United Nations
Educational, Scientific and
Cultural Organization

SCIENCE in Africa

UNESCO'S CONTRIBUTION TO AFRICA'S PLAN FOR SCIENCE AND TECHNOLOGY TO 2010

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Foreword

Koïchiro Matsuura
Director-General
of UNESCO
January 2007

The Year 2007 promises to be a year of great opportunity for science in Africa. The African Union Summit, to be held in Addis Ababa in January, will take as its special theme Science, Technology and Innovation for Africa's Socio-economic Development. African science ministers meeting in Cairo in November have also recommended that the Summit proclaim 2007 the Year of Science in Africa. These decisions reflect the continent's growing realization that it cannot achieve economic prosperity, nor reach international development goals, without first achieving progress in science, technology and innovation.

And there are many other encouraging signs. At its Summit in Khartoum in January 2006, the African Union not only endorsed Africa's Science and Technology Consolidated Plan of Action, but also established a tripartite AU/NEPAD/UNESCO High-Level Working Group to prepare a comprehensive programme for creating and funding regional centres of excellence, a key strategy of the Plan of Action.

The building of scientific capacity demands a broad-based approach. This includes investment in good governance and in the formulation of a coherent science, technology and innovation policy that is integrated in national development plans. It also requires a well-functioning and inclusive education system, as one of the basic preconditions for all forms of science and knowledge-based development. Of importance, too, is the need to strengthen the linkages between research institutions and policy-makers, industry and the private sector, in order to foster innovation and ensure that its fruits are widely diffused. UNESCO is already providing support in all these areas of capacity-building, in particular through the promotion of regional and international cooperation as a major driver of scientific development.

At their Cairo meeting, African science ministers recommended establishing a pan-African fund to accelerate the implementation of the Plan of Action. While increased international support is clearly important, the main basis of funding will remain that of African governments themselves. If African countries are to be in the driving seat of their own socio-economic development, they need to ensure sustained levels of investment in research and development (R&D). The target endorsed in Khartoum of devoting 1% of GDP to R&D by 2010 is an important step in this direction.

Ministers also endorsed in Cairo a 20-year Biotechnology Strategy which recommends pursuing biotechnology and biosafety in parallel, in order to ensure that Africa can capture the economic, health care, environmental and industrial benefits from biotechnology, while at the same time managing the potential challenges, risks and trade-offs associated with the development, commercialization and application of biotechnology – as called for in the Plan of Action. UNESCO stands ready to support this African initiative via its programmes in the life sciences and bioethics.

A Supplement to the present brochure illustrates UNESCO's action in Africa in the social and human sciences, especially with regard to the promotion of the ethics of science and technology, and in particular bioethics. In this connection, I wish to draw attention to the Dakar Declaration on the Ethics of Science in Africa adopted at the last session of the World Commission on Ethics of Scientific Knowledge and Technology, in December 2006. The Declaration provides an important framework for moving forward in this area.

Human security in Africa is a primary concern for UNESCO. In the coming months, UNESCO will expand the Indian Ocean Tsunami Early Warning System to include Eastern African states, thereby strengthening the network of sea-level stations in this sub-region.

I am pleased to present in the present brochure an outline of the ways in which UNESCO can contribute to Africa's Science and Technology Consolidated Plan of Action. Although a non-exhaustive list, the activities on the following pages will, I hope, serve to illustrate the depth of UNESCO's commitment.

Biodiversity, Biotechnology and Indigenous Knowledge

Conservation and sustainable use of biodiversity

To conserve and sustainably use biodiversity, African countries will need to harness and apply S&T...The NEPAD framework commits African countries to establishing regional networks of centres of excellence in science for conservation and sustainable use of the continent's biodiversity.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

Biodiversity is disappearing at an unprecedented rate. Worse, the trend appears to be accelerating, in spite of international commitments to reduce, or even halt, the rate of loss by 2010. Good systems of science governance capable of using biodiversity sustainably and equitably will be essential if we are to reverse the trend.

UNESCO helps governments and policy-makers make informed decisions about biodiversity conservation within international efforts like the Convention on Biological Diversity. UNESCO does this by collecting, peer-reviewing and 'packaging' scientific information in the form of scientific assessments like the Millennium Ecosystem Assessment. Published in 2005, the latter included 30 sub-regional assessments. That for Southern Africa observed, for example, that at least four of the eight Millennium Development Goals would not be met unless decisive action was taken to stabilize ecosystem services.

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Impala in Pendjari Biosphere Reserve in Benin.

BOX 1 - The biosphere reserve concept

The World Network of Biosphere Reserves currently consists of 507 sites in 102 countries. Of these sites, 71 are situated in 29 African countries (see Annex IV).

Each of these geographical areas has been nominated by the national government. Once approved by the MAB International Coordinating Council, the site remains under the sovereign jurisdiction of the country concerned. In parallel, it becomes an internationally recognized 'laboratory' for sustainable development. Each biosphere reserve also acts as a mechanism for knowledge-sharing, research and monitoring, education, training and participatory decision-making.

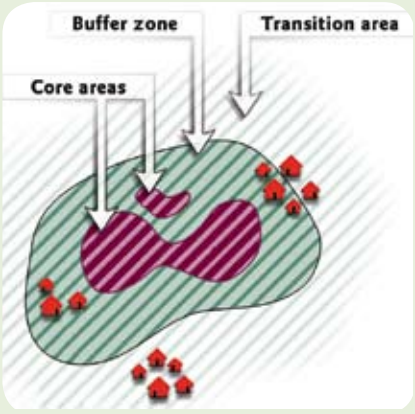
To reflect the fact that ecosystems don't recognize national borders, a growing number of biosphere reserves are transboundary. Africa counts three: the 'W' region straddling Benin, Burkina Faso and Niger, the Senegal Delta Transboundary Biosphere Reserve straddling Mauritania and Senegal, and (since 2006) the Intercontinental Biosphere Reserve of the Mediterranean shared by Morocco and Spain.

The 'W' Region Biosphere Reserve covers Soudano-Guinean, Sudanese and Sahel biogeographic regions representing a wealth of biodiversity. The creation of the 'W' transboundary biosphere reserve marked the first concrete action by the Environment Initiative launched by NEPAD at the World Summit on Sustainable Development in Johannesburg (2002).

There are MAB National Committees in 32 African countries. Read about AfriMAB in Box 6.*

For details: www.unesco.org/mab

* Angola, Burundi, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of Congo, Ethiopia, Gabon, Gambia, Guinea-Bissau, Ghana, Guinea, Kenya, Madagascar, Mauritius, Mali, Malawi, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Togo, Uganda, Tanzania (United Rep.), Zambia, Zimbabwe



The biosphere reserve concept adopts a zoning approach: strictly protected core areas are surrounded by buffer zones where people also live and work; and the whole is encircled by a transition area promoting sustainable development. Combining these zones makes it possible to experiment with simultaneously promoting conservation of wildlife and sustainable use of biodiversity through eco-tourism, eco-industries or organic agriculture. Similarly, one can experiment with integrating both scientific and traditional knowledge into management regimes, to foster sustainable development that is adapted to the local context.

UNESCO also identifies gaps in knowledge and needs for future assessment. It carries out policy research on issues such as the scientific, technical and legal aspects of bioprospecting of genetic resources.

UNESCO and its partners have developed research and monitoring programmes in eco-hydrology. Many of these programmes are implemented in biosphere reserves in Africa (see Boxes 1–6).

UNESCO can help the African Union mobilize and train conservation scientists, as for example through the post-graduate school in Kinshasa for tropical forest management (see Box 2). It can help strengthen African gene banks (see Box 7) and add economic value to Africa's biodiversity (see Boxes 3 and 4).

In relation to agriculture, UNESCO collaborates with the International Plant Genetic Resources Institute to promote the use of local crop varieties to improve the ecological and social resilience of agricultural systems. UNESCO also co-sponsors the International Assessment on Agricultural Science and Technology for Development under way in 2006.

Capacity-building and education in biodiversity is an integral part of UNESCO's Man and the Biosphere (MAB) Programme. Since 1989, UNESCO has annually recompensed 10 young researchers from around the world through the MAB Young Scientists Award scheme. Each receives US$5,000 to conduct interdisciplinary research on ecosystems, natural resources, biodiversity and sustainability.

African scientists have taken home 75 out of the 208 MAB awards to date. Tagir Tagelsir Hassan from the Upper Nile University in Sudan, for example, used his award in 2001 to study the combined effects of violence and unsustainable practices on wildlife in Radom Biosphere Reserve in Darfur.

BOX 2 - Educating Africa's forest managers

© UNESCO

Graduates from the School receiving their diplomas in 2005

The Democratic Republic of Congo is home to 47% of all African tropical forest and the world's second-largest block of remaining tropical forest after the Amazon.

The Regional Post-graduate Training School on Integrated Management of Tropical Forests and Lands (ERAIFT), now part of the University of Kinshasa, was set up by UNESCO-MAB in 1999. The School educates graduates from African countries to Masters and PhD level in the sustainable management of tropical forests using an interdisciplinary approach.

Since 1999, the School has trained 61 African specialists and managers from 10 countries. The fourth intake of students will take up their places in early 2007. They hail from 11** countries and include specialists in the computer sciences.*

The School seeks to help alleviate poverty by improving forest management. Through field work (often in the nearby Luki Biosphere Reserve), students sit down with local communities to define their needs. Projects are then implemented to improve agriculture and soil quality, develop forest products through tree nurseries and other means, or secure energy sources, including renewables such as solar and biofuels.

In 2006–2007, new buildings are being constructed and the equipment in the School's remote sensing and digital mapping laboratory is being modernized (see also Box 21). The laboratory is also linking up to the Satellital Observatory of Central African Forests, the Digitak campus and the Back Bone project of Kinshasa University.

Financial partners include Belgium, the European Union and the Government of the Democratic Republic of Congo.

For details: www.unesco.org/mab; m.mankoto@unesco.org

* Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of Congo, Guinea, Madagascar, Niger and Togo

** Angola, Benin, Burundi, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Guinea, Mauritania, Niger, Togo

BOX 3 - Saving the great apes from extinction

Time is running out for the great apes. Their survival will depend on whether we manage to curb the habitat fragmentation, poaching and disease which threaten the remaining gorillas, chimpanzees, bonobos and orang-utans.

Protecting the great apes will have the spin-off of preserving both their rich habitat and other animal species like elephants. It will also protect many of Africa's indigenous plant species, including the medicinal ones which play such a key role in the health of local populations.

© Mark Attwater

A bonobo baby. Humankind's closest relative, the bonobo is found only in the Democratic Republic of Congo.

UNESCO and UNEP launched the Great Apes Survival Project (GRASP) in 2001. GRASP groups the 21 great ape 'range states' in Africa and two in Asia. GRASP also involves donor nations, more than 30 NGOs and a number of private enterprises.*

UNESCO's role involves making environmental assessments of great ape habitat and building capacity in Africa to do the same (see Box 21). In 2006–2007, UNESCO-MAB is identifying 100 priority ape populations for protection and is organizing events to build awareness among local communities of the advantages of preserving great ape populations.

The Programme is also providing research grants to young scientists from 15 of the least developed range states to enable them to study great apes.

Within GRASP, the Democratic Republic of Congo hosted the first major intergovernmental meeting on great apes in September 2005. In the Kinshasa Declaration, ministers and other government representatives from all range states set themselves the target of 'securing a constant and significant reduction in the current rate of loss of great ape populations and their habitats by the year 2010 and securing the future of all the species and sub-species of great apes in the wild by 2015'.

For details: www.unesco.org/mab/grasp; s.mankoto@unesco.org

* Angola, Burundi, Cameroon, Central African Republic, Democratic Republic of the Congo, Côte d'Ivoire, Equatorial Guinea, Gabon, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Nigeria, Republic of Congo, Rwanda, Senegal, Sierra Leone, Sudan, Tanzania (United Rep.), Uganda

BOX 4 - Fostering sustainable use of biodiversity in drylands

Since 2004, MAB has been implementing a project funded by the Global Environmental Facility to Build Scientific and Technical Capacity for Effective Management and Sustainable Use of Biodiversity in Dryland Biosphere Reserves in West Africa. The six biosphere reserves are located in Benin (Pendjari), Burkina Faso (Mare aux Hippoptames), Côte d'Ivoire (Comoé), Mali (Boucle du Baoulé), Niger ('W') and Senegal (Niokolo Koba).

All six reserves belong to the West Sudano-Sahelian savannah biome, an area sharing common features in terms of climate, vegetation and bird and mammal species. They also share a relatively high human population density of 50–100 persons/km^2. Taken together, these reserves account for much of the 28.7 million ha of protected area in West Africa.

Problems in the biosphere reserves include water stress from the growing cultivation of cotton, a thirsty crop (Boucle du Baoulé and Comoé). Cattle and wildlife also compete for watering holes, another source of water stress (Boucle du Baoulé, Niokolo Koba and Pendjari).

In the core area, the project monitors ecosystem dynamics. The main human activities studied are fishing, hunting and gathering, agriculture and cattle-rearing. Sustainable development scenarios are being explored with site managers and local communities, who have identified alternative economic activities, such as bee-keeping and ecotourism, for which they have received support. Emphasis is placed on dialogue between stakeholders to prevent conflicts and elaborate agreed management rules.

For details: m.bouamrane@unesco.org

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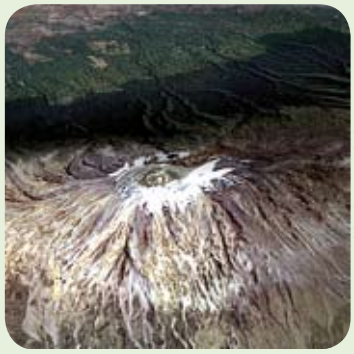
Project meeting with village women in Pendjari Biosphere Reserve.

