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The floating university *p. 13*

A World of SCIENCE

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IN THIS ISSUE

EDITORIAL

The quiet revolution

Science is *not* a global endeavour, alas. Just as the world has its info-rich and info-poor, so too it has its research-rich and research-poor. The digital divide is but a symptom of the scientific divide.

But after the economy and communication, could science, in turn, be globalizing? Caroline Wagner thinks so. A Research Fellow at RAND, a non-profit think tank, she is convinced that 'science is becoming a world system'. Wagner notes a 50% increase (to 15% of the total) in the number of articles being internationally co-authored in the ten years to 1997 – still the early days of Internet – and calculates that the global network of scientific collaboration consisted of 128 core countries in 2000.

One of the motors of broader international collaboration has been the development of ties between the diaspora and scientists at home, a process facilitated by the Web. Ana María Cetto wrote in UNESCO's *World Science Report 1998* that an estimated 40–60% of all Argentinian, Chilean, Colombian and Peruvian researchers were working in industrialized countries 'where their work is recognized and valued'. In Africa, Bience Gawanas has just deplored, at the First NEPAD Ministerial Conference on Science and Technology (S&T), the haemorrhage of highly trained experts lost to the continent on account of poor working conditions.

Decent working conditions demand sustained investment. It is thus gratifying that the NEPAD meeting should have vowed to raise spending on research and development to 1% of GDP – at least – by 2008, a level which would place Africa, in percentage terms, on a par with Central and Eastern Europe. A quantum leap, in sum, if the promise can be realized; most of the world's least developed nations are Sub-Saharan.

There does seem to be a growing awareness of the importance of S&T for development. A study by the UNESCO Institute for Statistics (UIS) in this issue reveals that the gap between developed and developing countries is gradually shrinking, albeit at a pedestrian pace with the notable exception of China and the Asian 'dragons'.

Any global survey of S&T today is hampered by imprecise data for many countries. The UIS and UNESCO's science policy analysts are currently preparing a review of progress worldwide in developing-relevant S&T statistics and the difficulties countries encounter in collecting and interpreting such data.

The ultimate goal is to build national statistical systems which are highly responsive to policy and information needs, with UNESCO facilitating this process through standard-setting and the gathering of cross-nationally harmonized data, in particular.

W. Erdelen
Assistant Director-General for Natural Sciences

Measuring progress towards knowledge societies

Many of the challenges countries and regions of the world are facing in such areas as sustainable development, economic growth, health care, education and agricultural production are increasingly subsumed to a common denominator: developing knowledge societies and economies. While the process towards knowledge societies is driven to a large extent by the industrialized countries, it is now widely recognized that 'catching up' in areas like those mentioned above depends crucially on each country acquiring, developing, managing and properly applying appropriate knowledge. Major factors underlying this trend are global institutions (such as the World Trade Organization, the various development banks and the United Nations system) and agreements, as well as the spread of information and communication technologies.

There are, of course, huge discrepancies between countries and (sub-)regions in their approaches to building a knowledge society. The form this process takes differs greatly for instance between the rapidly growing economies of China, Brazil or the newly industrialized Asian economies (the 'dragons'), on the one hand, and what we are seeing in many resource-based economies, on the other. And while the need to follow this path does not go unnoticed in many of the poorer countries, the difficulties in jumping on the bandwagon are enormous and the process itself is sometimes perceived as only widening the gap between them and the richer countries of the world.

Knowledge underpinning development is, of course, not equal to scientific knowledge. But no country will be able to achieve and durably maintain prosperity and a high quality of life without using the results of science and ensuring a well-educated population. Similarly, equitable and sustainable development can only be achieved if all countries – and men and women everywhere – share in developing and using science.

Measuring and monitoring progress

Can we see the world's countries and regions moving towards knowledge societies? Can we measure and monitor this process? And, conversely, can we interpret whatever information we collect on how countries invest in science and use it in terms of progress towards a knowledge society?

There is a long tradition of collecting data on the efforts of public and private actors in science and technology (S&T), and of turning these data into indicators of a country's performance. We are used to trying to measure not only input – basically investment – in S&T, but also output: what do we get in return for our investment?

