. He cautioned that some research investment must be viewed as a long-term commitment: a 12 to 15 year timeframe is not uncommon for the development of new hybrids and their dissemination, while the development of new farming systems can take even longer. Such initiatives require sustained, public investment, both in financial terms and in a solid commitment to capacity building and establishing new global partnerships. In order to succeed, such developments must be built on transparency, participation, ownership, focus, responsiveness, and impact.

There are already several major international initiatives aimed at reducing food insecurity, such as the World Food Summit Plan of Action. A complementary programme, the Comprehensive African Agricultural Development Programme (NEPAD), aims at integrated land and water management, improved infrastructure for rural market access, increasing productivity for food security, and strengthening the national agricultural research systems. Numerous other national and international research projects are currently researching various agronomic, economic, social and policy aspects of the problem. However, the complexity of Africa's 'food basket' means that development and promotion of a single technology will not be sufficient. Real results will only be forthcoming by aligning initiatives that share a common vision for African agriculture. This presents the dual challenge of expanding working definitions while also tightening national and international levels of engagement on the issues. In addition, there is a need to confront the gaps in measurement, policy, and institutional capacity and knowledge management, as well as to link these elements to the long-term strategies embodied in the three, commonly recognized pillars of sustainable development: economic growth, social development, and environmental management.

How then can research be strengthened and how can the efficiency of national and international research programmes be improved? Also, as Dr. Reifschneider asked, how can investment by the international donor community–which currently amounts to about 40 per cent of agricultural research in the continent–be increased and used more effectively? Professor Watson described a new effort that is now underway to address these questions: the 'International Assessment of Agricultural Science and Technology' is designed to evaluate the efficacy of agricultural research, as well as the economic, environmental, and social risks inherent in such research projects (www.agassessment.org). Given the observed stagnation of yield increases in parts of the African agricultural sector–and the fact that productivity per labour input is falling–this initiative is extremely timely.

At present, research resources in Africa are too poorly coordinated and too thinly spread, which leads to an inability to maintain reasonable salaries and a lack of additional incentives for researchers. As a result, performance suffers and the 'brain drain' continues. In addition, Africa still lacks efficient mechanisms to transfer research results to the farming community and effective methods for increasing opportunities to promote livelihood through better access to markets. More research is needed to underpin technology transfer, and to examine the socio-economic constraints that limit development. But national agricultural research and extension services are often not effective in playing their important role in this, and regional and sub-regional collaboration between research programmes is not fully exploited. This calls for greater linkages between national agriculture research systems, regional networks, and the international research community including the CGIAR.

Research into two specific, yet complementary biotechnologies needs further effort: genetic modification and organic (or 'traditional' methods). According to Dr. Kiome, genetic

modification of major crops has already been shown to decrease the 'yield gap'–the difference between the physiological potential yield and the actual harvested yield. For the most part, the decrease has been achieved by introducing genes that make the crop more resistant to pests, thereby reducing both pesticide usage and labour inputs. Recombinant diagnostic kits and animal diseases vaccines (e.g. for ECF, RVF, Rinderpest) have also been successfully applied and tested in Africa. Despite the potential gains from using this technology, he reported that only three countries in Africa (Egypt, Kenya and South Africa) develop their own transgenic products. Both the World Food Conference and the World Food Summit noted that biotechnology application has the potential to contribute to food security and African governments need to invest more in the application of biotechnology in addition to other scientific and technological innovations. This must however be underpinned by developing robust biosafety regulations and policies.

But biotechnology is much more than genetic modification. Further research is needed in other key areas such as tissue culture, biofertilisers, vermiculture, and organic manuring. Advances in these areas will lead to reduced reliance on artificial inputs and, with effective certification procedures, new markets for organic products; as Professor Swaminathan pointed out, many farmers in Africa have always been practising organic agriculture. As these areas of research are knowledge-intensive, rather than capital-intensive, even limited research funds can be used effectively.

Much research has been aimed toward improving productivity of agricultural commodities, which has largely been in the domains of agronomy and animal science. This is clearly important, but a key message from the session was the need to consider also the issues of availability of, and access to, food. This brings in the need for strengthened research in the socio-economic sciences. Apropos this, Dr. Izac noted that a 'holistic knowledge revolution' is now emerging, which blurs the boundaries between long-established disciplinary components of natural and social science. Built upon common research objectives and visions, and recognising the value of both quantitative and qualitative research, this broader perspective requires a new approach to the setting of research agendas, the sharing of knowledge and cooperative learning. This is particularly important in tackling the expanded agenda of possible response strategies to improve food security, especially in the face of global environmental change–for many people global change will bring further complications to an already difficult situation.

One example of this innovative interdisciplinary approach can be seen in a new research initiative "Global Environmental Change and Food Systems (GECAFS)" reported by Dr. Ingram. Building on the notion of food provision (which includes consideration of availability and access to food, in addition to production), GECAFS brings together three international global change research programmes–the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP) and the World Climate Research Programme (WCRP)–with CGIAR, FAO and WMO. It aims to determine strategies to cope with the impacts of global environmental change on food provision systems and to analyse the environmental and socio-economic consequences of adaptation. In order to be effective, such interdisciplinary research must address issues identified in consultation with policy makers, and be designed and implemented collaboratively in such a way so as to maintain close links between scientists and end-users.

In addition to needing an interdisciplinary approach, research on food provision needs to embrace the fundamental notion of vulnerability. Both the 'external' aspects of vulnerability (i.e. the exposure to stress and risk) and the 'internal' aspect (i.e. the capacity to cope) need to be incorporated, and need to be seen at a range of spatial levels, from global, though national and regional, to household. As Professor Vogel stressed, defining vulnerability aspects in both biophysical and socio-economic contexts will help prepare for both immediate disasters associated with droughts and flo ods, or with socio-political stresses, as well as with longer-term perturbations associated with changes in climate and other environmental factors.

Discussion and Summary

It is clear that science has much to offer in the quest to improve food security in Africa, but research must be better coordinated and targeted at specific problems. Three major impediments to progress are currently apparent:

- There is an urgent need to improve communication with farmers, policy makers and donors especially regarding what they need to know, and to be clear on what science has to offer. Appropriate, interdisciplinary research agendas, which address their needs, must be designed jointly, requiring heightened consultation *before and while* research is planned.
- The links between science, technology and end-user needs must be better defined and fully exploited. Many technologies are already 'on the shelf', but additional research is required to assess their effectiveness in solving current problems and making adaptations where necessary.
- Both external donor support and national emphasis for research in agriculture need to be strengthened. The Forum for Agriculture Research in Africa and NEPAD propose a six per cent annual growth in agricultural GDP by 2020. This will require a three per cent rate of growth in Total Factor Productivity which will require a larger investment in technology generation, adoption, and education systems, and improved conservation and efficient use of natural resources. This must be supported by long-term and well-targeted public sector funding for research.

Report prepared by John Ingram and Jill Jäger

Session 7

The Role of Global Observing Systems for Sustainable Development

ORGANIZED BY:

Integrated Global Observing Strategy (IGOS)
International Social Science Council (ISSC)

CO-CHAIRS

O. Young, Professor, Institute on International Environmental Governance, Dartmouth College, USA

J. Achache, Director, Earth Observation Programmes, European Space Agency

TOPICS / PANELISTS

Overview on global observing systems in support of sustainable development
G.O.P. Obasi, Secretary General, World Meteorological Organization (WMO)
P. Bernal, Executive Secretary, Intergovernmental Oceanographic Commission (IOC)

The importance of a consensus plan for implementation of a global observing system
Vice-Admiral C. Lautenbacher, Under Secretary of Commerce, Oceans and Atmosphere, USA

Combat against desertification in Africa: Case of the sub-Saharan Region
M. Buruku, Chief, Liaison Office, UN Convention to Combat Desertification (UNCCD)

Role of observing systems for disaster warning and mitigation: The International Charter Initiative
S. Briggs, Head, Earth Observation Application Department, European Space Agency

Global observation of forest cover and land use dynamics (GOFC/GOLD) in Africa
P.V. de Sanker, Centre for Regional Environmental Studies, University of Virginia, Malawi

Measuring sustainability: The scaling-up Initiative
M. Levy, Center for International Earth Science Information Network (CIESIN), USA

Information and adaptation: Development in a warming world
A. Sari, Executive Director, Pelangi, Indonesia

A challenge for the next decade: Ocean observation systems for sustainable development – toward improvement in economies and societies through environmental information
P. Bernal, Executive Secretary, Intergovernmental Oceanographic Commission (IOC)

Summary and closing remarks
W. Erdelen, Assistant Director-General for Natural Sciences, UNESCO

INTRODUCTION

Sustainable development requires adequate information on the status of the Earth system and on its processes, including the causes and consequences of environmental changes. It equally requires adequate information on the other two pillars of sustainable development, namely social and economical aspects.