BOX 5 - Monitoring change in mountains



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Satellite images of glacier retreat on Mount Kilimanjaro between 1993 (left) and 2000. Mount Kilimanjaro is a World Heritage site.

Since 2004, UNESCO-MAB and the Swiss-based Mountain Research Initiative have developed a global network of sites in selected mountain biosphere reserves to observe and study over time the signs of global change in nature and their socio-economic impact on the communities inhabiting these regions.

Of the 28 mountain biosphere reserves selected for the Global Change in Mountains (GLOCHAMORE) project funded by the European Union, four are in Africa: Tassili N'Ajjer (Algeria), Mount Kenya (Kenya), Oassis du Sud (Morocco) and Kruger to Canyons (South Africa).

In a 2004 survey, biosphere reserve managers reported on their experiences. In Mount Kenya Biosphere Reserve for example, flash floods and other hydrological hazards are silting waterworks and canals used for irrigation. In Kruger to Canyons Biosphere Reserve, local communities are suffering from water shortages.

Tell-tale signs of climate change identified by the managers include the melting of glaciers (see photo), changes in the distribution and numbers of plant and animal species, a longer growing period for vegetation – which has also moved up the mountain – and a drying out of the forest area due to the drop in precipitation which is in turn exacerbating the fire hazard.

Biosphere reserve managers will be crucial to the long-term viability of mountain monitoring, as they will act as the custodians of the information and data collected by national and visiting scientists.

For details (in Paris): t.schaaf@unesco.org; www.unesco.org/mab/mountains

BOX 6 - AfriMAB

Created in 1996 by national UNESCO-MAB committees from Africa, the AfriMAB network promotes regional cooperation in biodiversity conservation and sustainable development, particularly through four biogeographical sub-networks for arid and semi-arid zones, mountain regions, forest and savannah regions, and coastal and island zones. Each sub-network focuses on institutional, legal and regulatory frameworks; participation of stakeholders and social partners and benefit-sharing; scientific research and capacity building; and transboundary biosphere reserves.

A sub-regional REDBIOS network develops cooperation between biosphere reserves in the East Atlantic Region covering Cape Verde, Morocco, Senegal and the Canary Islands.

For details (in French): www.dakar.unesco.org/natsciences_fr/afrimabpres.shtml

Safe development and application of biotechnology

The objective is to create a critical mass of African scientists and technicians..., increase access to... affordable state-of-the-art class research facilities [and] increase mobility of scientists across the continent, to direct existing scientific expertise to addressing specific common research and innovation challenges [and to] stimulate the emergence and growth of African biotechnology innovation hubs.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

We use the term 'modern biotechnology' to describe techniques which are not used in traditional breeding or selection, such as the manipulation of genetic material and the fusion of cells.

The more sophisticated forms of modern biotechnology, including genomics and proteomics, present unprecedented opportunities for Africa to address some of its problems and stimulate economic growth, such as by producing high-yielding disease-resistant crops, or developing new vaccines and drugs for killer diseases. To seize these opportunities, Africa will need to build its capacity to develop and apply safely modern biotechnology in agriculture, health, mining and industry.

In the life sciences, UNESCO has considerable experience in setting-up and coordinating international collaborative networks like the global network of Microbial Resource Centres (MIRCEN), see Box 7 and Annex I.

Both the MIRCEN and UNESCO's Biotechnology Action Council (BAC) support and organize advanced courses and workshops, and scientific meetings. They also promote education and training in biotechnology via UNESCO Chairs. To date, UNESCO has catalysed the creation of three Chairs in biotechnology in Africa, in Burkina Faso, Kenya and South Africa (see Annex II). These Chairs make it easier for scientists to access and share affordable state-of-the art facilities in Africa for research in genomics, bioinformatics, gene technology and immunology.

Through its International Basic Sciences Programme, UNESCO can contribute to creating a critical mass of African scientists and technicians with the skills to engage in frontier life sciences in NEPAD's regional centres of excellence in biosciences (see also page 20). Within the cluster of UN agencies active in the field of biotechnology (UNIDO, FAO, WHO, IAEA, UNCTAD, etc.), UNESCO can coordinate the United Nations' contribution to the African Union's Biosciences Initiative within NEPAD.

UNESCO also has considerable experience in setting up centres of excellence, starting with the European Organization for Nuclear Research (CERN) in the 1950s. A more recent example is the Regional Centre for Biotechnology Training and Education set up in India in 2006. In parallel, UNESCO is working with designated regional centres which serve as Biotechnology Education and Training Centres (BETCEN) within the BAC programme. The African BETCEN is located in South Africa.

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Sorghum farmer in Burkina Faso. Improvements in crops adapted to drylands like millet and sorghum began to produce results in sub-Saharan Africa in the 1990s.

Also of note is the African Network of Scientific and Technological Institutions (ANSTI), hosted by UNESCO's Regional Bureau for Science in Nairobi. ANSTI provides African academics with grants allowing them to move between universities on the continent. It also funds a journal promoting the dissemination of African results in research (see Box 27).

BOX 7 - The Microbial Resources Network

The global network of Microbial Resource Centres (MIRCEN) involves over 30 existing academic research centres in developed and developing countries.

It promotes international cooperation in managing microbial and rhizobial gene pools, in building capacity through training activities and in the development of new, inexpensive technologies native to specific regions.

There are four MIRCEN in Africa, at universities in Egypt, Kenya, Senegal and South Africa (see Annex I).

For details: www.unesco.org/science/bes; l.hoareau@unesco.org

Securing and using Africa's indigenous knowledge

Despite their contributions [to biodiversity conservation and bioprospecting, increasing food production, fighting HIV/AIDS and other diseases, and stemming environmental degradation], indigenous knowledge and technologies are not adequately promoted and protected in most African countries.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

Local or indigenous knowledge can be defined as the cumulative and dynamic body of knowledge, values, practices and representations relating to the natural world possessed by peoples with close ties to their natural milieu. These sets of knowledge are widely recognized as essential building blocks for sustainable development and the conservation of biological and cultural diversity. They are also fundamental to sustaining rural livelihoods, identity and well-being.

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UNESCO's Nairobi office is working with Maasai communities in Kenya (here) and Tanzania to help them document their relation to plants and animals. The project is focusing on places where plant materials and different soil types are harvested for special ceremonies, food and medicines, shelter and fuel, and on sacred sites; it is also studying the interaction between language and biodiversity.

Since its inception in 2002, UNESCO's interdisciplinary Local and Indigenous Knowledge Systems (LINKS) programme has helped strengthen capacities to record local and indigenous knowledge in several countries around the world, in particular in small island developing states in the Pacific Ocean. LINKS has helped communities to elaborate pedagogical materials for intercultural education and develop advocacy tools to make local voices heard in governance of biodiversity.

UNESCO can add value to NEPAD plans to establish an African Indigenous Knowledge and Technologies Bank by using information and communication technologies (ICTs) to record, manage and transmit indigenous knowledge and know-how.

LINKS is seeking partners to develop a *Manual of Guiding Concepts and Practical Methods* for the documentation, safeguarding and wider application of indigenous knowledge in biodiversity conservation and sustainable development. An opportunity exists for example to develop an interactive DVD-ROM with the indigenous Himba, pastoralists of north-western Namibia, in collaboration with the University of Cologne (Germany) and Doxa Productions. This DVD-ROM would highlight Himba knowledge of their natural habitat and its changes by exploring the multiple aspects of cattle-rearing.

LINKS could also assist the African Union in integrating indigenous knowledge and practices in education curricula, particularly by redesigning science curricula to incorporate key elements of indigenous knowledge.

Building a sustainable energy base

The overall objective is to improve living conditions and ensure rural development through access to environmentally sound energy sources and to increase or enlarge the range of energy sources and technologies for household and commercial uses.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

Africa is the priority region of UNESCO's Renewable Energy Programme, which has three components: technical assistance and policy advice; training (see Box 8); and the creation of 'solar villages' in tandem with governments (see Box 9).

Why the focus on solar energy? For one thing, solar energy is abundant in Africa, unlike firewood. Firewood remains the main source of energy (80%) in sub-Saharan Africa, despite the fact that forest cover is diminishing at an alarming rate.

Almost 92% of the rural population and 48% of the urban population lacks access to any modern energy services in sub-Saharan Africa. Even in North Africa, 20% of rural dwellers remain deprived of energy. Connecting rural or remote communities to the national grid is prohibitively expensive, even in the long term, and would not be economically viable for governments of poor countries, since rural energy consumption would be low. By offering an alternative to the national grid, solar energy thus offers hope not only for the sustainable development of Africa but also for the development of rural and remote areas.

Solar energy can provide the basic electricity needs of 6 KW per village, in the form of lighting, pumped water and the electrification of health centres, schools and other public facilities. Television and radio provide a window on the world. Solar-powered refrigerators enable communities to preserve medicines and food. Solar cookers avoid the need to burn wood.

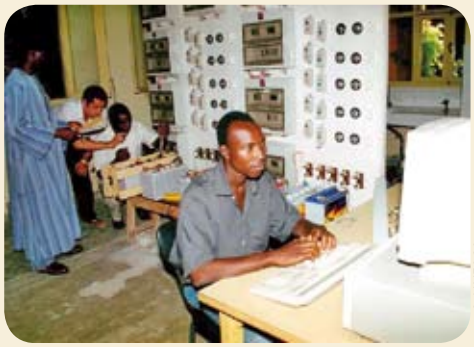
It is true that the initial investment remains high for the installation of solar systems but ongoing research and development (R&D) are bringing the costs down.

© UNESCO

Village square in Burkina Faso equipped with a solar street lamp.

Widespread use of solar energy would cut costs further. The running costs of a solar system with a lifetime of approximately 20 years are low. To operate an average light bulb requires an investment of about US$ 800 for the solar cells, storage batteries and regulators, etc. Once the system has been installed, lighting costs about US2 cents per hour.

BOX 8 - The Solar Summer School



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Sizing of a solar system and simulation of an electric breakdown during practical training organized within the solar summer school in 2001.

One component of UNESCO's training programme is an annual summer school on Solar Energy for Rural Electrification which was launched in 1989.

The three-week course is usually run from UNESCO's Headquarters in Paris (France) and includes one week of practical field work. For the field component, participants have so far visited industrial installations in Belgium, France, Germany, Italy, Morocco and Spain.

The summer course in July 2006 was attended by 34 engineers, technicians and teachers from Algeria, Burkina Faso, Cameroon, Chad, France, Guinea, Guinea Bissau, Mali, Mauritania, Niger, Senegal, Togo and Turkey.

For details (in Paris): o.benchickh@unesco.org

BOX 9 - Power to the people

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Irrigating fields in Mali using a solar-powered pump.

UNESCO supports pilot projects stimulating the use of solar energy to improve living conditions in rural areas. These 'solar villages' also serve to demonstrate the advantages of solar electricity to governments.

In 2005, the programme helped the Governments of Burkina Faso and Mali to install solar electricity in public facilities in remote villages. These included rural health care centres and maternity hospitals. Particularly needed in the maternity hospitals was solar water heating to improve hygiene and thereby protect mothers and their newborn babies from life-threatening infections.

Solar-powered irrigation of fields by pumping groundwater was also installed in these countries. Better irrigation could substantially reduce Africa's current dependence on imported staple foods. In turn, this would help to save foreign currency, reduce government deficits and create employment.

For details (in Paris):
o.benchickh@unesco.org

© UNESCO

Maternity hospital in Burkina Faso equipped with a solar water heater and solar lighting.

© ADEME

Village women filling buckets with water from a solar-powered pumping station. This pump saves women and girls from having to walk several kilometres each day to fetch water.

One aspect often overlooked are the opportunities for income generation and employment creation that the development of solar energy brings. This could transform rural areas into net exporters (to urban areas) of raw materials and some manufactured/processed products, instead of being the net importers they are now. This could lead to capital investment for new activities. Many of the more advanced solar technologies could be manufactured locally. African countries could become leading manufacturers of solar technologies, for example. This would not only improve exports of value-added products but also reduce oil imports.

To ensure that renewable energies take root and prosper in Africa, it is essential for countries to be able to use, adapt and maintain the technology. Technicians, teachers and engineers in African countries also need to break their isolation by exchanging knowledge and experience with their counterparts abroad. These are the twin objectives of UNESCO's Global Renewable Energy Education and Training Programme. In the 24 months to December 2005, UNESCO trained some 460 technicians, teachers and engineers from 23 countries* in renewable energy.

UNESCO has also developed a conceptual Training Solar Platform. Two prototypes have been put in service in Burkina Faso and Zimbabwe where they are used in week-long seminars and training programmes on decentralised rural electrification run at the national or sub-regional levels. The Platforms cover solar photovoltaics, mini-hydropower and mini-grids of electricity powered by renewable energy. UNESCO also designs, produces and disseminates updated learning cum teaching materials and tools on renewable energy and training curricula.

UNESCO provides technical assistance to countries in energy policy-making and planning in the form of advisory services and institutional capacity-building. Legislation is needed, for example, to eliminate the barriers to greater use of renewable energy and to set up the necessary infrastructure for developing and disseminating relevant technologies. UNESCO also helps African countries to define and implement priority national projects.

UNESCO works with sub-regional entities to help them improve energy management and planning. In June 2005, for example, the Community of Sahelo-Saharan States Organization adopted an integrated renewable energy programme presented by UNESCO to its Conference of Leaders and Heads of State in Ouagadougou (Burkina Faso).

At the continental level, UNESCO supports the programme of the African Energy Commission (AFREC) launched by NEPAD in 2001. UNESCO can contribute to this programme via the provision of training for trainers, in-service personnel, field operatives and project managers; by organizing regional consultations to identify renewable energy needs and define national and regional plans of action; and via institutional capacity-building, training seminars and advisory services to improve policy-making and planning.

UNESCO proposes launching an African Open Door Institute for Renewable Energy. This virtual institute would be linked to regional networks and specialized centres.

* Algeria, Burkina Faso, Cameroon, Chad, Congo, Cuba, Djibouti, Dominican Republic, Ecuador, France, Ghana, Guinea Bissau, Haiti, Indonesia, Maldives, Malaysia, Mauritania, Morocco, Niger, Nigeria, Senegal, Turkey and Togo

Securing and sustaining water

The goals are ... to improve the conservation and utilization of the continent's water resources [and] the quality and quantity of water available to rural and urban households; strengthen national and regional capacities for water resource management and reduce the impact of water-related disasters; enlarge the range of technologies for water supply and improve access to affordable quality water.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

One of the Millennium Development Goals to 2015 is to halve the proportion of people deprived of safe water (1.1 billion), most of whom live in Africa.

UNESCO is helping to achieve this goal by supporting research into issues linked to freshwater, including water-resource management, the integrated management of river basins (see Box 10), water hazards, desertification, sedimentation, flooding and water pollution.

Groundwater will be increasingly important in Africa in the future. The continent is expected to lose half of its reservoir capacity to sedimentation in the next 20 years, with silting of rivers being exacerbated by erosion resulting from deforestation and poor land management.

In Africa, UNESCO's International Hydrological Programme (IHP) has focused in 2002–2007 on improving knowledge and management of aquifers. These 'goldmines' under our feet can run for thousands of kilometres (see Box 12). Underrated and poorly understood, aquifers are nevertheless a treasure, providing low-cost, drought-reliable and high-quality water supplies for urban areas, rural populations and crop irrigation.

If groundwater is of strategic importance for urban areas (see Box 11), it is equally essential for rural populations (see Box 9). In sub-Saharan Africa, approximately 80% of the 300 million people who lack access to safe water supplies live in rural areas. This situation has enormous socio-economic implications, as it contributes to high rates of sickness and death from diseases like cholera that can cause prolonged absenteeism from work and school. The time spent caring for sick family members and fetching water also prevents women from undertaking more productive pursuits.

Local groundwater supplies tend to be adequate for watering community gardens and stock and for cottage industries like brick-making. Groundwater thus holds a vital key to poverty alleviation.

Women fetching water in rural Zimbabwe. Educational institutes in Zimbabwe are participating in WaterNet, a network launched by the UNESCO-IHE in 2005 **(see Box 13)**

BOX 10 - HELP!

Since its inception in 1999, UNESCO's Hydrology for the Environment, Life and Policy (HELP) initiative has established a global network of catchments to improve the links between hydrology and the needs of society.

HELP provides a framework for bringing together scientists, managers, law and policy experts, and users to address locally defined 'water related issues' within catchments. In Africa, 11 catchment basins belong to the HELP network.*
*In all, 42 African countries have established UNESCO-IHP Committees**.*

For details: www.unesco.org/water

* Bouregreg, Draa (Morocco), White Volta (Ghana), Upper Oueme (Benin), Atbara (Ethiopia-Eritrea-Sudan), Ewaso Ng'Iro, LakeNaivasha (Kenya), Nakambe (Burkina Faso), Gash (Sudan-Ethiopia-Eritrea), Blue Nile (Sudan-Ethiopia), Mandaratsy (Madagascar), Olifants, Thukela (South Africa), Greater Ruaha (Tanzania, United Rep.).
** Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comores, Congo, Cote d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, Tanzania (United Rep.), Togo, Uganda, Zambia, Zimbabwe.

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Woman in Wadi Allaqi Biosphere Reserve in Egypt. The UNESCO-IHP runs a global project known as G-WADI, which stands for Water and Development Information for Arid lands (www.gwadi.org). Run from UNESCO's Cairo and Tehran offices, the project strengthens capacity to manage water resources in arid and semi-arid areas, including in North Africa. The project is due to continue beyond 2008.

In parallel, groundwater sustains ecosystems and landscapes in humid regions and supports unique aquatic ecosystems in more arid regions and along coastal belts. There are clear signs however that the destruction of wetland and terrestrial ecosystems, as well as the migration of poor quality water, are making an irreversible impact on the environment by drying-up entire landscapes.

The UNESCO-IHP has a network of regional and international centres operating under the aegis of UNESCO. In Africa, there is a Regional Centre for Training and Water Studies of Arid and Semi-Arid Zones, which was set up in Cairo (Egypt) in 2001.
A Regional Centre for the Management of Shared Groundwater Resources is also foreseen for Tripoli (Libya) under the auspices of UNESCO. A third regional centre is planned for sub-Saharan Africa specifically on drought management (see Box 18). The UNESCO-IHE Institute for Water Education in Delft (Netherlands) itself has programmes in Africa (see Box 13).

A fourth component of UNESCO's water programme is the World Water Assessment Programme involving 24 United Nations agencies. Hosted by UNESCO, the Programme has so far produced two triennial *World Water Development Reports* on the state of the world's water resources. In 2003, one of the *Report's* seven case studies focused on the Senegal River Basin shared by Guinea, Mali, Mauritania and Senegal. In 2006, five out of 16 case studies focused on African countries: those on Ethiopia, Kenya, Mali, South Africa and Uganda. The Programme also helps individual countries to organize their water sectors.

In 2005, UNESCO and WMO launched the International Flood Initiative to improve the understanding and handling of floods around the world (see also Box 22.)

© UNESCO BPI/AUD

Water transport in the lacustrian town of Ganvié in Benin.

BOX 11 - An early warning system for Africa's polluted urban aquifers

Africa's urban population has nearly tripled since 1970, with 35 cities now accommodating more than a million inhabitants. The rural exodus has been accentuated by severe climatic conditions, desertification and poverty.

Urban aquifers will need to meet the growing demand for water but they will also have to cope with more diverse sources of urban pollution, including organic chemicals, pesticides, nitrates, heavy metals and waterborne pathogens.

'It is economically impractical and may sometimes even be technically impossible to clean up urban aquifers once they have become polluted over a large area' explains UNESCO programme specialist Emmanuel Naah. 'Consequently, in the long term, polluted urban groundwater will either be abandoned, leading to acute water shortages, or require complex and expensive treatment systems to avoid placing public health in jeopardy'.

A project initiated by UNEP and UNESCO-IHP in 2002 has assessed the impact of pollution on aquifers in nine major cities: Abidjan (Côte d'Ivoire), Dakar (Senegal), Ouagadougou (Burkina Faso), Bamako (Mali), Cotonou (Benin), Keta (Ghana), Mombasa (Kenya), Addis Ababa (Ethiopia), and Lusaka (Zambia).

The project has developed methodologies for assessing groundwater vulnerability, identifying pollution hot spots and major threats. It has also set up an early warning system network of African scientists and is building awareness of the dangers of such practices as indiscriminate waste disposal among decision-makers in the public and private sectors, including municipalities. 'The idea was to provide a robust system of monitoring,' recalls Naah, 'to give legislators and water managers early warning so that they can take timely action against pollution'.

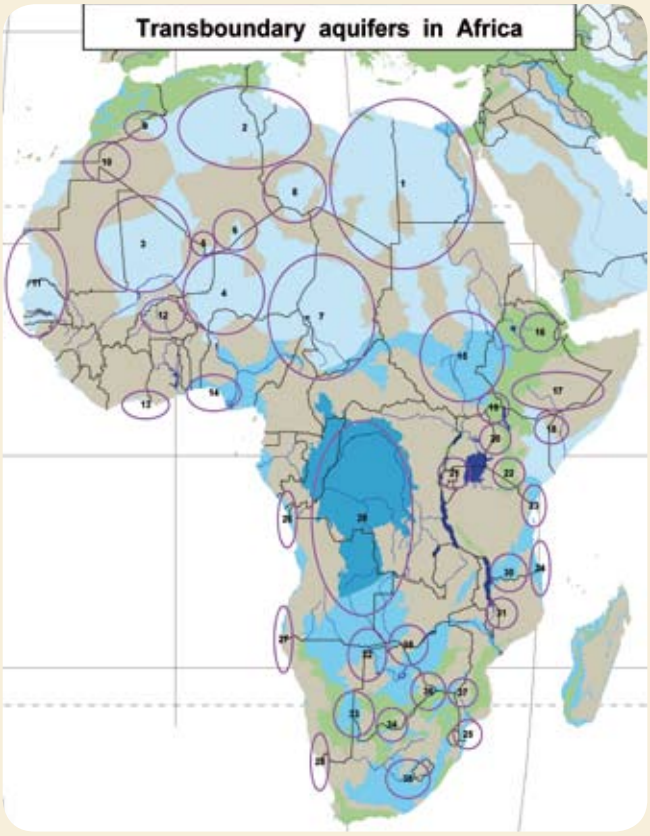
© UNESCO

Ferry service across the river in Cotonou..

An evaluation workshop in Cape Town (South Africa) in November 2005 decided to develop the project further.

For details (in Nairobi): e.naah@unesco.org

BOX 12 - Africa's buried treasure



In 2002, hydrogeologists from more than 25 countries conducted the first continental survey of transboundary aquifers in Africa, through a UNESCO project that is drawing up the first world map of transboundary aquifers between 2002 and 2007.

The African survey uncovered about 38 transboundary aquifers, five of which had never before been identified (see map). Hydrogeologists from Benin, for example, learned that the aquifer providing water for Cotonou extended across the border into Togo. Both countries have expressed interest in developing a framework to manage this aquifer jointly, which will become increasingly important as rainfall in the region declines with climate change.

The UNESCO project for Internationally Shared Aquifer Resources Management (ISARM) encourages governments to manage shared resources jointly with their neighbours and to establish legal agreements.

The United Nations' International Law Commission is currently working on codification of the law governing transboundary aquifers, with the scientific and technical support of the UNESCO-IHP. Two international agreements have been reached in recent years in the Sahelian region. In 2000, Chad, Egypt, Libya and Sudan adopted a Programme for the Development of a Regional Strategy for the Utilisation of the Nubian Sandstone Aquifer System (1 on the map).

A second agreement binding Algeria, Libya and Tunisia established a Consultative Mechanism for the Northwestern Sahara Aquifer System (2 on the map) in 2002. The two reservoirs combined contain approximately 373 000 km³ of 'fossil water' that is the legacy of a bygone era when the Sahara was a lush savannah about 10 000 years ago. Controversy surrounds the mining of fossil water.

Details of these and other agreements may be found in Groundwater in International Law *published jointly by UNESCO and FAO in 2006.*

For details (in Paris): a.aureli@unesco.org

BOX 13 - A tale of two networks: the Nile Basin and WaterNet

After jointly developing and running a regional training course for river engineering professionals for the ten Nile Basin countries for many years, the UNESCO-IHE Institute for Water Education in Delft (Netherlands) and Hydraulic Research Institute in Cairo (Egypt) have developed a regional network of water sector professionals.

In addition to information-sharing, the Nile Basin Capacity-Building Network stimulates collaborative applied research on six main issues of relevance to the region. Sudan is hosting a research cluster that investigates river morphology phenomenon, sedimentation problems in reservoirs and soil erosion problems. Within this cluster, Sudanese engineers cooperate with their Ethiopian and Egyptian counterparts. Tanzania is collaborating with five other Nile basin countries on the potential of both large and small-scale hydropower. Egypt has taken the lead in stimulating research on the application of geographic information systems to the modelling of river channels. For their part, Ethiopia, Uganda and Kenya are hosting regional research clusters on river structures and micro-dams, environmental issues and flood management respectively. In this way, each country is developing its own centre of excellence.

In June 2004, the first results of the Nile network were presented to interested water managers and politicians from the region.

The UNESCO-IHE initiated a second network in Africa in 2005. Known as WaterNet, this independent network counts 44 members representing 30 educational institutes in Botswana, Kenya, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe.

In 2006, the UNESCO-IHE was involved in nearly two dozen additional capacity-building cum research projects involving scientists in Mozambique, Rwanda, Tanzania, Zimbabwe, Ethiopia, Eritrea and Sudan. It was also involved in the TIGER Initiative (see Box 22).

For details:
nbcbn.com (Nile Basin network);
www.unesco-ihe.org

Bugala Falls on the Nile in Uganda.

Combating drought and desertification

Two-thirds of the continent is desert or drylands and almost three-quarters of agricultural land is degraded.... The overall objective is to improve scientific understanding of, and sharing of information on, the causes and extent of drought and desertification in Africa; mobilize, build and promote sharing of scientific expertise and technical skill ...; and grow regional and continental centres of excellence in drought and desertification research.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

Drought is a chronic problem in Africa. Approximately 75% of Africans live in arid or semi-arid regions, compared to 52% of the global population, according to the *World Water Development Report* (2006). 'In addition, 20% of Africans live in areas that experience high interannual climatic variability. ...This explains why Africa suffers from water scarcity and water stress'.

© NASA/Goddard Space Flight Center Scientific Visualization Studio

NASA MODIS image of drylands in Africa in 2001.

Climate aside, human activity is another key factor behind desertification. Most seriously affected are the dryland areas south of the Sahara, where experts expect the situation to worsen in coming decades. Population pressures on marginal lands will increase their already high vulnerability to drought. Demand for water by a growing population and expanding economy will only intensify. Moreover, the balance of opinion is that Africa will experience decreasing water reliability in coming decades with climate change.

Severe droughts in the 1980s and 1990s reduced food production and disrupted national economies to such an extent that 20 countries were forced to appeal for international support. The 1991–1992 drought in Southern Africa affected 20 million people at a cost of US$ 2 billion in emergency relief. More recently, drought in the Horn of Africa has threatened about 23 million people.