A number of global observing systems that provide data about Earth's environment are already in place, both in space and *in situ*. However, these instruments require further improvement. Moreover, because monitoring of environmental changes requires observations over decades at all scales–from local to regional and global–efforts must be taken to ensure their continuity.

In recent years, observing systems that address the human dimension of sustainable development have become increasingly important as we seek to understand and manage coupled human-natural systems and, in some cases, human-dominated ecosystems.

This session provided a comprehensive overview of the role of observing systems in support of sustainable development by highlighting key initiatives such as:

- Application of satellite technologies, in combination with ground-based observations, in addressing key issues of sustainable development, particularly in Africa.
- The construction of sustainability measures that go beyond narrow economic concerns to allow for assessments of trends in human/environment relations.
- The creation of assessment and monitoring systems needed to provide a foundation for devising appropriate human responses to large-scale environmental and socio-economic changes.

PRESENTATIONS

In order to effectively set the stage for this session's presentations, Professor Obasi and Dr. Bernal provided a comprehensive overview of major global observing systems. They briefly described the mandate and contributions of several systems including the World Weather Watch Global Observing System (WWW/GOS); the Global Atmospheric Watch (GAW); the World Hydrological Cycle Observing System (WHYCOS); and the Global Ocean Observing System (GOOS).

These systems are essential for the improvement of weather and marine forecasts, and have beneficial applications in response to Agenda 21 and various Conventions such as the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention to Combat Desertification (UNCCD), the Vienna Convention on Ozone, etc. Drs. Obasi and Bernal also underlined the need for continuous support for such systems, from both governmental and private sectors.

Desertification in sub-Saharan Africa, disaster warning and mitigation, forest cover and land use management–all of these topics are critical to key issues related to sustainable development, and all are currently benefiting from global and systematic observations obtained from space and ground-based systems. In addition to providing concrete examples of how data contribute to action to support sustainable development, presenters in this session placed heavy emphasis on the benefits of such systems, as well as the need to maintain and improve current capacities. A number of presentations dealing with coupled human/natural systems outlined the need to develop observing systems designed to collect and evaluate data and information regarding the human dimensions of these systems. In fact, several presenters spoke about initial efforts to develop quantitative measures of these human dimensions.

Vice-Admiral Lautenbacher stressed the importance of global observing systems (particularly for climate studies which are a priority for the USA), the need for international cooperation (the IGOS-Partnership being a good example), and the policy dimension of climate research. He specifically made reference to recent statements from U.S. President Bush and to the ongoing work of the Climate Science Group to clarify uncertainties on climate variability.

Vice-Admiral Lautenbacher briefly recalled several projects–both space and non-space–currently being conducted and financed by the USA in conjunction with the National Oceanic & Atmospheric Administration (NOAA) including the National Polar-Orbiting Operational Environmental Satellite System (NPOESS), which is now entering industrial development phase for a launch in 2009; the ARGO network for the observation of the oceans, now in an advanced implementation stage; and, the support provided to the GODAE and GOOS activities, etc. He strongly voiced the USA commitment to the Global Climate Observing System (GCOS) as a key element for climate research and operational monitoring.

Speaking specifically to the situation in sub-Saharan Africa, Mr. Buruku stressed the importance of systematic observations of affected areas in order to identify both qualitative and quantitative trends related to desertification and drought. He described the links between science and poverty reduction and emphasized the need to complement data on biological and physical conditions of affected countries with socio-economic data and information on land use. This presentation also highlighted the importance of capacity-building in developing countries as a vital means of enabling scientists to take full advantage of space technologies such as the Early Warning Systems (EWS) and the National Action Programmes (NAP), which is being implemented in 28 sub-Saharan countries. Yearly reports on these activities are made to the UNCCD Secretariat, making it possible to assess progress and to identify further actions needed (e.g. the development of quantitative indicators to overcome the problem of inadequate measurement systems, which is a major obstacle in Africa).

Dr. Briggs illustrated the benefits being realised from the recent International Charter Initiative, announced at UNISPACE III. This programme has allowed numerous space agencies from Europe, North America and Asia, to mobilise their space assets to support early warning and mitigation of major natural and man-made disasters. Dr. Briggs provided numerous examples of how close interactions between space agencies, civil protection authorities, and NGOs have contributed to more effective management of floods, forest fires, earthquakes, landslides and land subsidence, and volcanic eruptions.

Dr. de Sanker focused on the description of the Miombo network, an observing system designed to track patterns of land use change in southern Africa. The activities of this network are closely linked to the joint IGBP/IHDP core project on Land Use and Cover Change (LUCC). He also provided a comprehensive description of the status and current results from the GOFC/GOLD project performed under GTOS. This project utilises Landsat 5 and 7 data to provide important information/products for climate studies, as well as for natural resource management. Examples of the end products were given by Dr. de Sanker, including improved global land cover, land cover change, forest cover and forest cover change, and regional carbon data bundles. Unfortunately, said Dr. de Sanker, *in situ* data collection in Africa, which is essential to complement and validate space observations, has been declining in recent years.

Dr. Levy began by explaining the issues and complexity in defining a representative environmental sustainability index, which is due to the large number of indicators, variables and limitations that result from the lack of standards, reliable data, tools, coordinated methods, etc. He then described the development of an environmental quality index that yields aggregate scores for individual countries in a manner that resembles the UN's Human Development Index. Dr. Levy pointed out a number of problems arising from this level of aggregation, but also discussed possible methods to overcome them while still producing results that allow for comparison across countries.

Using climate change as an example, Dr. Sari outlined the importance of adaptation in contrast to mitigation. Dr. Sari insisted on the critical need to make data and information available to public policymakers so that they can make informed decisions about adaptation. Referring to the IPCC Working Groups Reports and to the risk of non-linear effects and abrupt climate changes, he described the possible resulting effects on the socio-economical and environmental development of countries–particularly tropical developing countries, which would be more vulnerable than developed countries. Dr Sari provided evidence to suggest that a dramatic global temperature increase would lead to important economic losses in these countries because of water shortage, lower rain-fed cereal production, increasing number of extreme events and natural disasters, etc. In addition, this situation would have an impact on health (e.g. it could lead to increased propagation of malaria). In closing, he stressed the crucial importance of capacity building for developing countries, particularly the need to collect and integrate data from various sources, to develop common methodologies, and to address vulnerability aspects without any further delay.

In looking ahead to the challenges of the next decade, Dr. Bernal discussed the roles of the private and public sectors in operating observing systems, taking as examples GOOS and the recent IOC initiative Business Partnerships for Global Observing Systems (BPOS). He pointed out that private actors are already significant players in this field and raised questions about the proper division of labour between private and public actors in this realm. He used the challenges currently facing GOOS to illustrate his points. GOOS, he said, should be configured for both science and society, and should aim to provide products and services for the environment, society, and the economy. Thus, a sustained investment strategy for GOOS–that engages the private sector–should be developed. Dr. Bernal demonstrated the success of this approach with two case studies that focused on the oil and tourism/leisure industries. In both instances, improved marine observations and weather/climate/ocean forecasts are now crucial to operations and strategic planning.

Discussion and Summary

This session dealt with a particularly challenging question: *How to integrate environmental observations data with socio-economic information for better decision making?* Several speakers noted the major gap between existing environmental observing systems–which reflect major undertakings in

data collection and harmonisation by international organizations such as WMO, IOC, UNESCO, FAO, etc.–and the socio-economic observing systems that are still in early stages of development. Clearly, there is a need for socio-economic observing systems that provide data for integrated, coupled human/natural models at local, regional and global levels. At the same time, a major effort is also required to identify and define appropriate socio-economic indicators.

Participants agreed that the WSSD offered a unique opportunity for key players to collectively:

- Acknowledge and re-affirm the high importance of environmental observing systems, including space and *in situ* systems.
- Reinforce the role of IGOS to ensure the continuity of these systems.
- Stimulate the creation of an equivalent system for socio-economic issues.
- Encourage the development of integrated/coupled human-natural models.
- Stimulate cooperation between the private and public sectors in collecting data and producing information for decision makers.
- Assist developing countries that lack resources to deal with consequences of environmental and socio-economic changes.