Agriculture remains the most important sector in the African economy, with 70% of agricultural output coming from small farmers. Traditional farmers reliant on rain for their animals and crops in such

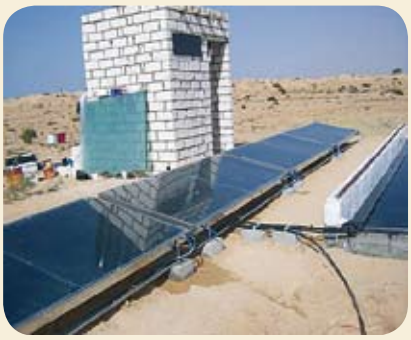
BOX 14 - Improving life on the land

The Sustainable Management of Marginal Drylands (SUMAMAD) project strives to improve the living standards of dryland dwellers by rehabilitating degraded lands and stimulating productivity through a combination of traditional knowledge and scientific expertise. The approach is site-specific. Depending on the needs, new management practices may concern soil seed banks, improving grazing ranges, artificial recharge of groundwater, fruit and fuelwood plantations, soil fertility management, wind erosion control and so on.

In parallel, the project helps dryland dwellers generate income by proposing alternative livelihoods, such as ecotourism, apiculture, the manufacture of cosmetics like soap and skin lotion (from goat's milk, olive oil, etc.), arboriculture and organic agriculture. Several income-generating activities target women specifically, like jewellery-making and handicraft-sewing.

SUMAMAD was launched in 2002 by UNESCO, the United Nations University and the International Center for Agriculture in Dry Areas. It involves a network of universities and research centres in land management in China, Egypt (see photos), Iran, Jordan, Syria, Tunisia, Pakistan and Uzbekistan. After the pilot phase winds up in 2008, it is planned to extend the project to institutions south of the Sahara.

For details: www.unesco.org/mab/ecosyst/drylands.shtml; t.schaaf@unesco.org



© UNESCO

Left: The new solar desalination system under construction in Omayed Biosphere Reserve on the Egyptian coast in 2005. Untreated water is first extracted from wells in the area. The solar panels in four distillation units then heat the saline water, which evaporates as water vapour, leaving the heavier salt behind. The project remedies a chronic shortage of freshwater, identified by the local Bedouin themselves as their top priority. The project was devised by Boshra Salem from the University of Alexandria and Andreas Schneider of Clear Water Solutions within SUMAMAD, which is also showing the Bedouin how to harvest rainwater using low-cost structures and developing income-generating activities like fig-drying and handicraft-sewing. **Right:** Bedouin children savouring their first drink of desalinated water.

a fragile environment are ecologically, geographically and economically marginalized. There is in fact a spiralling impact which favours desertification, with one disaster increasing the vulnerability of communities to the next.

UNESCO is helping to combat desertification by promoting more sustainable land management via its network of biosphere reserves (see Box 4) and via projects like that for the Sustainable Management of Marginal Drylands (see Box 14) or a study into the potential for camel farming (Box 15) . UNESCO helps to build countries' capacity to manage water effectively (see page 9) and is encouraging countries in Africa to make greater use of renewable sources of energy, particularly solar energy (see page 7) . A number of initiatives target children and the general public, including the desertification kit for schools (see Box 16).

UNESCO took the lead in organizing a major scientific conference in Tunis in June 2006 to identify research priorities for drylands (see Box 17). The Organization has also conducted a feasibility study for a centre on drought management for sub-Saharan Africa (see Box 18).

© NASA

Satellite image of sand dunes encroaching on Nouakchott, the capital of Mauritania.

BOX 15 - Studying the pros and cons of camel farming

Camels are often kept in excessive numbers in the open desert, putting a strain on desert vegetation. Camel farms may be the answer. By feeding camels farm-grown native desert plants and halophytes (salt-tolerant plants), camel farms would enable the ecosystems of grazing rangelands to recover.

Camel farms could also reduce the amount of freshwater needed for milk production and save on electricity. Camel's milk does not need to be produced in an air-conditioned environment and a camel produces four times more milk per day (8 litres) in the open desert than a cow. (Cows can produce 25 litres of milk per day but only in an air-conditioned environment.)

UNESCO's Doha office is developing a research project to study the pros and cons of establishing camel farms in the Arabian Peninsula and dryland countries of Africa. Scientists working on the project will study such aspects as the nutritional and medicinal (dis)advantages of camel's milk versus cow's and goat's milk and the quantity of water needed to produce one litre of camel's milk in comparison to one litre of goat's and cow's milk. The project will also study public attitudes to camel milk.

© UNESCO

Camels in Sudan.

Scientists will also study the genetic variety of camels in different parts of arid lands to ascertain whether (and which) camels can be fed with indigenous or halophytic plants and still produce milk that is of good quality and plentiful.

The results of the study will be shared both with the Arabian Peninsula and with dryland countries in North and sub-Saharan Africa like Mauritania and Sudan.

For details: b.boer@unesco.org

BOX 16 - A desertification kit for kids

In 2003, UNESCO's Man and the Biosphere (MAB) Programme prepared a desertification kit for schools in tandem with the UN Convention to Combat Desertification (UNCCD) and with funding from the governments of Italy, Switzerland and Monaco.

The kit targets teachers and their 10–12 year old pupils. It comprises a teacher's guide, a compilation of case studies, a classroom poster showing desertification in the world and a comic book.

© UNESCO

Part I of the teacher's guide explains the causes of desertification and consequences on climate and geography, biology and on the socio-economic sphere.

An extract from the comic book for the desertification kit, *The school where the magic tree grows*. The comic book sees young Chileans travelling to Europe and Africa to meet local populations also suffering the effects of desertification, with whom they exchange experiences.

Part II introduces the UNCCD and describes activities for combating desertification.

The kit includes case studies of solutions employed in Algeria, Chile, China, Ecuador, Gambia, India, Italy, Kenya, Niger, Peru, Spain and Uzbekistan.

Between 2003 and 2006, the kit was distributed to schools in drylands in Africa and around the world.*

For details (in Paris): t.schaaf@unesco.org; www.unesco.org/mab

* Algeria, Benin, Botswana, Burkina Faso, Cameroon, Central African Republic, Chad, Gambia, Kenya, Madagascar, Mali, Namibia, Niger, Nigeria, Senegal and South Africa

BOX 17 - Scientists pick research priorities for curbing desertification

Drylands have suffered from underinvestment for decades. As a result, the situation has deteriorated to the point where US$2.4 billion is now spent annually fighting land degradation in the world's drylands, a problem experts expect to worsen.

At a conference co-organized by UNESCO in Tunisia in June 2006, the Tunis Declaration *was adopted by 400 experts, scientists and decision-makers from dryland regions. It singles out the following areas for priority research: the interdependence and conservation of cultural and biological diversity; integrated management of water resources; the identification of sustainable livelihoods for the inhabitants of drylands; renewable energy suitable for dryland development; and coping with natural and man-made disasters, as well as the costs related to inaction in fighting land degradation.*

Read the Tunis Declaration*: www.unesco.org/mab/ecosyst/futureDrylands.shtml*

© UNESCO

Girl selling charcoal in Ouagadougou in 2005.

BOX 18 - Towards a sub-regional centre for managing drought

In response to requests from national governments in sub-Saharan Africa, the Intergovernmental Council of the UNESCO-IHP has agreed to facilitate the development of a Regional Integrated Drought Risk Management Centre.

The idea for the centre was first put forward in Pretoria (South Africa) in September 1999 by delegates to the International Conference on Integrated Drought Management – Lessons for sub-Saharan Africa. The centre would aim to make vulnerable communities in sub-Saharan Africa resilient to both normal and extreme climatic variation by 2015.

Co-host of the conference in Pretoria, the UNESCO-IHP undertook a feasibility study in 2003 which confirmed the need for such a centre with a focus on capacity-building. The study recommended testing the approach in the Southern African Development Community before expanding into other parts of Africa.

A service provider to governments, NGOs and the private sector, the centre would compile and disseminate fact sheets to governments, NGOs and the private sector via electronic networks and other means on regional drought baselines and the economic costs and benefits of drought preparedness. It would provide training materials and conduct training itself whenever appropriate. It would also develop media programmes to educate the general public about integrated drought risk management.

The centre would identify appropriate mechanisms into which integrated drought risk management could be mainstreamed in sub-Saharan Africa. It would also strengthen interdisciplinary mechanisms for dealing with drought.

The next step will be to identify a host country for the centre before the proposal is put to UNESCO's governing bodies in October 2007.

For details (in Nairobi): e.naah@unesco.org

© Paul Desanker

Girls collecting firewood for the evening meal in a village in Malawi's Salima District. Firewood is collected from deadwood in the forest.

Information and Communication Technologies and Space Science and Technologies

Information and Communication Technologies

The Harnessing and Developing Software for E-learning Project will focus on developing new generations of e-learning systems, training in the use of new e-learning systems and improving infrastructure for ICT software R&D.

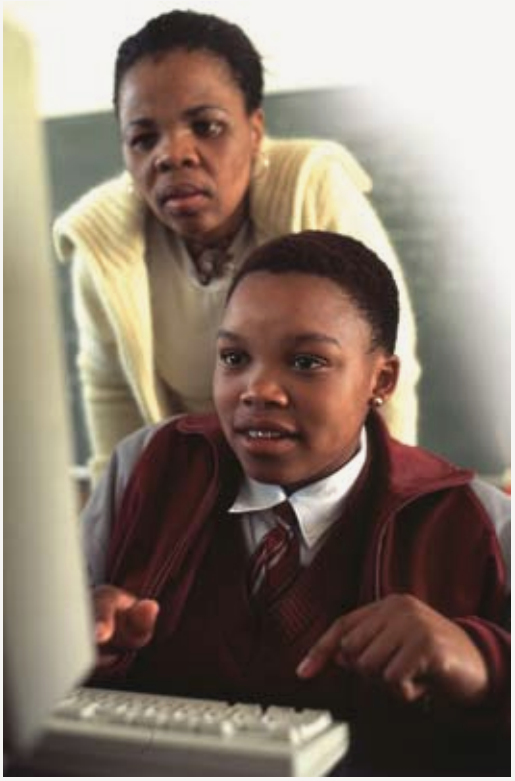
Africa's Science and Technology Consolidated Plan of Action, 2006–2010

Two major problems facing most African Faculties of Science and Engineering are the scarcity of books and the shortage of skilled human resources. UNESCO is promoting the use of ICTs in science and engineering courses to combat this problem. One product freely available to African universities is the online *Encyclopedia of Life Support Systems* (see Box 19).

A project run by UNESCO's Nairobi office is training university staff how to convert lecture notes into an interactive e-learning format. The project provides distance (virtual) training using CDs as well face-to-face training in workshops. The idea is to develop a large pool of trained e-content developers in the region by holding national and regional training workshops for e-content development. It will also help teaching staff in science and engineering courses to digitize their teaching notes into an e-learning format.

UNESCO has launched a Virtual Campus for the Mediterranean basin that could be extended across sub-Saharan Africa (see Box 20).

For its part, the UNESCO Bilko project is an example of how e-learning can be applied to a specific field, in this case remote sensing (see Box 23).



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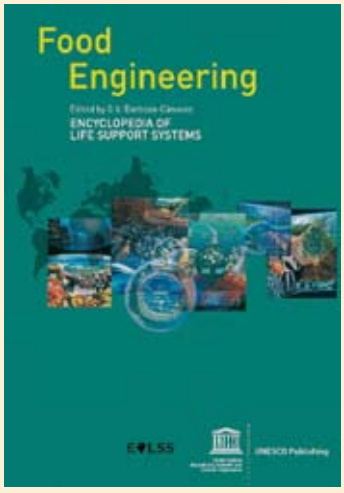
Computer lesson at Intlanganiso High School near Cape Town in South Africa in 2003.

BOX 19 - The Encyclopedia of Life Support Systems

This encyclopedia covers all the systems which support life on Earth, the way they are maintained and the threats that endanger them. It focuses on all aspects of sustainable development, from ecological issues to food engineering and human security.



A virtual dynamic library equivalent to 200 printed volumes, the encyclopedia contains contributions from thousands of scholars in over 100 countries.

The encyclopedia was launched by UNESCO in 2002 and has been sponsored by EOLSS Publishers in the UK. Internet-based, the encyclopedia is regularly updated.

For now, only exceptional articles from the encyclopedia have been published in print format, including one full theme on food engineering (left) in 2005. The latter is being expedited free of charge by UNESCO to universities in least developed countries which have registered for the online encyclopedia.

The encyclopedia is available free of charge to universities and other institutions of higher learning in least developed countries, subject to approval by the UNESCO-EOLSS Joint Committee. By 2006, dozens of universities in Africa had taken advantage of this possibility.*

To register for free access: www.eolss.net/eolss_subuldc.aspx

For details: unesco-eolss@unesco.org

*Institutions in Eritrea, Ethiopia, Lesotho, Mozambique, Namibia, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania (United Rep.), Zimbabwe

BOX 20 - An Avicenna campus for sub-Saharan Africa?

The Avicenna Virtual Campus was launched by UNESCO in November 2002 with funding from the European Commission through its Euro-Mediterranean Information Society (EUMEDIS) programme. In less than four years, the project has created a self-perpetuating campus based on cooperation among 15 universities around the Mediterranean basin. All now share teaching resources in science and engineering; these include free online courses and a Virtual Library.

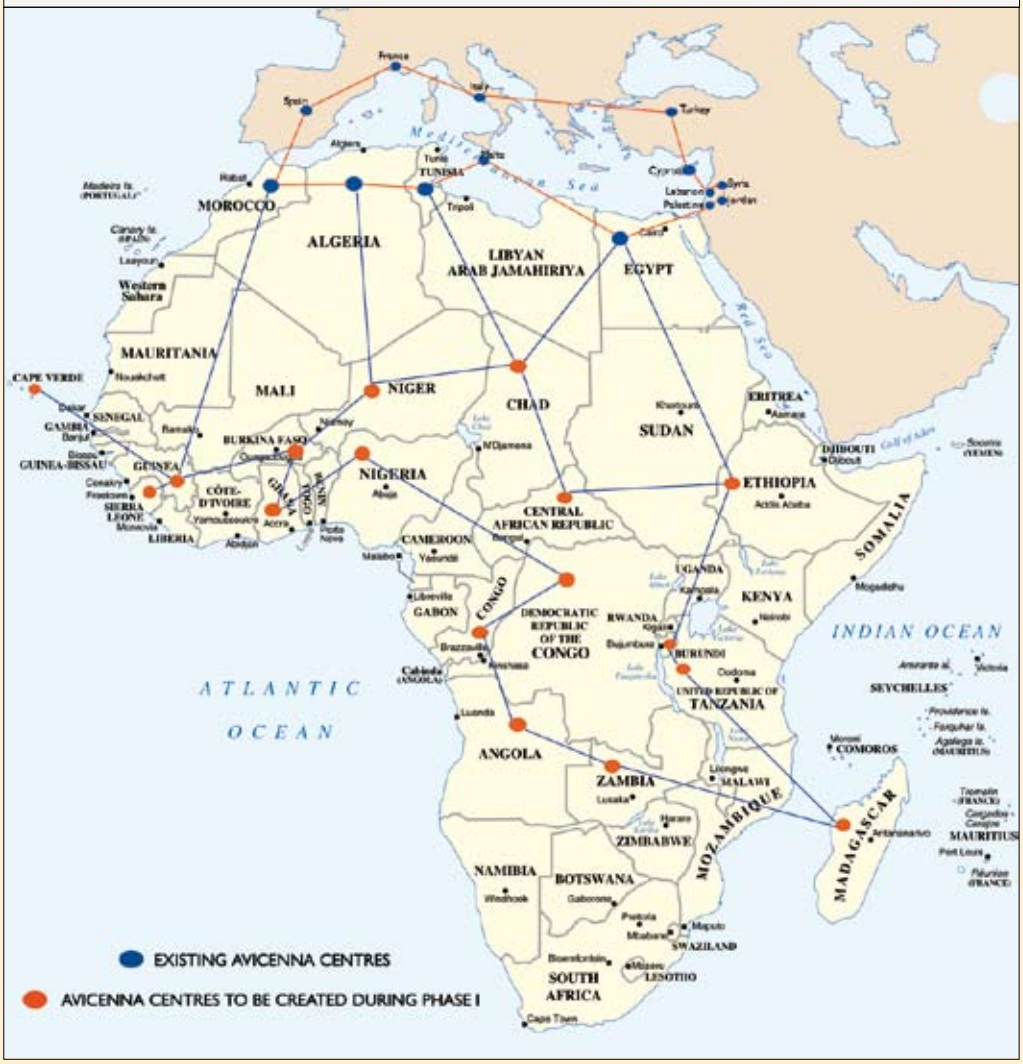
By 2006, Avicenna had trained 300 teachers in online course production (see photo) and a further 300 tutors in how to use the courses. More than 200 online modules had been produced. Some 135 000 students were using these learning modules, a figure expected to double in 2007–2008.

At the African Union's Summit in Khartoum (Sudan) in January 2006, UNESCO agreed to use the Avicenna model to train teachers in sub-Saharan countries within NEPAD. The first project will target the Democratic Republic of Congo, with funding from the African Development Bank. In parallel, the model is being used to teach 200 000 teachers in Algeria, where it is also planned to open 40 Avicenna centres.

© UNESCO

Teacher training in online course production in Tunisia in January 2006, within the Avicenna Virtual Campus project.

PROPOSED FIRST PHASE EXTENSION OF THE AVICENNA NETWORK ACROSS AFRICA



UNESCO proposes extending the Avicenna network across Africa within NEPAD. In a first phase, 17 Avicenna e-learning centres would be created, one at the leading university in each participating country (see map), for an estimated cost of 4.5 million euros over three years. These centres would share all the resources developed by the 15 existing Avicenna centres around the Mediterranean and acquire the know-how to contribute their own.

At present, the African Virtual University is the only existing network on the continent. Funded by the World Bank, the African Virtual University provides private e-learning centres. The spread of this fee-paying model is hampered however by the fact that most students are poor.

Some 1000 blind students participate in the Avicenna Virtual Campus via the Alexandria Library in Egypt. A feasibility study was being prepared in 2006 for a similar project with the Avicenna Centre at the Université virtuelle de Tunis.

For details (in Paris): m.miloudi @unesco.org; m.el-tayeb@unesco.org; http://avicenna.unesco.org

Establishing the African Institute of Space Science

Space science provides a unique vantage point from which to study the natural environment on the grandest possible scale and from which to deliver communications. By its very nature, space provides a platform for addressing problems from a regional perspective... This programme will focus on determining the feasibility of establishing the African Institute of Space Science.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

'Biodiversity loss, climate change and deforestation are all interwoven problems', recalls Walter Erdelen, UNESCO Assistant Director-General for Natural Sciences. 'Since land, water and atmosphere are interlocking components of a single Earth system, our global Earth observing initiatives likewise need to be interlocking.'

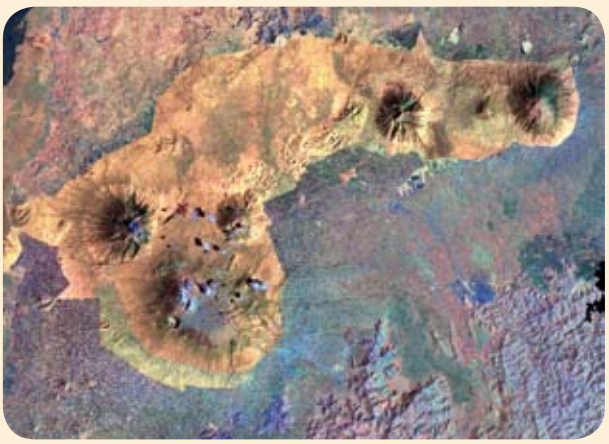
UNESCO is a partner in the Integrated Global Observing Strategy (IGOS) grouping space agencies and global observing systems like that for the oceans which uses both ocean satellite missions and *in situ* tools like the robotic Argo floats (the latter collect information on the temperature and salinity of the world's oceans). UNESCO's Intergovernmental Oceanographic Commission supports the development of the African component of the Global Ocean Observing System and the Ocean Data and Information Network for Africa (see Box 24).

IGOS contributes to the scientific and socio-economic strategy of the Global Earth Observation System of Systems, an intergovernmental project launched in 2003 to build a long-term, comprehensive system of Earth observation by 2015. The Group of Earth Observations (GEO) is open to all Member States of the United Nations. Current Members of GEO comprise 65* countries plus the European Commission and 43 Participating Organizations, including UNESCO.

* In 2006, the African Members of GEO were: Algeria, Cameroon, Central African Republic, Egypt, Guinea-Bissau, Mali, Mauritius, Morocco, Niger, Nigeria, Republic of the Congo, South Africa, Sudan, Tunisia and Uganda

BOX 21 - Mapping natural and cultural heritage from space

Through the Open Initiative launched by UNESCO and the European Space Agency (ESA) in 2001, it has been possible to map the mountain gorilla habitat not only in the Democratic Republic of Congo, Rwanda and Uganda but also in all the World Heritage sites and parks hosting the mountain gorilla.



© LANDSAT, NASA

Satellite image showing vegetation of the mountain gorilla habitat in the Democratic Republic of Congo, Rwanda and Uganda.

© M.Graye, IGCP

Mother and child mountain gorillas in Rwanda

The project uses optical and radar satellite imagery to monitor the mountain gorillas' habitat, in a joint effort with the Government of Belgium. It is also training local site managers, park rangers, conservation authorities and NGOs to use remote sensing and maps. Having a better understanding of the sites under their care will ultimately make them more effective in protecting the gorillas.

In another project, the University of Cape Town (South Africa) and UNESCO are using remote sensing to document digitally the cultural heritage of Africa in a database on African Cultural Landscapes and Heritage. *Partners Egypt and Morocco are similarly using remote sensing to conserve natural and cultural heritage in North Africa.*

For details:
www.unesco.org/science/
ma.hernandez@unesco.org

© J.Hart, CWS

Park rangers using GPS equipment to identify natural bridges then mark them on the new map derived from satellite imagery.

A number of UNESCO networks are using remote sensing to foster sustainable development in Africa. One applies remote sensing to the sustainable management of ecosystems and freshwater in Africa. Twelve countries** were participating in the network in 2006, which includes several regional associated institutions like the African Association of Remote Sensing for Environment.

© UNESCO

Secondary pupils and their teachers learning how to launch a 'rocket' in Abuja, Nigeria (May 2005). This demonstration was part of a workshop organized by UNESCO's Space Education Programme (SEP), which seeks to prepare the next generation of the space workforce. The workshops include talks by space experts, including an astronaut, on current events like the lunar and Mars exploration missions. SEP also donates portable telescopes to schools, provided by Meade Instruments Inc. In Nigeria, UNESCO is working closely with the National Space Research and Development Agency. Countries are invited to express interest in hosting similar workshops. For details, contact: y.berenguer@unesco.org

UNESCO is also using space technologies to map natural and cultural heritage from space (see Box 21) and to gather water-related geo-information within the TIGER Initiative (see Box 22).

** Benin, Botswana, Côte d'Ivoire, Equatorial Guinea, Guinea, Mozambique, Niger, Senegal, South Africa, Democratic Republic of Congo, Nigeria, Zimbabwe.

UNESCO also provides support for training in remote sensing image analysis (see boxes 2, 21 and 23) and pilots the Pan African Geological Information System (Box 25).

UNESCO has been running a Space Education Programme since 2001 to encourage the young to enter into careers in space science and technology (see photos).

BOX 22 - TIGER

The TIGER Initiative was launched by the European Space Agency in the wake of the World Summit on Sustainable Development in Johannesburg in 2002. TIGER helps African countries overcome problems they face in collecting, analysing and disseminating water related geo-information by exploiting the advantages of Earth observation technology. The Initiative involves more than 150 African organizations, water authorities, remote sensing centres and universities.

UNESCO participates in TIGER via the Geological Applications of Remote Sensing (GARS) Programme it co-cosponors with the IUGS (see page 22), the UNESCO-IHP (see page 9) and the UNESCO project on the Application of Remote Sensing in Africa. Two TIGER projects were being led by UNESCO in 2006.

The first concerns the River Gash, a source of frequent terror for the inhabitants on both sides of its banks. Gash is a transboundary catchment of 31000 km² shared by Sudan, Eritrea and Ethiopia, which experiences flooding about every one to five years.

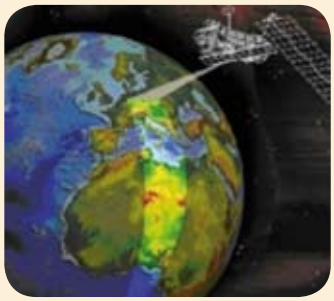
The course of the river has changed in recent years and sedimentation poses a problem. The river runs for 200 km and has a mean annual discharge of 680 million m³.

UNESCO Chairholder in Water Resources in Sudan (see Annex II), Dr Kamaluddin El Siddig Bashar, leads a project team which is putting in place a system for flood forecasting, early warning and preparedness in the Gash River basin using space technology.

A second TIGER project focuses on transboundary water allocation and conflict prevention in the Incomati River Basin. It estimates the rainfall-runoff relationship and monitors water use using Earth Observation analysis. This project involves the UNESCO-IHE Institute for Water Education in Delft (see Box 13).

For details: www.tiger.esa.int/; www.unesco.org/science/earth/; www.unesco.org/water

BOX 23 - Teaching remote sensing image analysis



The UNESCO Bilko Project began in 1987. This complete system for teaching remote sensing image analysis has been developed primarily for oceanography and coastal management but Bilko routines may be used to analyse any image in an appropriate format.

The project facilitates hands-on training for those traditionally excluded from it by the high cost of commercial image-processing software and computer equipment to run the software, as well as the difficulty of acquiring remotely sensed images for teaching purposes. Since its inception, the project has produced eight modules of computer-based lessons and distributed copies to over 500 marine science laboratories and educational establishments and more than 2000 individual users in over 70 countries around the world. Bilko is available to registered users for free.

Bilko is comprised of a PC-based powerful software, an introductory tutorial, thematic modules applied to specific problems and a network of users and lesson producers. Overall control of project development rests with the International Bilko Executive Steering Team made up of volunteers.

UNESCO maintains a basic level of financial support for Bilko through its Coastal and Small Islands Platform and, more recently, through the UNESCO-IOC. This covers the cost of publishing and distributing lessons and software, as well as the day-to-day running of the project.

Southampton Oceanography Centre in the UK is currently responsible for the Bilko website: www.noc.soton.ac.uk/bilko/; j.ahanhanzo@unesco.org

Improving Policy Conditions and Building Innovation Systems

African Science, Technology and Innovation Indicators Initiative

Science, technology and innovation (STI) indicators are crucial for monitoring Africa's scientific and technological development. They are useful in formulating, adjusting and implementing STI policies. Indicators can be used to monitor global technological trends, conduct foresight exercises, and determine specific areas of investment. An example is the target of a ratio of R&D spending to GDP of 1% for African countries.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

It was at the First African Ministerial Conference on Science and Technology in November 2003 that countries reaffirmed their commitment to increasing public spending on R&D to at least 1% of GDP within five years. In parallel, they undertook to develop a common set of S&T indicators for integration into the African Peer Review Mechanism. They also committed themselves at the time to establishing an African Observatory of Science and Technology Indicators which would produce the African Innovation Outlook.