Report prepared by Walter Erdelen

Session 8

Decoupling Economic Growth from Environmental Impact

ORGANIZED BY:

Swedish Environmental Advisory Council
International Council for Science (ICSU)

CO-CHAIRS

J. Jäger, Executive Director, International Human Dimensions Programme on Global Environmental Change (IHDP)
J. Goldemberg, Secretary of the Environment, Governo do Estado de São Paulo, Brazil

TOPICS / PANELISTS

Opening remarks
L. Sommestad, Acting Minister for the Environment, Sweden replaced by B. Kjellén, Ambassador, Sweden

Decoupling: Past trends and prospects for the future
C. Azar, Professor, Chalmers University of Technology, Sweden
J. Holmberg, Assistant Professor, Chalmers University of Technology, Sweden

Indicators of decoupling
K.G. Ruffing, Acting Director for Environment, Organization for Economic Cooperation and Development (OECD)

What policies and instruments are needed to achieve decoupling?
J. Aloisi de Larderel, Director, Division of Technology, Industry and Economics, United Nations Environment Programme (UNEP)

Industrial ecology and sustainable development: Challenges and opportunities
R. Ayres, Professor Emeritus of Management and the Environment, INSEAD

Transition paths to a new era of green industry: Technological and policy implications
R. Lempert, Senior Scientist, RAND Corporation, USA

The role of business for achieving decoupling: Are market incentives strong enough?
G. Tosen, General Manager, Research, Development & Demonstration, Resources & Strategy, Eskom, South Africa

INTRODUCTION

Sustainable production and consumption are necessary to achieve sustainable societies. Is it possible to decouple economic growth and environmental impact? The Swedish Environmental Advisory Council commissioned a report from various scientists involved in the analysis of sustainable energy and material use.[9] In addition, OECD also prepared a report on indicators for decoupling.[10] With these reports as a point of departure, this session addressed issues relating to decoupling and clean technology.

PRESENTATIONS

Ambassador Kjellén opened the session on behalf of the Swedish Acting Minister for the Environment, Lena Sommestad. He expressed great expectations on the session as decoupling is a "burning issue" if the world is to embark on the road to sustainable development and as the combination of qualified speakers and a knowledgeable audience provided a unique opportunity to discover new insights, develop a common understanding, and explore new ideas on how to tackle this challenge.

Several factors make decoupling a critical issue. For instance, despite measures undertaken in industrialised countries, and the development of solutions for some problems, environmental degradation continues. New pressures arise as economies grow–often because of unsustainable

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9. *Decoupling: Past trends and prospects for the future.* May 2002. The Swedish Environmental Advisory Council. EDITA NORSTEDTS TRYCKERI AB. ISSN 0375-250X. Available online at: www.sou.gov.se/mvb/pdf/decoupling.pdf. The report and a brochure, a summary, can be ordered from the Swedish Environmental Advisory Council (+46 8 4052183 or 4051000)

10. Indicators to measure decoupling of environmental pressure from economic growth, SG/SD (2002)1, OECD, General Secretariat, May 2002.

consumption and production patterns. Although we have bebegun to deal with point source emissions (e.g. from industry and energy plants), other practices such as chemical use, intensified traffic, more electrical equipment, bigger houses, etc. pose new pressures on the environment.

Ambassador Kjellén stressed that many developing nations, particularly South and East Asia and Latin America, will experience a rapid economic growth, largely driven by demographic forces. As fertility rates in these areas fall, the youthful and mature populations will continue to expand, leading to a significant rise in the adult work force, which implies tremendous possibilities for economic growth. While some would argue that economic development leads to environmental improvement, Ambassador Kjellén said history shows the contrary: even though many environmental problems are coupled with poverty, environmental degradation tends to become more severe as economic growth 'takes off.' Moreover, aging populations in developed countries may create an economic downturn that makes it more difficult to invest in the technologies and measures needed for decoupling.

At best, said Ambassador Kjellén, we have 10 to 20 years to find solutions to unsolved problems. For industrialised countries, the big challenge is to develop more sustainable consumption and production patterns, which are important for human health, the environment, and the economy. Sweden, he said, welcomes the proposed global 10-year work programme to be adopted in Johannesburg. He highlighted the need to create a platform that facilitates: experience sharing, increased cooperation between different actors, increased focus on key areas and important sectors, and better means of monitoring and assessing progress. In addition, sustainable consumption and production policies at the international level must contribute to increased business opportunities, innovation, and technology exchange. In new growth areas, there is an opportunity to 'leapfrog' and avoid mistakes that were made in industrialised countries. Investing in clean technologies from the start will save both money and the environment.

In order to learn from history, Ambassador Kjellén challenged the participants at the seminar to look for answers to the following questions: *Where did we succeed/not succeed to decouple and why/why not? What can developed and developing countries learn from this for the future? Is the situation in currently developing countries different from those that prevailed in Europe and North America at the beginning of the industrial revolution? What do the current trends show? What issues are most demanding and how should we tackle them?*

It was with questions like these in mind that the Environmental Advisory Council of the Swedish Government commissioned the previously mentioned report. As science seeks to intelligently tackle the challenges and furnish the knowledge needed to move ahead, it is vital to identify measures to be undertaken by different parties including government, industry, and civil society.

Professors Azar and Holmberg began by discussing the current dilemma. Calls are being made for eco-efficiency and/or an improvement of resource efficiency by a factor of 10. But at the same time, some analysts claim there is an environmental 'Kuznets' curve that implies a fall in environmental pressure as nations get richer. Such improvements have been observed in many cases, but the situation is deteriorating in other areas. They went on to summarise key trends of energy and materials use over time in both developed and developing countries, focusing on Sweden, the European Union, Japan, and the USA, as well as on China, India, and Brazil.

Their findings indicate that absolute emissions of carbon dioxide (CO_2) have been increasing in most countries and periods studied. In 1998, US emissions were 225 Mton C/yr higher than in 1990; this corresponds to the total emissions in Africa. Emissions in Brazil, China, and India increased by 325 Mton C/yr over the same period. Some countries have experienced periods with constant or even falling emissions, but this is the exception rather than the rule, and is usually linked to oil crises or economic recessions. To stabilise atmospheric CO_2 concentrations, CO_2 emissions must be decoupled much more rapidly. It is extremely unlikely that this will happen without effective policies.

Between 1970 and 1998, some decoupling of CO_2 emissions from GDP took place in the world's major economies: the EU (2.1 per cent/yr), Japan and the US (1.8 per cent/yr), as well as in some developing countries such as China (3.2 per cent/yr). However, India increased its emissions over GDP by 1.4 per cent/yr over this period. The drop in CO_2 intensity has

been prompted by some decoupling of energy from GDP (see next paragraph) and CO_2 from energy, the latter resulting from increased use of natural gas and nuclear power. In the South, fossil CO_2 per energy has tended toward an increase from rather low levels. With industrialization, the proportion of biomass drops and the proportion of fossil energy in the energy supply mix rises.

There has also been a decoupling of energy from GDP growth, at least in the EU (0.4 per cent/yr), Japan (0.2 per cent/yr), and the US (1.4 per cent/yr) over the past 40 years. However, it should be noted that this decoupling was faster during the 1970s and early-1980s than during the 1960s and the 1990s. Clearly, higher energy prices and security-of-supply concerns during the oil crises triggered action to increase energy efficiency. Decreased energy intensities can also be linked to structural changes in economies in which the service sector has become increasingly more important. However, this tends to be counteracted by rapid increases in transportation volumes and electricity use, driven by continued income growth (and population growth, particularly in the US). As a result, primary energy supply in the OECD countries was roughly 50 per cent higher in 1999 than in 1971.

Concerning materials, Profs. Azar and Holmberg indicated that there is no clear tendency toward an increasing or decreasing intake of materials in industrialised countries, which means that economic growth is roughly cancelled out by a decrease in materials intensity. For single groups of materials, the tendency varies substantially: plastics and aluminium have grown even faster than GDP for several decades, whereas other materials tend to grow in line with GDP (e.g. paper) or slower than GDP (e.g. iron and steel). At the same time, the accumulated stock of materials in society continues to increase, mainly due to expansion in building volumes and infrastructure. A large proportion of the materials is, however, not added to the stock, but is used dissipatively (e.g. energy fuels and many chemical products).