The UNESCO Institute for Statistics (UIS) in Canada is UNESCO's official statistical agency. It produces global and internationally comparable statistics on education, science, technology, culture and communication. In S&T, these cover national data on human resources and expenditure on research and development (GERD).

The UIS is the official UN statistical agency for the international collection of data in S&T and the lead UN agency for elaborating statistical standards for developing countries, particularly in science, technology and innovation. The UIS currently gathers R&D statistics for Africa and other non-OECD countries. It also organizes training sessions and advises in statistics gathering in these countries. The two most recent global surveys of S&T statistics were conducted in 2004 and 2006 (see figure).

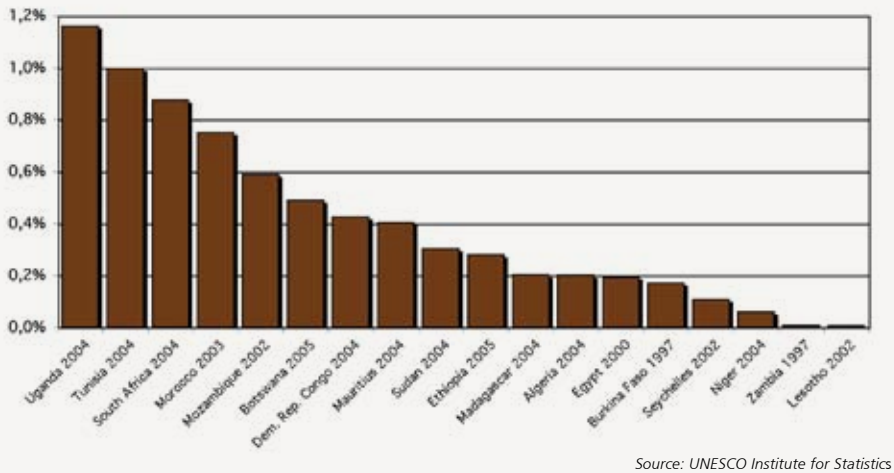
In partnership with other UN agencies, the OECD and the World Bank, the UIS can assist the African Union in its plans to develop an Africa-wide set of indicators. Through its workshops and training programmes, the UIS has established direct contact with African S&T statisticians. There has been extensive discussion about the practical application of international statistical standards and problems of data collection and advocacy, especially in countries with the lowest statistical capacity.

The preparation of reliable national statistics is a task that is inseparable from the process of S&T policy formulation and one which requires close collaboration between policy-makers and statisticians.

What is an indicator?

An indicator is a statistic or variable that provides a simple and reliable means of measuring achievement which tells the policy-maker and the public about the state of society, the environment or the economy. We cannot see the wind, but the swaying branches of a tree are a good indication that the wind is blowing. Some of the indicators used by countries to inform science and technology policy are: research and development expenditure, the number of people engaged in research, the number of in-country patents, the number of scientific articles, the number of university graduates in subjects related to science, technology and innovation.

GERD as a percentage of GDP in Africa, 2004 or latest available year



Source: UNESCO Institute for Statistics

Improving regional cooperation in science and technology

Regional cooperation in S&T can [include] joint science projects, sharing of information, conferences, building joint or common laboratories, setting common standards for R&D and exchange of expertise. A common problem or challenge, such as the development of a HIV/AIDS vaccine, can [stimulate] cooperation.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

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Active learning workshop in optics and photonics for university physics instructors in Morocco in 2006, within UNESCO's Physics Programme, A key area for industry, optics forms the basis of many advances in high technology, including the laser and optical fibres used in telecommunications. Since another workshop in Ghana in 2004, physics teachers from seven African countries have formed an electronic group to facilitate the online exchange of news and information on the active learning method.

One of UNESCO's primary tools for fostering S&T around the world are its intergovernmental programmes in basic sciences, ecology, geology, hydrology and oceanography. These not only provide a framework for cooperation on specific projects but also enable the development of international and regional networks. Examples are the networks grouping biosphere reserves (Boxes 1–6, Annex IV), Microbial Resource Centres (Box 7), catchment basins (Box 10), marine institutions (Box 24), geological surveys (Box 25) and faculties of science and engineering (Box 27).

Over the years, a number of centres of excellence have been set up under the aegis of UNESCO. These provide a hub of expertise in the region. One example is the Regional Centre for Training and Water Studies of Arid and Semi-Arid Zones in Egypt (for examples of other existing and planned centres, see pages 5 and 10 and Box 18).

UNESCO launched the International Basic Sciences Programme (IBSP) in 2004 to develop countries' capacity in this area by focusing on benchmark centres. The programme can establish centres of excellence itself and/or promote the activities of existing centres. Among the

BOX 24 - An African network for ocean and coastal monitoring

*The Ocean Data and Information Network for Africa (ODINAFRICA) of UNESCO's Intergovernmental Oceanographic Commission (IOC) brings together marine-related institutions from Africa *. The Flemish Community of Belgium has provided US$2.5 million to support the development of ODINAFRICA in 2004–2007.*

In the current phase to 2007, the Coastal Ocean Observing System is focusing on upgrading and expanding the African network for in situ *measurements and monitoring of ocean variables, especially sea-level. Tide gauges will be installed at Nouakchott (Mauritania), Dakar (Senegal), Takoradi (Ghana), Limbe (Cameroon), Pointe Noire (Congo), Nosy Be and Fort Dauphin (Madagascar), Moroni (Comoros), Djibouti (Djibouti), Alexandria (Egypt), Cap Bon (Tunisia) and Agadir (Morocco).*

* Algeria, Angola, Benin, Cameroon, Comoros, Congo, Cote d'Ivoire, Egypt, Gabon, Ghana, Guinea, Kenya, Madagascar, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Senegal, Seychelles, South Africa, Tanzania (United Rep.), Togo, Tunisia

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Digitization of data for inclusion in the *Marine Atlas of Africa*, at the Kenya Marine & Fisheries Research Institute in Mombasa

The capacity of the National Oceanographic Data Centres to manage data streams from the coastal ocean observing network is also being strengthened.

Moreover, a set of core information products is being prepared by each Centre to develop information delivery to the end user. The main regional product will be a Marine Atlas for Africa. *The Atlas should be completed by December 2006, after which it will be distributed online and on a DVD.*

For details: www.odinafrica.net; (in Nairobi): m.odido@unesco.org
Marine Atlas for Africa:
http://iodeweb2.vliz.be/omap/OMAP/index.htm

© UNESCO

Satellite dish installed at the *Institut Halieutique et des Sciences Marines* in Tulear, Madagascar, to facilitate VSAT Internet access. The Very Small Aperture Terminal is a ground station used to communicate data via satellite.

IBSP projects launched on the African continent in 2005 is one targeting the establishment of an East African Biological Resource Centre to secure the conservation and sustainable utilization of microbial diversity (see Box 7), in response to a call by countries in the region, and another project for a centre to develop mathematical physics in Africa.

Together with the World Foundation for AIDS Research and Prevention, and with funding from the Italian government, UNESCO is helping to develop sub-regional AIDS centres in sub-Saharan Africa grouping education on prevention, training and scientific research under one roof. The most recent centre opened its doors in Cameroon in February 2006 (see photos). UNESCO and its partners are working with similar centres in Burkina Faso, Côte d'Ivoire and Nigeria.

UNESCO's International Institute for Capacity-Building in Africa, situated in Addis Ababa (Ethiopia), has been instrumental in the launch of the Federation of African Chemical Societies in 2006, the founding members of which are the Chemical Societies of Egypt, Ethiopia, Nigeria, South Africa, Sudan and Tunisia, as well as the African Association of Pure and Applied Chemistry based in Tanzania. The Federation plans to embrace as many African chemical societies as possible in the coming years and to establish working groups in food chemistry, environmental chemistry, analytical chemistry, natural products and medicinal chemistry, among other areas (see Box 30).

UNESCO is the only specialized agency within the United Nations to have a long-term involvement in geology and geophysics, via its International Geoscience Programme (IGCP) founded in 1972. Africa is a continent rich in minerals, fossil fuels and other geological resources. For African countries in transition, it is becoming increasingly urgent to exploit these geological resources to ensure socio-economic development. Geology is consequently attracting more attention from policy-makers and government officials.

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The First Lady of Cameroon, Chantal Biya, cutting the ribbon at the opening ceremony of the newly constructed sub-regional AIDS centre (below) near Yaoundé in February 2006.

© UNESCO

At the same time, IGCP projects are focusing more on applied research. This covers such areas as the water cycle, geological hazard mitigation, climate change and new methods for identifying mineral resources. Although only two out of the 48 IGCP research projects in 2006 were directly concerned with sub-Saharan Africa, many of the remaining projects involved African geoscientists. The aim is to increase the number of IGCP projects with an African component. There are 22 National IGCP Committees in Africa*.

* Algeria, Benin, Burkina Faso, Cameroon, Chad, Democratic Republic of Congo, Cote d'Ivoire, Egypt, Ghana, Kenya, Liberia, Madagascar, Morocco, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Tanzania (United Rep.), Togo, Uganda, Zimbabwe.

BOX 25 - A Pan-African geological network

Some 33 African countries participate in the Pan African Geological Information System (PANGIS) through their geological surveys and universities.*

The partners use UNESCO software and personal computers to reorganize their bibliographical and factual geodata handling, thus making them more accessible to scientists and engineers from other disciplines, as well as to managers and policy-makers. The partners also receive assistance in setting up Geographic Information Systems and in using modern technology for geological research, such as satellite imagery for remote sensing.

For details: www.unesco-nairobi.org/Earth_Science.htm; www.cifeg.org/

* Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Congo, Djibouti, Ethiopia, Gabon, Ghana, Guinea, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Niger, Senegal, Sierra Leone, Swaziland, Tanzania (United Rep.), Togo, Tunisia, Uganda, Zambia, Zimbabwe

BOX 26 - Developing leadership skills

Between 2006 and 2009, the UNESCO-IOC is organizing a total of 55 workshops in five regions, including 22 in East and West Africa. These workshops empower senior management and scientists working in marine institutes to identify and implement problem-solving projects that are the most appropriate for local conditions. The objective is to work with marine institutes to strengthen their internal structures.

The workshops develop leadership skills, proposal-writing and team-building. After the first workshop in Maputo in November 2005, participants reported that it had helped them to refine their mandate, improve response time on coastal development issues, increase transparency and develop new proposals for external funding.

The UNESCO-IOC expects the programme to nurture networks of institutes capable of playing multi-faceted roles. These roles range from providing policy- and decision-makers with advisory services and building awareness to enlist the community in the decision–making process to creating an environment that attracts – and retains – the best local scientific and managerial talents.

For details: e.desa@unesco.org

© ICTP

The three Mori Fellows pictured here in 2006 are working towards their PhD at UNESCO's Abdus Salam International Centre for Theoretical Physics in Italy. From left, Brice Rodrigue Malonda Boungou from the Centre for Atomic, Molecular Physic and Quantum Optics in Cameroon, Uguette Flore Ndongmouo Taffoti from the Institute of Mathematics and Physical Sciences in Benin and Ali Bashir from Bayero University in Nigeria. Upon their return to their respective institutions, each will join a network of ICTP alumni across Africa and around the world. UNESCO set up the Mori Fellowships in 2005 to enable at least 20 PhD students from Africa to complete their doctoral research at the ICTP, in two six-month stints over two years.

In tandem with the International Union of Geological Sciences (IUGS), UNESCO's Nairobi office has produced thematic geological maps in recent years and run postgraduate training in the Earth sciences, remote sensing and geodata handling (see Box 25), climate change and industrial pollution.

UNESCO's Nairobi Office is also supporting efforts to devise local and international geo-conservation schemes in sub-Saharan Africa, including the nomination of the region's most significant geo-scientific monuments to protect natural and cultural heritage (see Annex III).

The Association of African Women Geoscientists was founded in May 2000 at a workshop in Dar es Salaam (Tanzania) sponsored by UNESCO's Nairobi Office.

For details of UNESCO's programmes in ecology and hydrology, see pages 2 and 9.

UNESCO is also setting up regional parliamentary fora on science and technology (see page 27).

BOX 27 - African scientists working for African science

The African Network of Scientific and Technological Institutions (ANSTI) was set up in 1980 by UNESCO, which hosts the ANSTI secretariat in Nairobi.

UNESCO mobilizes extra-budgetary resources both within the institutions themselves and from other sources to train young scientists at the post-graduate level and broaden the experience of senior scientists.

ANSTI membership is open to the Faculties of Science and Engineering of all sub-Saharan universities and other institutions of higher education.

Every year, the grants awarded to senior African academics from ANSTI member institutions enable them to undertake teaching and/or research at another ANSTI institution. These take the form of post-graduate training fellowships, staff-exchange fellowships or travel grants.

A total of 248 grants have been awarded in the last 15 years. The grant beneficiaries return to their institutions, bringing with them their newly acquired knowledge and skills.

In parallel, UNESCO facilitates the dissemination of research results across Africa through a grant it provides to the African Journal of Science and Technology *published by ANSTI.*

For details:
Joseph.Massaquoi@unesco.unon.org;
www.ansti.org/

BOX 28 - Helping universities fight HIV/AIDS

Since 2001, UNESCO has been working with the faculties of science and engineering in 23 universities in Botswana, Eritrea, Ghana, Kenya and Rwanda to help them develop an institutional policy and reform curricula to mainstream HIV/AIDS in their physical, biological and engineering courses.

© I Choose Life-Africa

Students listening to a lecture on HIV/AIDS at Kenyatta University in Kenya

With African women in the 15–24-year age bracket tending to be hardest-hit by the pandemic, UNESCO's Nairobi office has teamed up with the NGO African Women in Science and Engineering (AWSE). Together with AWSE, UNESCO has organized two project workshops, in 2004 and 2006.

A consensus emerged at the latter on the need for a common undergraduate course for all first-year students. Within months of the workshop, 21 universities had submitted proposals, 18 of which qualified for a grant enabling them to organize a one-day workshop on how to mainstream HIV and AIDS into science and engineering courses in the universities' respective faculties. In parallel, 15 science lecturers from the five countries of the sub-region attended training workshops on how to teach both the common undergraduate course and the integrated ones.

'The project has been received with a lot of enthusiasm from participating universities', says UNESCO project coordinator Alice Ochanda, 'and the need to spread it to many more across the continent is evident'.

For details (in Nairobi):
alice.ochanda@unesco.unon.org

Building public understanding of science and technology

S&T development cannot be achieved without the participation and support of the populace and their political institutions... The overall objective is to increase awareness of the contributions that S&T can make to Africa's economic recovery and sustainable development and to increase public participation in S&T policy-making.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

The United Nations' International Year of Physics in 2005 sought to rally the public by recalling the important benefits physics has brought society over the past century. Coordinated by UNESCO, the Year relied heavily on relays in countries to convey the message. The Ghana Institute of Physics, for example, organized a Physics Talent Search for 10–18-year olds which attracted over 6000 contestants; five commemorative stamps were issued and a national radio station initiated a weekly one-hour science programme. The Government has since decided to continue the Physics Talent Search and another outreach programme, Science on Wheels, which tours schools.

International Years are a great opportunity to foster greater public awareness of the benefits science brings but only one of the means at UNESCO's disposal. The Organization is currently coordinating a travelling exhibition on mathematics, for example (see photo) and is planning to test a kit on genetically modified organisms in schools in 2007 (see Box 29). For its part, UNESCO's Space Education Programme opens the eyes of school children to the career

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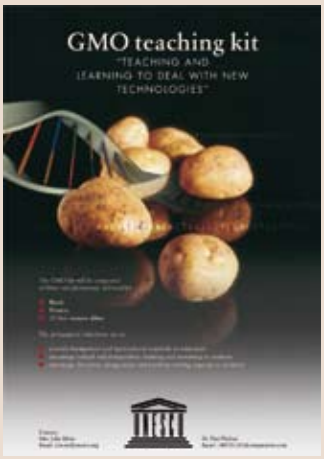
UNESCO coordinates an interactive maths exhibition on Experiencing Mathematics which travelled to cities in South Africa, Mozambique and Namibia between June 2005 and April 2006. In the photo, a tricycle with square wheels from the exhibition, which demonstrates that mathematics is not only omnipresent in daily life but can also be fun. Countries interested in hosting the exhibition are invited to contact Minella Alarcon: m.alarcon@unesco.org

BOX 29 - GMOs demystified

Genetically Modified Organisms (GMOs) are organisms whose genetic material has been altered through genetic engineering. These alterations enhance, or introduce, particular traits that can be exploited in various sectors like agriculture, medicine or industry.

The issue of GMOs has increasingly become a matter of public concern, generating debates on their safety for human health and the environment and on the economic implications of some advances. Some applications of GMOs have been more easily accepted than others, as in the case of vaccine development, whereas other applications, like those related to food production, remain controversial.



In late 2006, UNESCO was in the final stages of putting together a Pedagogical Training Kit on Genetically Modified Organisms. The kit will provide teachers with the tools and information they need to teach secondary school pupils about GMOs and thereby do their bit to 'cultivate' the knowledgeable consumers of tomorrow. The kit will address the broad issues surrounding GMOs, their development and application in diverse fields, the potential benefits and risks, as well as the ethical and safety considerations.

In a second phase in 2007, it is planned to evaluate the kit in selected schools around the world, including several in Africa, within UNESCO's Associated Schools Programme, in order to finalize the kit prior to mass production and distribution.

At a time when governments are being called upon to take decisions and formulate policy on the use of new technologies, the GMO kit project may, in the future, be adapted and extended to address the basic information needs of policy-makers who do not have a scientific background.

© UNESCO/ Angela Ngalati Kambaila

Plant biology class in a secondary school in Zambia in 2003

For details:
l.hoareau@unesco.org or
j.heiss@unesco.org

options of exploring inner and outer space (see photo on page 18).

UNESCO supported the founding of the Federation of African Societies of Chemistry in 2006, one of the missions of which is to raise public understanding of the benefits of chemistry for society (see Box 30).

Within its Science Communication Initiative, the Organization is also working with the British Broadcasting Corporation (BBC) to 'bring science to the screen' (see Box 31).

BOX 30 - Helping the public grasp the value of chemistry

© CEEM

Science teachers discovering microscience kits in biology at a training course organized by the Centre of Excellence in Microscience in Cameroon in 2006. The kits also exist for chemistry and other fields.

The Federation of African Societies of Chemistry was founded in February 2006 in Addis Ababa (Ethiopia) with the support of UNESCO. One of its roles will be to 'improve chemistry teaching and raise public understanding of chemistry and the role it plays in economic development', explains Federation President Temechegn Engida, who is Vice-President of the Chemical Society of Ethiopia and a National Programme Officer at UNESCO's International Institute for Capacity-Building in Africa (IICBA), situated in Addis Ababa. Dr Engida is himself a specialist in chemistry education.

The Federation will foster networking and reform of chemistry education.

It is exploring the possibility of distributing DIDAC teaching materials to schools via member chemical societies. These chemistry teaching materials have been developed jointly by UNESCO, the photographic giant AGFA, the International Union of Pure and Applied Chemistry (IUPAC) and the Royal Flemish Chemical Society in Belgium.

Avenues are also being explored for participating in the Global Microscience Programme run by UNESCO and IUPAC in tandem with the RADMASTE Centre in South Africa. This project has developed low-cost, safe, small-scale kits for conducting experiments in chemistry and other disciplines at school (see photo), and has introduced the methodology throughout the world. In Africa, there are UNESCO-associated microscience centres in Cap Verde, Cameroon, Comores, Gabon, Kenya, Mauritius, Senegal and South Africa.

To help member chemical societies 'spread the word' about the value of chemistry for society and the need both to integrate science in national policy development and to invest in chemistry, the Federation plans to publish the works of chemists who have made valuable contributions to society. In addition, it will be providing products and services to students, teachers and policy-makers.

For details:
www.unesco.org/science/bes/chemistry;
www.unesco-iicba.org;
j.hasler@unesco.org

BOX 31 - Bringing science to the screen

In September 2006, UNESCO acquired the rights for one year, at minimal cost, to 46 titles from the award-winning BBC Horizon series for 41 African and 9 Asian countries.*

UNESCO is distributing each of the 50 minute programmes to public service broadcasting channels in all 50 countries, which will be entitled to screen each film up to six times. Subjects range from Einstein's Theory of Relativity to the science of natural disasters and gene therapy.

The deal was signed with BBC Worldwide, the commercial arm of the British Broadcasting Corporation.

For details (in Paris):
i.panevska@unesco.org;
a.candau@unesco.org

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A beach shortly after a tsunami devastated countries around the Indian Ocean in December 2004. Here, in Lok Ngha near Banda Aceh in Indonesia, the height of the tsunami waves can be determined from the sharp cut-off point between rock and vegetation, 34 m above the ground.

* Algeria, Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia

Building science and technology policy capacity

The aim is to stimulate the establishment of science, technology and innovation courses at post-graduate level in African universities, to build a critical mass of science policy advisors to African governments and the policy sector and to build and disseminate information and experiences on science, technology and innovation policy analysis, advice and development.

Africa's Science and Technology Consolidated Plan of Action, 2006–2010

Good government is one of the most effective ways of unlocking human potential and improving living standards.

Governments govern through policies. One reason for the poor rate at which most African countries have accumulated technological capacity is that government decisions tend to be governed by development policies which contain very little S&T content. Consequently, there may be S&T policies in place but they attract little attention. The overall policy documents today in most African countries are either poverty reduction strategies or economic recovery strategies.

In order to ensure that S&T features in the decision-making process, S&T policies must be integrated into the overall development policies of countries. UNESCO can help governments in Africa develop a national system of science governance, formulate strategies for science, technology and innovation and integrate these into national development plans. UNESCO has worked with a number of African countries in recent years to reform their science systems, including Namibia and Mozambique. The current reform of Nigeria's science system illustrates UNESCO's approach (see Box 32).

At the regional level, UNESCO works with the African Union and NEPAD, acting as an international observatory and clearing house for issues relating to science and government. UNESCO organizes expert group consultations and has published a guide on how to mainstream S&T issues in national development policies. In 2001, UNESCO's Division of Science Policies and Analysis published a feasibility study on *Debt Relief for Science and Technology*[*], in response to a proposal by the Governments of Senegal and Mali to use financial resources freed up by the relief of the debt burden on least developed countries to finance S&T.

UNESCO is also helping to set up regional parliamentary fora on science and technology. The Arab Policy Forum convened for the first time in Cairo (Egypt) in December 2004. This has since been followed by regional parliamentary fora for South Asia and Latin America (2005), and Western Asia in 2006. The Director-General of UNESCO launched the Nigerian Parliamentarian Forum on Science and Technology in Abuja in 2006 but there is as yet no regional parliamentary forum on S&T for sub-Saharan Africa.

* www.unesco.org/science/psd/thm_pros/series/all.shtml

BOX 32 - A fresh start for Nigeria

At the request of the Government of Nigeria, an International Advisory Board for the Reform of the Science, Technology and Innovation System of Nigeria (IAB) was established by UNESCO in October 2004.

A core activity of the reform programme is a joint review of investment, industry and innovation in Nigeria involving UNESCO, UNCTAD, UNIDO and WIPO.

In May 2006, President Olusegun Obasanjo announced a US$5 billion endowment fund for the establishment of a National Science Foundation of Nigeria (NSF-N). The NSF-N was one of three recommendations put forward by the IAB that was favourably received by the President.

The other recommendations concern awarding six Nigerian universities incentive measures to enable them to rank among the 200 top universities in the world by 2020 and the creation of technology-based 'good business' zones in each State.

The Ministry of Science and Technology was preparing a draft bill on the creation of the NSF-N in collaboration with UNESCO in mid-2006. Once approved by Cabinet, the bill is to be submitted to Parliament for consideration.

In August 2006, the President urged UNESCO to fast-track both the science reform programme and the elaboration of an Action Plan on Science, Technology and Innovation.

President Obasanjo of Nigeria

For details: www.unesco.org/science/psd

Annexes

Annex I

Microbial Resource Centres in Africa

TYPE OF CENTRE	HOST INSTITUTION	DESCRIPTION
Rhizobium MIRCEN	University of Nairobi, College of Agriculture and Veterinary Sciences, Department of Soil Science, Nairobi, Kenya	Research and Training Regional Centre for East Africa, produces 1500–800 kg of rhizobial inoculant per annum
Rhizobium MIRCEN	Laboratoire de Microbiologie, Institut sénégalais de recherche agricole, Dakar, Senegal	Research and Training Regional Centre for West Africa, conducts field trials with rhizobial and mycorrhizal inocula
Biotechnology MIRCEN	Faculty of Agriculture, Ain Shams University, Cairo, Egypt	Research and Training Activities for Arab States, conducts culture collection research
Industrial Biotechnology MIRCEN	University of the Free State, Department of Microbiology and Biochemistry, Bloemfontein, South Africa	Research and Training Activities for Southern and sub-Saharan Africa, conducts culture collection research

Annex II

UNESCO Chairs in Science and Technology in Africa

COUNTRY	TITLE & YEAR OF CREATION	HOST UNIVERSITY
ALGERIA	UNESCO–Natural Gas Chair in Sustainable Development studies, 1999 UNESCO Chair in Future-oriented Studies and Integrated Management of Coastal Zones, 2005	Houari Boumedienne University of Sciences and Technology Institut des sciences de la mer et de l'aménagement du littoral (ISMAL)
ANGOLA	UNESCO Chair in Chemical and Environmental Engineering, 1994	Agostinho Neto University
BENIN	UNESCO Chair in Science, Technology and Environment, 1996 UNESCO Chair in Mathematical Physics and Applications, 2006 UNESCO–Natura Chair in Food and Nutrition, 2002	National University of Benin Abomey-Calavi University Université d'agronomie
BURKINA FASO	UNESCO Chair in Gender, Science and Development in Africa, 2004 UNESCO Chair in Biotechnology, 1997	University of Ouagadougou University of Ouagadougou
EGYPT	UNESCO–Cousteau Ecotechnie Chair/Network in Environment and Sustainable Development, 1997 UNESCO/Arab Region Ecotechnie Network, 2002	South Valley University South Valley University
EQUATORIAL GUINEA	UNESCO Chair in Environmental Education, 1998	National University of Equatorial Guinea
GUINEA	UNESCO Chair in Technology and Rural Development, 1996	University of Conakry
KENYA	UNESCO Chair in Biotechnology, 2001	Jomo Kenyatta University of Agriculture and Technology
LESOTHO	UNESCO Chair in Water Management, 1997	National University of Lesotho
LIBYAN ARAB JAMAHIRIYA	UNESCO Chair for Water in Arid and Desertic Zones, 2001	University Al-Fateh
MALAWI	UNESCO Chair in Renewable Energy, 1999	University of Malawi
MALI	UNESCO–EOLSS Chair in Environmental Teaching and Research, 2001	University of Mali
MOROCCO	UNESCO interdisciplinary Chair in Sustainable Water Resources Management, 1998 UNESCO Chair for Training and Research in Marine Sciences, 1994 UNESCO–Natural Gas Chair in Environmental Management and Sustainable Development, 1997 UNESCO Chair in Water, Women and Decision-making, 2006	Hassania School of Public Works Ibn Tofaïl University and Chouaib Doukkali University Mohamad V University Al Akhawayn University
MOZAMBIQUE	UNESCO Chair in Tropical Medicine, 1998 UNESCO Chair on Man and Environment in Southern Africa, 1992 UNESCO Chair in Cardiopediatrics, 1998 UNESCO Chair in Marine Sciences and Oceanographic Issues, 1998	Eduardo Mondlane University Eduardo Mondlane University Eduardo Mondlane University Eduardo Mondlane University
NAMIBIA	UNESCO–UNU Chair on the Concept and Practice of Zero Emissions in Africa, 1996	University of Namibia
NIGER	UNESCO Chair in Renewable Energies, 2000 UNESCO Chair in Geosciences, 1998	Abdou Moumouni University of Niamey Abdou Moumouni University of Niamey
NIGERIA	UNESCO Chair in Geosciences, 2006	University of Ibadan