In many cases, the flows to air and water of emissions that are detrimental to health and the environment (e.g. sulphur dioxide, particulates, and CFCs) have been considerably reduced in industrialized countries. This is particularly true for emissions from the production system (factories, chemical plants, etc.). In contrast, consumption emissions are increasing for many materials and can often be traced back to specific uses (e.g. copper emissions emanate predominantly from brake linings and tap water systems).

There is no tendency towards decreasing total volumes in hazardous chemicals and waste. The study noted that statistics and data on chemical flows are insufficient or not available, and it is difficult to trace them indirectly. As chemicals are produced in society, they are not directly linked to material intake. Furthermore, they are often used in processes without being incorporated in the final products.

Profs. Azar and Holmberg concluded by pointing out that it is the absolute numbers–not the relative–that matter. A general decoupling of materials and energy from economic development is less interesting than a decoupling of specific impacts that cause concern (e.g. emissions of metals and persistent chemicals foreign to nature, as well as CO_2 and acidifying substances). Thus policy makers should focus on the key areas of concern, not on overall indicators of dematerialization.

After describing the Organisation for Economic Cooperation and Development (OECD) as a forum to compare experiences, discuss common problems, develop policy responses, and hold governments accountable for implementation through peer-review processes, Mr. Ruffing highlighted the organizations' work on sustainable development. Major achievements to date include:

- OECD Ministerial Mandate on Sustainable Development (May 2001)
- Other work in-house (e.g. on sustainable consumption patterns)
- OECD Global Forum on Sustainable Development
- OECD Development Cooperation & Sustainable Development

OECD's Ministerial Mandate on Sustainable Development incorporates several key components. The organization uses agreed upon sustainable development indicators in peer-review processes and is engaged in the development of indicators of decoupling. It also considers the social aspects of sustainable development. The next step is to overcome obstacles to policy reforms and to promote policy coherence and integration. It is also in the mandate to make an OECD

report to WSSD. All of these activities will feed into the production of an OECD report to WSSD.

Specific to the issue of decoupling environmental pressures from economic growth, Mr. Ruffing indicated that this initiative is one of five objectives of the OECD Environmental Strategy adopted by Environment Ministers and requested in the Ministerial Mandate. He noted that decoupling is said to occur when the growth rate of the environmentally relevant variable is less than the growth rate of the related economic variable. As did previous speakers, he emphasized the need to focus on absolute vs. relative decoupling. With that in mind, Mr. Ruffing went on to describe various decoupling targets. Firstly, he said, absolute decoupling is important for environmentally harmful substances, which must be maintained below the threshold levels that the environmental media can safely absorb. Secondly, he called for a social benefit/cost test. Thirdly, he identified the optimal level of a marketed natural resource as 'the level that would result from the removal of environmentally harmful substances and the full internalization of all environmental costs.'

Mr. Ruffing then cited a recent report,[11] to provide evidence of decoupling in OECD countries. The report identified 31 decoupling indicators, covering a broad spectrum of environmental issues between 1980 and 1998. Relative decoupling was found to be widespread, and absolute decoupling also quite common in particular cases (e.g. CFC emissions, SO_x, NO_x, and, in some countries, water use). In fact, absolute decoupling was recorded in at least one OECD country for all but two of the decoupling indicators examined at the national level. However, said Mr. Ruffing, further decoupling is still possible.

Finally, Mr. Ruffing gave examples of policy tools that could be used to promote additional decoupling. The first is in the form of economic instruments such as: waste and other fees; taxes on energy and water use; deposit-refund schemes; removal of environmentally harmful subsidies; tradable permits for waste or air emissions, etc. Policy makers should also consider a complementary role for regulatory instruments such as: waste management directives; energy-efficiency standards; extended producer responsibility; water quality standards; and pollutant release and transfer registers. Social instruments, such as eco-labels, can provide another effective tool, and can be implemented through public information campaigns; education; public debate and participatory decision-making; and partnerships with other actors (e.g. NGOs, private sector). Other possible tools include environmental assessments and goal setting; sustainable consumption indicators (including decoupling indicators); infrastructure provision; and zoning and land-use planning.

The presentation of Mrs. Aloisi de Larderel focused on policies and instruments to support decoupling of economic growth from environmental impact. She began with some sobering statistics:

- If market forces continue to drive the globe's political, economic and social agenda, more than half the people in the world could be living in severely water-stressed areas by 2032.
- Unless urgent action is taken, more than 70 per cent of the Earth's land surface could be affected by the impacts of roads, mining, cities and other infrastructure developments in the next 30 years.
- At present, 20 per cent of the population accounts for 86 per cent of the consumption, and generates 70 per cent of the CO_2 emissions.

Within this context, Mrs. Aloisi de Larderel highlighted UNEP's three key roles: 1) monitoring the state of the world environment; 2) identifying solutions through international agreements and voluntary initiatives; and, 3) helping implement solutions. In line with Global Environment Outlook (GEO3) key conclusions, this involves rethinking environmental institutions, strengthening the national policy cycle and enhancing international policy framework, improving synergies with trade, increasing technology contributions, and improving coordination of measures and shared responsibilities.

Mrs. Aloisi de Larderel defined the chief aim of decoupling as 'high quality of life for all, within the carrying capacity of the planet.' This aim requires reduced resource inputs for increased outputs, recognises the importance of maintaining

11. Indicators to measure decoupling of environmental pressure from economic growth, SG/SD (2002)1, OECD, General Secretariat, May 2002.

environmental capital, and uses composite criteria rather than simple economic growth indicators to predict welfare.

The need for such decoupling, said Mrs. Aloisi de Larderel, is evident in the global changes already occurring, in unsustainable production and consumption patterns, and in conflict over resources such as water. Support for decoupling is apparent in recent evolutions in policy including global change decisions on sustainable production and consumption, OECD work on indicators, the European Union's proposal for a 10-year work programme, and the WSSD preparatory committees.

There are many ways to achieve sustainable development and the instruments at our disposal are many, said Mrs. Aloisi de Larderel. For example, we can encourage better life-cycle management of products and materials, as well as cleaner and safe production methods. We can re-orient industry toward the real needs of customers by focusing on sustainable products and services, responding to changing consumer patterns, and revising organizational purchasing policies and procedures. We should also encourage prevention criteria and sustainability indicators in decision-making processes. More specifically, she highlighted the use of some specific international initiatives such as Cleaner Production (CP) in industry, achieving Sustainable Consumption (SC) patterns in society at large, and encouraging development of community emergency plans to guard against risks from technological or natural disasters (e.g. the Awareness and Preparedness for Emergencies at Local Level-or APELL-programme).

In addition, a range of environmental management systems and tools is now available to companies and organizations, including environmental management accounting, sustainable development criteria in financing and investment, longer term substance stewardship, and the use of energy audits and conservation.

The implementation of such initiatives requires the collective effort of all stakeholders: government policy makers (especially economic development, finance, and trade), environment agencies and advisors, industry/business associations and consumer groups, international development agencies and policy research institutes. Building such collective arrangements is one of UNEP's most important tasks.

Such systems depend on a solid basis of technical programmes and actions. For example, to more widely promote the cleaner production concept, the UN Environment Programme (UNEP) and UN Industrial Development Organization (UNIDO) have created a network of 22 national clean production centres, and further centres have developed independently. The International CP Declaration is an instrument to engage top management, and now has more than 300 high-level signatories. New mechanisms of CP financing have become a major element in promoting change in companies, as have regular updates of information sources. Training in CP and APELL has been undertaken in all regions. The creation of new networks and implementation of new initiatives to promote more sustainable consumption patterns through programmes such as the Life-cycle Initiative, are now moving ahead more strongly as a result of WSSD endorsement.

Together with key partners from all sectors of society, UNEP continues to raise awareness, develop partnerships, and encourage the application of all these systems, programmes and tools to support sustainable development.

Professor Ayres began his talk with a list of debatable–or at least debated–points that he indicated he would take for granted for purposes of this short presentation.

1. Economic growth is essential. Anti-growth arguments are not convincing to anybody in developing or industrialised countries.
2. We cannot assume that our grandchildren will be richer than we are, even though we are richer than our grandparents were, an argument that has often been used by conservatives to justify passing problems on to future generations.
3. The global environment is already degraded in significant ways, and some of the damage–including climate warming, which should be relabelled 'climate chaos'–is irreversible and will likely make real growth harder to achieve. For example, repairing storm or flood damage adds to the GDP, but not to real welfare.
4. Waste residuals, or emissions–such as carbon dioxide, ozone-depleting substances, acid rain, toxic chemicals, and so on–are the specific cause of most of the environmental harm. These products, or rather by-products of economic activity, are the reason decoupling is on the agenda.

Prof. Ayres addressed specific factors that must be considered. First of all, decoupling requires dematerialization and greater energy (exergy) efficiency. However, despite some misleading indicators, dematerialization is NOT happening today in the way that matters. In terms of fuels, the world realized some stabilization since the temporary down trend following the energy crisis of the mid-1970s, but the upward trend now continues.

Similarly, the post-war peak and subsequent decline in production and consumption of construction materials reflected the baby-boomers becoming housed, followed by the oil crisis. Again, the trend has been generally up again since the early-1980s. The pattern for metals is the same, although slightly less marked. Chemicals experienced a little dip (mainly in petrochemicals) after the mid-1970s, but are back on an upward trend since the early 1980s. Finally, food crop production *per capita* in the USA is actually down somewhat, but Prof. Ayres does not believe that this is especially good news.

The punch line is this, said Prof. Ayres: There is no reason to assume that decoupling will occur automatically in the future, either as a result of technological progress or a change in human nature. Why? Basically, because technological progress–especially increasing efficiency and lower costs–are exactly the engine that has powered economic growth in the first place, and will continue to do so unless we change the rules. The current *modus operandi* generates a 'cyclic growth engine' in which lower costs lead to lower prices and increased demand, *ergo* continued growth! The case of electric power (exergy consumption) is the most obvious: electricity conversion efficiency results in falling prices and increased demand. On top of that, one must consider the falling price of power sources as compared to wages. There is a definite link between resource consumption and economic growth.

To continue, Prof. Ayres provided a short course in why neo-classical economics has missed this key point, and why this matters. Firstly, he said, it is important to understand two paradigms. The neo-classical paradigm treats production and consumption as abstractions (everything is measured in dollars) and assumes that economic output is a function of labour and capital inputs. However, that doesn't explain growth. In order to explain standard production function vs. real GDP since 1900, economists have introduced something called 'technical progress'. This is used to explain why growth of output (GDP) is much faster than growth of inputs, capital, and labour. This is convenient, said Prof. Ayres, because if you don't need resource consumption to explain growth, then decoupling is easy–they were never coupled in the first place, at least not in the standard theory.

However, the reality is that resource consumption and growth are coupled. If we define something called energy (exergy) services–or what a physicist or an engineer would call work–and if we insert this as a third factor of production, it turns out that we can explain growth since 1900 quite well. Thus, we must think of the economic system as a materials-processing (exergy) system. In order to grow, we will definitely need to continue to generate exergy services. But we need to find new ways of doing this in order to dramatically reduce the accompanying wastes and residuals. In conclusion, Prof. Ayres repeated his opening point: Decoupling will not happen by itself, but only with very determined and purposeful help from governments.

Starting from the premise that the 21st century will surprise us many ways–new technologies will disrupt our expectations, the environment will respond to human influences, political and social change will create commonplace practices that seem unimaginable today–Dr. Lempert highlighted how new information technology can be used to evaluate and apply the policies that can promote the long-term, radical change that will be required in order to achieve sustainable development. While large-scale meetings such as the WSSD are constrained by the broad range of interests, values and expectations of delegates, they remain important to reaching consensus on small, incremental steps toward overarching goals. Information technology, said Dr. Lempert, can assess means to use such incremental steps to move towards large long-term changes. The key, he said, is that information technologies allow us to 'shape the future' rather than make futile attempts to predict it.

Creating long-term policy is nothing new, but Dr. Lempert suggests that the sustainability challenge is unique in that it requires shaping the evolution of social, economic, technological, and environmental systems so complex that even our best intuition will not suffice in crafting a successful response.

To effectively apply the new assessment tools offered by information technology, it is important to follow four key principles:

- Consider multiple scenarios, with the aim of capturing the broadest possible range of future possibilities.
- Seek robust strategies that perform well across a broad range of plausible futures, as well as ways to value the desirability of alternative futures.
- Apply adaptive strategies–that is, strategies explicitly designed to evolve over time in response to new information–to achieve robustness. The goal is to institutionalise systematic processes of error detection and correction.
- Build adaptive, error-correction processes into the new information technology so that it can respond to the unprecedented challenges that lay ahead.

Dr. Lempert demonstrated this approach by showing a series of computer-generated 'landscapes' of plausible futures which explore many combinations of future economic growth rates and decoupling rates (the rate at which environmental impacts decouples from economic growth). Showing both extremes and all the points in between, the landscape can be used to make choices about near-term policies related to areas such as research and development or environmental taxes. Moreover, it supports long-term monitoring and adaptation as additional information is discovered and integrated, while also identifying errors and facilitating appropriate responses.

The technology makes it possible to compare alternative strategies (e.g. a 'business as usual' strategy vs. a 'crash' program) across tens of thousands of alternative futures. Invariably, the ideal path for some futures fails miserably in others, but the technology provides a good starting point for rational discussion and decision making that can be used to establish goals and track progress.

This technology, said Dr. Lempert, can be applied to problems as complex as climate change, which clearly require long-term radical change. For example, information technology has played an important role in policy experiments related to tools such as emissions trading and transparency of environmental information, which can create the market forces required for crucial near-term components of a robust strategy. Governments may need to develop incentives that encourage commercial firms to invest in new environmental technologies.

In closing, Dr. Lempert highlighted how information technology provides a mechanism for slowly advancing minimal standards and while also offering radical innovators the realistic hope that if their innovation really works, it may eventually become the new standard. In addition, although it is impossible to predict the long-term consequences of short-term actions, he emphasized that information technologies can also be used as an effective tool for ensuring accountability among governments and business.

In addressing the role of business for achieving decoupling, Mr. Tosen highlighted the typical phases of economic revolutions. Identifying social, economic and environment as the three key drivers of sustainability or 'eco-efficiency', he began by providing an overview of how dramatic population growth in the coming decades will impact our planet. At present, 90 per cent of the population growth is in developing nations, where 1.3 billion people live on $1/day and two billion people have no access to commercial energy of any form.

This creates a global 'trilema' said Mr. Tosen: as population increases, so do gross domestic product and primary energy consumption. A key aspect of achieving sustainability is the need to reduce primary energy consumption by 25 per cent in the next 50 years, largely through global electrification. This need was highlighted by examining the predicted growth rates for energy consumption in developing regions such as Africa, South America and the Middle East, which currently account, respectively, for a mere two, four, and three per cent of total energy consumption. Whereas energy consumption in industrialised countries is expected to increase by 25 to 50 per cent by 2020, consumption in the developing regions will likely double or triple.

It is therefore critical that we find ways to fill the global CO^2 emissions gap. To do so, we need technologies that are cleaner, more efficient and less wasteful–many of which will involve microprocessor control. While aggregate global energy intensity is declining at one per cent per annum, efficiency through the entire energy supply chain (extraction, fuel transport, conversion, delivery and EU) has only reached five per cent. Clearly, there is much room for improvement.

Comparing phases of economic revolution, Mr. Tosen highlighted the fact that from an industrial perspective, having moved through the phases dominated by science and technology, infrastructure development, and business transformation, we are now entering the fourth phase of commodities and efficiency. In contrast, we are still in the early stages of the business transformation phase in terms of the information economy. He predicts we will enter the fourth phase by 2010, at which time information and communication technology (ICT) will start to realise opportunities in dematerialization, intelligent energy systems, smart transportation and distribution systems, and E-learning.

Mr. Tosen then used this model to describe the challenges and potential of the 'bio-economy'. As opposed to the conventional economy, which relies on non-renewable energy sources, processes involving fossil carbon energy, and leads to products and waste, the bio-based system will use renewable energy sources, bioprocesses (i.e. renewable energy) and lead to bio-products and biological by-products, which can be fed back into the system. Thus, the bio-based system is sustainable. At present, this alternative economy is still in the early stages of the science and development phase. By 2010, Tosen predicts we will be approaching the phase between infrastructure development and business transformation in this area.

In order to achieve this sustainable system, Mr. Tosen highlighted the need to invest in innovative research, development and demonstration (RD&D) initiatives and in system development. This would allow developing nations to leapfrog over the historic pathways of development to implement cleaner, more efficient technologies much earlier.

The role of business, said Mr. Tosen, is to become an active partner in multi-stakeholder sustainable development projects, thereby pursuing and demonstrating credible, measurable results. Business should also invest in developing countries as a means of contributing to poverty alleviation in a sustainable manner. Together, the public and private sectors should work to solve immediate problems, implement evolutionary technology improvements, define research to achieve future technical and policy objectives, and enable destinations of the greatest societal value. For this public/private partnership to succeed, a clear, consistent and balanced regulatory environment is imperative. In addition, the private sector must practice accountability, transparency and appropriate reporting to support the 'triple bottom line'.