COUNTRY	TITLE & YEAR OF CREATION	HOST UNIVERSITY
SENEGAL	UNESCO Chair in Integrated Coastal Management and Sustainable Development, 1997	Cheikh Anta Diop University of Dakar
SOUTH AFRICA	UNESCO Chair in Technological Entrepreneurship, 2005 UNESCO Chair in Geohydrology, 1999 UNESCO Chair in Biotechnology, 1999 UNESCO Chair in Renewable Energy, 1998 UNESCO Chair in Mathematics and Science Education, 1992	Tshwane University of Technology University of Western Cape University of the North M.L. Sultan Technikon University of Western Cape
SUDAN	UNESCO Chair in Water Resources, 1994 UNESCO Chair in Women, Science and Technology, 2003 UNESCO Chair in Desertification, 2001 UNESCO–Cousteau Ecotechnie Chair, 2004 UNESCO Chair in Marine Biology and Oceanography, 2006 UNESCO Chair in Transfer of Technology, 2006	Omdurman Islamic University University of Sciences and Technology University of Khartoum ComputerMan College for Computer Studies Sudan Institute for Natural Sciences, Ministry of Higher Education and Scientific Research Industrial Research and Consultancy Centre, Ministry of Science and Technology
SWAZILAND	UNESCO–Association of African Universities Chair for Women in Science and Technology, 1995	University of Swaziland
TOGO	UNESCO Chair in Renewable Energies 1999	University of Lomé
TUNISIA	UNESCO–Natura Chair in Diagnostic Analysis of Farmer Managed Irrigation, 1992 UNESCO Chair in Mathematics and Development, 2003	National Agricultural Institute of Tunis University of Tunis El Manar
UGANDA	UNESCO Chair in Post-harvesting Technology, 1996	Makerere University
UNITED REPUBLIC OF TANZANIA	UNESCO–Natura Chair in Food Security and Nutrition for Health and Development, 1992	Sokoine University of Agriculture
ZAMBIA	UNESCO Chair in Renewable Energy and Environment, 2001	University of Zambia
ZIMBABWE	UNESCO Chair in Renewable Energy, 1997 UNESCO–Natura Chair for the Sustainable Protection of Harvests, 1992 UNESCO Chair in Immunology and Infectious Diseases, 1992	University of Zimbabwe University of Zimbabwe University of Zimbabwe

Annex III

World Heritage Sites in Africa

COUNTRY	NAME & YEAR OF INSCRIPTION	CATEGORY
BENIN	Royal Palaces of Abomey, 1985	Cultural
BOTSWANA	Tsodilo, 2001	Cultural
CAMEROON	Dja Faunal Reserve, 1987	Natural
CENTRAL AFRICAN REPUBLIC	Manovo-Gounda St Floris National Park, 1988	Natural
CÔTE D'IVOIRE	Mount Nimba Strict Nature Reserve,1981, 1982 Taï National Park, 1982 Comoé National Park,1983	Natural Natural Natural
DEMOCRATIC REPUBLIC OF CONGO	Virunga National Park, 1979 Garamba National Park, 1980 Kahuzi-Biega National Park, 1980 Salonga National Park, 1984 Okapi Wildlife Reserve, 1996	Natural Natural Natural Natural Natural
ETHIOPIA	Rock-Hewn Churches, Lalibela, 1978 Simien National Park, 1978 Fasil Ghebbi, Gondar Region, 1979 Aksum, 1980 Lower Valley of the Awash, 1980 Lower Valley of the Omo, 1980 Tiya, 1980 Harar Jugol, Fortified Historic Town, 2006	Cultural Natural Cultural Cultural Cultural Cultural Cultural Cultural
GAMBIA	James Island and Related Sites, 2003 Stone Circles of Senegambia, 2006	Cultural Cultural
GHANA	Forts and Castles, Volta, Greater Accra Central and Western Regions, 1979 Asante Traditional Buildings, 1980	Cultural Cultural
GUINEA	Mount Nimba Strict Nature Reserve, 1981, 1982	Natural
KENYA	Lake Turkana National Parks, 1997, 2001 Mount Kenya National Park/NaturalForest, 1997 Lamu Old Town, 2001	Natural Natural Cultural
MADAGASCAR	Tsingy de Bemaraha Strict Nature Reserve, 1990 Royal Hill of Ambohimanga, 2001	Natural Cultural
MALAWI	Lake Malawi National Park, 1984 Chongoni Rock Art Area, 2006	Natural Cultural
MALI	Old Town of Dienné , 1983 Timbuktu, 1988 Cliff of Bandiagara, 1989 Tomb of Askia, 2004	Cultural Cultural Cultural Cultural
MAURITIUS	Aapravasi Ghat, 2006	Cultural
MOZAMBIQUE	Island of Mozambique, 1991	Cultural
NIGER	Air and Ténéré Natural Reserves, 1991 W National Park of Niger, 1996	Natural Natural
NIGERIA	Sukur Cultural Landscape, 1999 Osun-Osogbo Sacred Grove, 2005	Mixed Cultural
SENEGAL	Island of Gorée, 1978 Djoudj National Bird Sanctuary, 1981 Niokolo-Koba National Park, 1981 Island of Saint Louis, 2000 Stone Circles of Senegambia, 2006	Cultural Natural Natural Cultural Cultural

COUNTRY	NAME & YEAR OF INSCRIPTION	CATEGORY
SEYCHELLES	Aldabra Atoll, 1982	Natural
	Vallée de Mai Nature Reserve, 1983	Natural
SOUTH AFRICA	Fossil Hominid Sites of Sterkfontein, Swartkrans, Kromdraai and Environs, 1999, 2005	Cultural
	Greater St Lucia Wetland Park, 1999	Natural
	Robben Island, 1999	Cultural
	Khahlama / Drakensberg Park, 2000	Cultural
	Mapungubwe Cultural Landscape, 2003	Cultural
	Cape Floral Region Protected Areas, 2004	Natural
	Vredefort Dome, 2005	Natural
TOGO	Koutammakou, the Land of the Batammariba, 2004	Cultural
UGANDA	Bwindi Impenetrable National Park, 1994	Natural
	Rwenzori Mountains National Park, 1994	Natural
	Tombs of Buganda Kings at Kasubi, 2001	Cultural

COUNTRY	NAME & YEAR OF INSCRIPTION	CATEGORY
UNITED REPUBLIC OF TANZANIA	Ngorongoro Conservation Area, 1979	Natural
	Ruins of Kilwa Kisiwani and Ruins of Songo Mnara, 1981	Cultural
	Serengeti National Park, 1981	Natural
	Selous Game Reserve, 1982	Natural
	Kilimanjaro National Park, 1987	Natural
	Stone Town of Zanzibar, 2000	Cultural
	Kondoa Rock Art Sites, 2006	Cultural
ZAMBIA	Mosi-oa-Tunya/Victoria Falls*, 1989	Natural
ZIMBABWE	Mana Pools National Park Sapi and Chewore Safari Areas, 1984	Natural
	Great Zimbabwe National Monument, 1986	Cultural
	Khami Ruins National Monument, 1986	Cultural
	Mosi-oa-Tunya/Victoria Falls*, 1989	Natural
	Matobo Hills, 2003	Cultural

* transboundary property

Annex IV

Biosphere Reserves in Africa (see also map)

COUNTRY		NAME & YEAR OF CREATION
ALGERIA	ALG 1	Tassili N'Ajjer, 1986
	ALG 2	El Kala, 1990
	ALG 3	Djurdjura, 1997
	ALG 4	Chrea, 2002
	ALG 5	Taza, 2004
	ALG 6	Gouraya,2004
BENIN	BEN 1	Pendjari, 1986
	BEN -BFK-NER	«W» Region, 2002* - *Shared with Burkina Faso and Niger*
BURKINA FASO	BFK 1	Mare aux hippopotames, 1986
	BEN -BFK-NER	«W» Region, 2002* - *Shared with Benin and Niger*
CAMEROON	CMR 1	Waza, 1979
	CMR 2	Benoué, 1981
	CMR 3	Dja, 1981
CENTRAL AFRICAN REPUBLIC	CAF 1	Basse-Lobaye, 1977
	CAF 2	Bamingui-Bangoran, 1979
CONGO	PRC 1	Odzala, 1977
	PRC 2	Dimonika, 1988
COTE D'IVOIRE	IVC 1	Taï
	IVC 2	Comoé
DEMOCRATIC REPUBLIC OF CONGO	DRC 1	Yangambi, 1976
	DRC 2	Luki, 1976
	DRC 3	Lufira, 1982
EGYPT	EGY 1	Omayed, 1981
	EGY 2	Wadi Allaqi, 1993
GABON	GAB 1	Ipassa-Makokou, 1983
GHANA	GHA 1	Bia, 1983
GUINEA	GUI 1	Mont Nimba, 1980
	GUI 2	Massif du Ziama, 1980
	GUI 3	Badiar, 2002
	GUI 4	Haut Niger, 2002
GUINEA-BISSAU	GBS 1	Boloma Bijagós, 1996
KENYA	KEN 1	Mount Kenya, 1978
	KEN 2	Mount Kulal, 1979
	KEN 3	Malindi-Watamu, 1979
	KEN 4	Kiunga, 1980
	KEN 5	Amboseli, 1991
	KEN 6	Mount Elgon,2003

COUNTRY		NAME & YEAR OF CREATION
MADAGASCAR	MAG 1	Mananara Nord, 1990
	MAG 2	Sahamalaza-Iles Radama, 2001
	MAG 3	Littoral de Toiliara, 2003
MALAWI	MLW 1	Mount Mulanje, 2000
	MLW 2	Lake Chilwa, 2006
MALI	MLI 1	Boucle de Baoule, 1982
MAURITANIA	MAU-SEN	Senegal Delta, 2005* - *Shared with Senegal*
MAURITIUS	MAR	Macchabee/Bel Ombre, 1977
MOROCCO	MOR 1	Arganeraie, 1998
	MOR 2	Oasis du sud marocain, 2000
	MOR-SPA	Intercontinental of the Mediterranean, 2006* - *Shared with Spain*
NIGER	NER 1	Air et Tenere, 1997
	BEN-BFK-NER	«W» Region, 2002* - *Shared with Benin and Burkina Faso*
NIGERIA	NIR 1	Omo, 1977
RWANDA	RWA 1	Volcans, 1983
SENEGAL	SEN 1	Samba Dia, 1979
	SEN 2	Delta du Saloum, 1980
	SEN 3	Niokolo-Koba, 1981
	SEN-MRT	Senegal Delta, 2005* - *Shared with Mauritania*
SOUTH AFRICA	SAF 1	Kogelberg, 1998
	SAF 2	Cape West Coast, 2000,
	SAF 3	Waterberg, 2001
	SAF 4	Kruger to Canyons, 2001
SUDAN	SUD 1	Dinder, 1979
	SUD 2	Radom, 1979
TUNISIA	TUN 1	Djebel Bou-Hedma, 1977
	TUN 2	Djebel Chambi, 1977
	TUN 3	Ichkeul, 1977
	TUN 4	Iles Zembra et Zembretta, 1977
UGANDA	UGA 1	Queen Elizabeth, 1979
	UGA 2	Mount Elgon, 2005
UNITED REPUBLIC OF TANZANIA	URT 1	Lake Manyara, 1981
	URT 2	Serengeti-Ngorongoro, 1981
	URT 3	East Usambara, 2000

* transboundary property

UNESCO FIELD OFFICES IN AFRICA	
REGIONAL BUREAU FOR SCIENCE IN AFRICA	Kenya (Nairobi)
REGIONAL BUREAU FOR SCIENCE IN THE ARAB STATES	Egypt (Cairo)
OTHER UNESCO FIELD OFFICES	Burundi (Bujumbura), Cameroon (Yaoundé), Congo (Brazzaville), Democratic Republic of Congo (Kinshasa), Ethiopia (Addis Ababa), Gabon (Libreville), Ghana (Accra), Mali (Bamako), Morocco (Rabat), Mozambique (Maputo), Namibia (Windhoek), Nigeria (Abuja), Rwanda (Kigali), Senegal (Dakar), United Republic of Tanzania (Dar es Salaam), Zimbabwe (Harare)

In September 2005, the African Union and its New Partnership for Africa's Development (NEPAD) adopted Africa's Science and Technology Consolidated Plan of Action to 2010. Erected on the three interrelated pillars of capacity-building, knowledge production and technological innovation, the Plan 'articulates Africa's common objectives and commitment to collective actions to develop and use science and technology for the socio-economic transformation of the continent and its integration into the world economy'.

UNESCO has its part to play in achieving these objectives. Within the ongoing programmes and activities outlined in the present brochure, UNESCO can help Africa to capitalize on its strengths and build on the three pillars underpinning its development goals.

Cover photos: (front) Senegalese boy studying a specimen under a magnifying glass © La main à la pâte (back): an irrigated field in Mali using a solar-powered pump © ADEME; workshop organized in Tunisia by UNESCO on optics and photonics for university physics instructors © UNESCO; biologist in the lab © Laurence Gough