In closing, Mr. Tosen indicated that business strongly supports the legacy projects under the auspices of WSSD (African Grid Interconnectivity R&D; AIDS Vaccine Regional Programme; Global Monitoring and Sensing; M&S teaching; African Biotech Programme; Science and Society), as well as the NEPAD initiative as a means of promoting sustainable development in Africa.

Discussion and Summary

This session generated much discussion around the question: *What are the most important tasks for the scientific society in the process of decoupling economic growth from environmental impact?* Participants identified several important issues that must be addressed:

Measuring decoupling gives useful indicators of the economic and ecological perspectives of sustainable development. We need scientific data and indicators for both relative and absolute decoupling.

Indicators and methods for sustainable development should also include the social factor. The scientific society should contribute social-scientific knowledge directed toward bringing about change in consumption and production patterns aimed both at societal frameworks and individual behaviour.

When it comes to energy use and carbon dioxide emissions, the scientific society should especially contribute two things: a) information that is region specific and that conveys concrete images of climate change; and b) concrete suggestions for effective political measures such as legislation, taxes, and resources to heighten awareness among the general public.

The scientific society should carry out a thorough survey on the usage of materials and diffusion of chemicals and develop statistics in areas that are currently lacking data. The top priority questions for the scientific society are: a) *Where do we have the knowledge?* and b) *Where is this knowledge*

lacking? Maybe we should establish an international research panel (e.g. the International Panel on Material Usage and Chemical Diffusion) in the same vein as the Intergovernmental Panel on Climate Change (IPCC). The panel's task would be to develop a consensus-based message on material and chemical usage throughout the world and its impact on the environment and health. The message should be disseminated to politicians, media, and the general public. Further, participants agreed that because current knowledge is based solely on statistics in the public domain, how statistics can be collected is also an important issue. They recognised that the business sector possesses essential information on chemical usage and, therefore, the scientific community must build cooperation with companies that have this vital data. Everyone agreed that environmental impact is just one aspect of the equation–there is an economic value in the material stockpiled in society. The question is: *How can we maintain the value of such material?* The scientific society should also contribute a plan for efficient recovery systems in order to take advantage of and preserve the value in these material flows.

Report prepared by Siv Näslund and Kristina Olsson

Session 9

High-level Panel Discussion on the Role of Science and Technology for Sustainable Development in Africa

ORGANIZED BY:

African Academy of Sciences (AAS)

IN COLLABORATION WITH:

International Council for Science (ICSU)
Third World Academy of Sciences (TWAS)
World Federation of Engineering Organizations (WFEO)

CHAIR

T.R. Odhiambo, Honorary President, African Academy of Sciences (AAS)

TOPICS / PANELISTS

Introductory Remarks
M.H.A. Hassan, President, African Academy of Sciences (AAS) and Executive Director, Third World Academy of Sciences (TWAS)

HE B. Ngubane, Minister of Arts, Culture, Science and Technology, South Africa

D. King, Chief Scientific Advisor to the Government, Head of the Office of Science and Technology, U.K.

HE T.T. Isoun, Minister of Science and Technology, Nigeria

C. Magarinos, Director General, United Nations Industrial Development Organization (UNIDO)

C. Paterman, Research Director, European Commission

HE L. Sommestad, Acting Minister for the Environment, Sweden replaced by B. Kjellén, Ambassador, Sweden

K. Mshigeni, UNESCO / ZERI Africa Chair and Director, UNDP/UNOPS Regional Project on Sustainable Development from Africa's Biodiversity, University of Namibia, Namibia

G.O.P. Obasi, Secretary General, World Meteorological Organization (WMO)

J. Mugabe, Executive Secretary, African Commission on Science and Technology and Expert on Science and Technology Policy Development, NEPAD Secretariat, South Africa

H. Van Ginkel, Rector, United Nations University

INTRODUCTION

The session focused its deliberations on the priorities of science and technology for sustainable development in Africa. Individual presentations were aimed at a general audience, which included representatives of national delegations, the UN Major Groups, international organizations, and other participants with an interest in Africa's development.

PRESENTATIONS

Professor Hassan opened the session by expressing the need to strengthen Africa's scientific human capital. This is directly linked to the need to provide adequate financial resources to help African governments support new initiatives, such as the New Partnership for Africa's Development (NEPAD), and to develop regional centres of excellence. Prof. Hassan also emphasized the urgency of these issues to address the continent's current brain drain challenge.

In his agenda-setting address, Professor Odhiambo called for Africa to embark on a new beginning, to develop a new vision, and to initiate a new thrust. These efforts must be founded upon the power of forgiveness: forgiving and forgetting the injustices of the past (especially the slave trade, the apartheid, etc.). The new beginning must be built upon hope and characterised by enhanced creativity. It must generate a paradigm shift that will stimulate the highest quality education, training, and research–all of which will ultimately stimulate wealth creation, thereby giving Africa a more competitive edge in global trade.

Dr. Ngubane focused on the need to vigorously fight Africa's poverty. He also called upon leaders to intensify their efforts to secure an endowment fund for the promotion of science and technology development in Africa. Further, he highlighted the necessity for enhanced partnerships amongst African scientists, and also with their peers in industrialised countries. In particular, Dr. Ngubane addressed the need to:

- establish regional centres of excellence;
- build demonstration centres to enhance diffusion of science and technology;
- reduce brain drain and establish strategic networks between African scientists and their peers in the diaspora;
- set appropriate targets and priorities, which should include the promotion of biotechnology skills, energy technologies, low-cost housing development, and information technology.

Dr. Isoun advanced the discussion by speaking about the urgent need to create an 'enabling environment' for science and technology in Africa, which necessarily includes initiatives to allocate more funds for research in African universities and research institutes, and to forge partnerships with industry. In expressing his appreciation for the philosophical background provided by the Chair, Dr. Isoun re-emphasized the need to capitalise on recent success stories so that Africa can move forward with greater confidence and hope.

In the following presentation, Dr. King outlined the advantages of establishing appropriate functional advisory bodies on science and technology, which can play a significant role in advising government on science-based development, on dealing with crises, on the importance of openness and transparency, and on the need for greater investment in capacity building at various levels. At the same time, Dr. King emphasized the need to promote strategies that involve North-South partnerships. He concluded by reminding all panel members that scientists and engineers have important roles to play in helping governments make the right decisions.

As the Director-General of UNIDO, Dr. Magarinos was able to draw on past experience to discuss how the development and application of science and technology can contribute to promoting industrial performance. Thus, he focused on the need to mobilise technologies and develop skills that will help developing nations catalyze industrial growth. The world needs to promote industrial expertise in the South–especially in Africa–by capitalizing on niches in which Africa has a competitive advantage, said Dr. Magarinos. He cited several examples of success that have significant value-added components, such as Kenya's leather industry (based in Thika).

Dr. Paterman highlighted the role of science and technology as an engine for sustainable development and called upon governments of developing nations to market this role as a means of increasing financial allocations to science and technology. He emphasized that we are now a knowledge-based economy and a knowledge-based society. Therefore, governments must learn to use this knowledge base to eradicate poverty, to combat major diseases (e.g. HIV/AIDS, malaria, tuberculosis), to advance research, to promote the exchange of scholars (both North-South and South-South exchanges), to forge linkages with industry, and to stimulate innovation. He concluded by saying that developing nations will require the assistance of developed nations to enter and participate in the main stream of modern development.

Dr. Van Ginkel addressed the need to accord due attention to the improvement of education. Science, technology, and education must be brought together, he said. Teachers in the classrooms must be mobilised and networks that help build endogenous capacity must be established. Dr. Van Ginkel offered additional suggestions and recommendations including:

- training more people in science and technology to help attain a critical mass and to make up for current losses;
- catalyzing the development of special research and development projects directed toward addressing common regional problems;
- developing new products, based on Africa's geographical uniqueness, and marketing them to the world;
- interpreting science and technology in its broadest sense; and
- establishing centres of specialization based in various countries, each addressing a specific problem, but all inter-linked to a hub (as in the UNU/INRA scenario).

Dr. Mugabe presented key highlights of NEPAD and discussed how the new body views science and technology in

the context of Africa's future development. NEPAD, he said, has ambitious goals, covering areas of science and technology development, stimulating food security, promoting poverty reduction, and good governance. In order to achieve these goals, Africa must:

- develop and enhance its ability to make meaningful contributions to global science, global knowledge, and global markets;
- apply science and technology to solve its critical problems, focusing on the enhanced use of information technology, biotechnology, and GIS tools while also promoting the scientific application of indigenous knowledge;
- create new platforms for developing concrete activities that are broad-based and built upon earlier initiatives such as RANDFORUM. These activities should also focus on adding value and should be anchored to high-level political support; and
- take action now, applying strategies that support transparency, that rely on consultations with all stakeholders, that enhance capacity building, and that are aligned to global trends.

In the final presentation, Dr. Mshigeni challenged Africa not to lose hope. There are great opportunities in Africa toward poverty reduction, toward promoting sustainable livelihoods, toward addressing some of the burning environmental issues of the day (e.g. the water hyacinth crisis in Africa's rivers and lakes), and toward generating new products for global markets. The key, he said, lies in ensuring adequate provisions are made for science and technology capacity building, for research and development, and for catalyzing linkages with Africa's poor, rural village communities. Dr. Mshigeni cited a success story in Tanzania, where he used science and technology as a basis to promote the innovative development of seaweed farming in marine waters. The initiative has helped employ more than 40,000 coastal rural villagers in Zanzibar and is also making significant contributions to foreign exchange earnings in the country.

Dr. Mshigeni is now coordinating new initiatives, funded by the UN Development Programme (UNDP), the UN University (UNU), UNESCO, and the Government of the Republic of Namibia, which are directed toward promoting mushroom farming (for food, cash income, and medicinal applications) and toward promoting science-based uses of water hyacinth (*Eichhornia crassipes*). He concluded by making an appeal to African governments–and also to the donor community–to support such initiatives, which clearly demonstrate that NEPAD's dreams can be achieved.

Discussion and Summary

Session participants concluded that African societies, in general, and African leaders, in particular, together with developed countries and multi-lateral institutions, must pursue new means and increase efforts to create the financial resources and political will required to promote and develop the highest quality education, training, and research institutions. One essential prerequisite for poverty reduction and wealth creation involves devising effective investment strategies for nurturing human capital that is skilled in issues related to scientific research and technological development. Over time, such strategies would help improve Africa's ability to participate in the global economy.

Session participants also acknowledged that science and technology are the primary engines for achieving sustainable economic growth. Training people in science and technology, and catalysing the development of multidisciplinary, goal-oriented research and sustainable development projects are essential for addressing social, economic, and environmental needs, both at local and global levels.

These goals can be advanced through multi-level strategies characterised by stronger links between the many stakeholders involved in science and society. For example, Africa should pursue new endowment funding mechanisms for establishing regional centres of excellence and building demonstration centres dedicated to the diffusion of science and technology. In addition, closer ties between science and technology and the industrial sector are required, as is increased capitalization of niche markets in which Africa enjoys a competitive advantage. More effort is needed to promote policies designed to reduce brain drain and to establish strategic links and exchange programmes between African scientists and their colleagues in the diaspora. At the foundation of all these efforts lies the need to set appropriate targets and priorities, which should include the promotion of

biotechnology, energy technologies, global information systems, scientific application of indigenous knowledge, and information technologies.

Session participants also emphasized the need for scientific institutions within Africa to develop the capacities to take an active vital role in advising governments on science-based development issues. Such efforts, they acknowledged, depend on openness and transparency, and will take hold only if greater investments are made in scientific capacity building at all levels.

Lively discussions followed each presentation, much of which called for the need to build confidence among Africa's scientists and to ensure that all stakeholders are on board. Knowledge-based approaches must be embedded in Africa's cultural heritage, major elements of which include community and spiritual connectedness and a strong sense of the importance inherent in sharing information with neighbours. The hope for a new millennium of progress and material well-being for Africa depends, in part, on acknowledging and cultivating Africa's traditional values and principles.

Report prepared by Daniel Schaffer and Diego Malpede

Ubuntu Declaration on Education and Science and Technology for Sustainable Development

On 4 September 2002, eleven of the world's foremost global educational and scientific organizations released a formal declaration in support of sustainable development.

The *Ubuntu Declaration* states that greater global emphasis on education is essential to reaching sustainable development goals, and that there is a need to integrate a sustainable development focus into the curriculum at every level of education, starting in primary school. The Declaration effectively creates a major global alliance to promote science and technology courses and teaching throughout educational systems worldwide.

The Declaration issued at WSSD identifies four overarching goals:

- curriculum development
- North-South networking
- strategic educational planning and policy-making, and
- capacity building in scientific research and learning.

Hans van Ginkel, UNU Rector and President of the International Association of Universities, said additional members will be sought for the alliance of policy makers, educators, professionals and researchers at international academies of science and institutions of higher education. "Sustainable development is not a one-day tutorial," he emphasized. "Education means much more than simply pre-employment training. Integrating sustainable development into the curriculum at all education levels and sectors is needed to ensure that students from primary to post-secondary are aware of its imperatives and respect its principles and values in their professions and as habits of everyday life."

Walter Erdelen, Assistant Director-General for Natural Sciences, UNESCO, said the alliance also looks to education ministries at the national level to re-evaluate and relate school programs to sustainable development, and to ensure the appropriate training and retraining of teachers. "This effort helps to respond to the critical necessity to resolve tension between growth and development, on the one hand, and conservation and environmental protection on the other," he added. "Expanding the educational base, and in particular the scientific-technological base, is also essential for reversing the growing inequity among nations."

Also participating in the announcement were Mohamed Hassan, Executive Director, Third World Academy of Sciences; Dato Yee-Cheong Lee, President-elect, World Federation of Engineering Organizations; Thomas Rosswall, Executive Director, International Council for Science; and Richard Clugston, President, University Leaders for a Sustainable Future.

Ubuntu Declaration on Education and Science and Technology for Sustainable Development

In an effort to make integrated solutions work for sustainable development and to mobilize the education sector to contribute to sustainable development;

We, the education and scientific organizations of the world,

United Nations University; United Nations Educational, Scientific and Cultural Organization; African Academy of Science; International Council for Science; International Association of Universities; Copernicus-Campus; Global Higher Education for Sustainability Partnership; Science Council of Asia; Third World Academy of Sciences; University Leaders for a Sustainable Future; and World Federation of Engineering Organizations,

call for an initiative to strengthen science and technology education for sustainable development.

Cognizant that integrated solutions for sustainable development depend on the continued and effective application of science and technology, and that education is critical in galvanizing the approach to the challenges of sustainable development;

Endorsing the Earth Charter as the inspiring, fundamental and balanced set of principles and guidelines for building a just, sustainable and peaceful global society in the 21st century, which should permeate all levels and sectors of education;

Noting that science is all science - natural, social and human;

Recognizing the necessity to bridge the knowledge gap between the nations of the world through a fundamental redress of the distribution of education for sustainability;

Acknowledging that the ultimate goal of education in all its forms is to impart knowledge, skills and values to empower people to bring about changes;

Concerned that education has not been utilized as a vehicle for attaining sustainable developmentc;

Reaffirming the indispensable role of education in achieving sustainable development, and the important role education plays in the mobilization of science and technology for sustainability as contained in Chapter 36 of Agenda 21;

Recalling the Lüneburg Declaration on Higher Education for Sustainable Development of 10 October 2001, and its emphasis on the indispensable role of higher education informing and supporting all education in addressing the critical challenges of sustainable development;

And recognizing that the Scientific and Technological community, as represented by the International Council for Science, Third World Academy of Sciences, and World Federation of Engineering Organizations in the WSSD process has called for a new social contract between science and technology and society for sustainable development;

Determined to work towards the goals contained in the Millennium Declaration, Monterrey Consensus and the Doha Development Declaration;

Call on Governments of the World Summit on Sustainable Development and the Post-Summit agenda to:

Designate educators as the tenth stakeholder group in the WSSD process.

Call on educators, Government and all relevant stakeholders to:

Review the programmes and curricula of schools and universities, in order to better address the challenges and opportunities of sustainable development, with a focus on:

- Plans at the local, regional and national country levels;
- Creating learning modules which bring skills, knowledge, reflections, ethics and values together in a balanced way;
- Problem-based education at primary and secondary levels in order to develop integrated and non-instrumental approaches to problem solving at an early stage in the education cycle;
- Problem-based scientific research in tertiary education, both as a pedagogical approach and as a research function;

Promote efforts to attract young people to the teacher profession both to meet the Millennium Development goals of universal access to primary education as well as to further strengthen primary, secondary and tertiary education. In developed countries the major challenge in the coming years will be to offset the high outflows of experienced teachers reaching retirement age or taking up other challenges;

Develop mechanisms to continuously inform teachers and update programmes on major progress in scientific and technological knowledge relevant for sustainable development;

Promote knowledge transfers in innovative ways in order to speed up the process of bridging gaps and inequalities in knowledge. This is the shared responsibility of teachers, schools, research and education institutions and governments.

To achieve these challenges and objectives, we are resolved to work towards a new global learning space on education and sustainability that promotes cooperation and exchange between institutions at all levels and in all sectors of education around the world. This space must be developed on the basis of international networks of institutions and the creation of regional centres of excellence, which bring together universities, polytechnics, and institutions of secondary education and primary schools. We invite all other responsible stakeholders to join us in this endeavour.

Part IV: The Way Forward

The tangible outcome of the official part of WSSD is the adoption by governments of two documents that had been under negotiation since the final and fourth meeting of the Intergovernmental Preparatory Committee (Bali, Indonesia, 27 May - 7 June 2002). Referred to as the Type I Outcome, these two documents are the *Johannesburg Declaration on Sustainable Development and the Plan of Implementation of the World Summit on Sustainable Development.*

In addition to these government commitments and to the recommendations contained in these two documents, which were addressed to all stakeholders, WSSD led to many voluntary international partnerships initiatives or Type II Outcomes. These partnerships reflect the dynamic interaction among Major Groups–including the S&T community–the business sector, civil society in general, governments, and international organizations. At the time of the Summit, approximately 250 such initiatives were submitted to the Summit and included in an official *List of International Partnerships for Sustainable Development.* However, it must be noted that the List is open ended, and is held by the Secretariat of the UN Commission on Sustainable Development (UN Headquarters, New York).

The *Johannesburg Declaration on Sustainable Development* is a short policy and political document that makes no specific reference to the role of science and technology in moving toward sustainable development. In contrast, the *Plan of Implementation of the World Summit on Sustainable Development* represents a major step forward. In the context of this plan, governments acknowledge the essential role of science and technology, not only for identifying and understanding interrelated environmental and development issues, but also for generating and contributing significantly to the implementation of possible solutions. Thus, *the Plan of Implementation* clearly identifies science and technology as important elements of achieving the overarching goal of sustainable development.

The *Plan of Implementation* contains many recommendations related to enhanced utilisation of science and technology, as well as on capacity building in numerous fields of science and technology. It is also encouraging to find five distinct sections in the chapter on "Means of Implementation" which are devoted to *sui generis* recommendations concerning the enhancement of science, technology, education, capacity building, and data/information/indicators, all in support of sustainable development.

The S&T-related recommendations in the *Plan of Implementation* represent a much improved recognition of the role of science and technology for sustainable development, particularly when compared to the substance of *Agenda 21,* the major outcome of UNCED (the Earth Summit, 1992 - Rio de Janeiro). While *Agenda 21* will remain the comprehensive blueprint and long-term agenda for sustainable development, the *Johannesburg Plan of Implementation* focuses more on 'making it happen', with targets of 2015 set for some important aspects. Delegates deliberately chose this time horizon to coincide with the Millennium Development Goals adopted by the UN General Assembly in 2000.

A new social contract leads S&T into the future

For the S&T community, the *Plan of Implementation* provides a solid foundation for the creation of a new contract between science and society–a contract focused on ensuring that the great potential of science and technology is fully exploited. The S&T community will endeavour to fulfil its social obligations by providing essential elements to solutions that address the serious problems underlying our current, unsustainable path of development.

The spirit of this new contract is evident in one important aspect the *Plan of Implementation.* The plan strongly recommends that the UN Commission on Sustainable Develop-

ment be strengthened, in part by *"giving greater attention to the scientific contributions to sustainable development through, for example, drawing on the scientific community and encouraging national, regional, and international scientific networks to be involved in the Commission."*

Admittedly, many challenges remain. For instance, governments must deliver on their commitments to supporting science and technology. In turn, the S&T community worldwide must collaborate to deliver globally oriented solutions that can be adapted and implemented at the local level. To this end, ICSU and TWAS, along with the newly created International Council for Engineering and Technology (ICET) and its two founding members, WFEO and the UN International Union of Technical Associations and Organizations (UATI), will present their governing bodies with proposals that outline ways to re-orient major portions of the global R&D system toward support for sustainable development. Moreover, these new plans will attack the issues in a more targeted approach, including the launch of new, solutions-based initiatives.

In particular, ICSU, TWAS and the International Initiative on Science and Technology for Sustainable Development (ISTS) are considering a joint initiative, including the establishment of a consortium, geared toward implementing the 'Next Steps' agreed upon during the Mexico City *Synthesis Conference on Science and Technology for Sustainable Development*.[12] As joint organizers of this scientific meeting–which was key to the WSSD preparatory process–these three organizations are taking the lead to address urgent concerns identified by delegates. For instance, participants concluded that local efforts toward sustainable development must be upheld by better support from the S&T community, and that a great deal of this assistance should come in the form of solution-focused, site-specific research and development. Such research should be conducted in close collaboration with stakeholders and decision makers that operate within or influence the local situation.

Living up to the commitments made by the S&T community at the WSSD will require substantial changes in the way scientists subscribing to the 'new contract' conduct their work. This includes carrying out research in a manner that is consistent with the realization that knowledge is more likely to be applied if it is produced through collaborative processes that allow for greater participation, particularly by social stakeholders. For this reason, one of the most critical elements of the way forward is to seek broader input in setting future S&T agendas for sustainable development.

12. See "Science and Technology for Sustainable Development: Consensus Report and Background Document." Mexico City Synthesis Conference, 20-23 May 2002. *ICSU Series on Science for Sustainable Development No. 9.*

Annexes

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Annex C: Acronyms Appearing in Report

AAS	African Academy of Sciences
ACTS	African Centre for Technology Studies
APEC	Asia-Pacific Economic Cooperation
APELL	Awareness and Preparedness for Emergencies at Local Level
BEAM	Building Engineering Ability in Mozambique
BPOS	Business Partnership for Global Observing Systems
CEC	Commonwealth Engineers Council
CIESIN	Center for International Earth Science Information Network
CGIAR	Consultative Group on International Agricultural Research
CNRS	Centre National de la Recherche Scientifique
CSD	United Nations Commission on Sustainable Development
EOP	Earth Observation Programs
ESA	European Space Agency
ESCA	Engineering Council for South Africa
EWS	Early Warning System
FAO	United Nations Food and Agriculture Organization
GABS	Global Alliance for Building Sustainability
GAW	Global Atmospheric Watch
GECAFS	Global Environmental Change and Food Systems
GEO3	Global Environment Outlook
GOFC	Global Observation of Forest Cover
GOLD	Global Observation of Land-use Dynamics
GOOS	Global Ocean Observing System
IAEA	United Nations International Atomic Energy Association
IAP	Inter-Academy Panel on International Issues
ICC	International Chamber of Commerce
ICET	International Council for Engineering and Technology
ICGEB	International Centre for Genetic Engineering and Biotechnology
ICRAF	International Centre for Research in Agroforestry
ICSU	International Council for Science
ICTP	International Centre for Theoretical Physics
IFS	International Foundation for Science
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IHDP	International Human Dimensions Programme on Global Environmental Change
IMPECT	Inter Mountain Peoples Education & Culture in Thailand Association
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
ISSC	International Social Science Council
IUMS	International Union of Microbiological Societies
IYPF	International Young Professionals Foundation
LEAD	Leadership for Environment and Development International
LINKS	Local and Indigenous Knowledge Systems (United Nations)
LUCC	Land Use and Cover Change
NAP	National Action Programmes
NEPAD	New Partnership for Africa's Development
NOAA	National Ocean & Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
OECD	Organisation for Economic Cooperation and Development
RICS	Royal Institution of Chartered Surveyors
SAICE	South African Institute of Civil Engineering
TAPE	United Nations Engineering and Technology for Poverty Eradication
TWAS	Third World Academy of Sciences
UATI	United Nations International Union of Technical Associations and Organizations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UNU	United Nations University
WFEO	World Federation of Engineering Organizations
WHO	United Nations World Health Organization
WHYCOS	World Hydrological Cycle Observing System
WMO	United Nations World Meteorological Organization
WWW/GOS	World Weather Watch Global Observing System

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