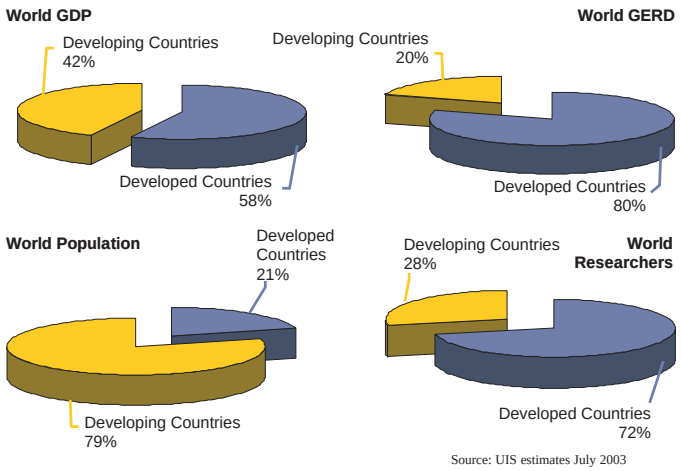
As we come to understand better how companies and societies benefit from S&T, there is a growing need for increasingly sophisticated, complex and broader indicators of the actual processes that lead to prosperity and quality of life. A very useful tool for both policy-making and public debate on a country's performance, for instance, are compound indicators that combine data on the creation and diffusion of knowledge, S&T performance and the 'productivity' of the economy, the education system and the information infrastructure. These are now being used in the European Union to give a bird's eye view of investment and performance in the 'knowledge' economy. Even unsophisticated indicators, however, can identify very real trends in development.

A snapshot of global investment in R&D today

Here, we limit our world survey to a few straightforward indicators of input to research and development (R&D) in terms of human and financial investment.

In 2001, the UNESCO Institute for Statistics published a report on *The State of Science and Technology in the World 1996–1997*. An R&D survey conducted since then of UNESCO's Member States, combined with data taken from such international sources as the Latin American Network for S&T Indicators (RICYT), OECD, Eurostat and the World Bank, has enabled the Institute to update these figures to 2000[1]. The following analysis presents no more than a snapshot of emerging trends; a more in-depth study will be published in a forthcoming UNESCO report on science.

Figure I
World GDP, population and R&D resources in 2000



Source: UIS estimates July 2003

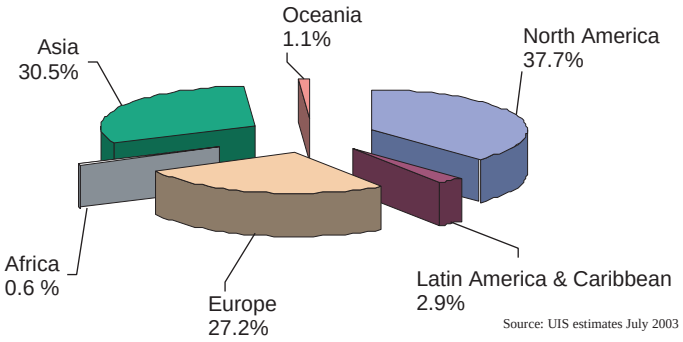


Figure II
Shares of world GERD in 2000
By region

Global gross expenditure on R&D (GERD) rose to an estimated $PPP 746 billion in 2000, up from $PPP 547 billion in 1997. The volume of R&D investment has increased in absolute terms nearly everywhere – if at varying rates – and in any event much faster than the stock of full-time equivalent (FTE) researchers, up by only 1.7% to just under 5.3 million over the same period.

Even if the general situation of the developing world remains far from satisfactory, there are signs that the gap may be closing little by little. Earlier UNESCO estimates had suggested that, in 1985, the developing countries represented as little as 12% of total researchers. By 1997, this figure had climbed to 28%, although it has stagnated since (Figure I). Other gaps seem to be shrinking: between 1997 and 2000, the share of GDP of the developing countries increased by some 3% to approximately 42% and their share in world GERD rose from just under 16% to 20%. This compares with a population size of 79% of the world total in 2000, as opposed to slightly less than 78% in 1997 and 76% in 1985.

Could the notions of developed and developing be blurring the picture?

The very notions of 'developed' and 'developing' are increasingly blurring the true picture. The positive developments are to a large extent concentrated in a few regions or even a few countries. And grouping some of the very low-income countries in the Commonwealth of Independent States (CIS) as 'developed' when Singapore, the Republic of Korea and the like are still 'developing' shows that statistically meaningful conclusions are better drawn at a more disaggregated level.

What one can say is that the share of the traditional 'big-spenders' on R&D, namely Europe, North America and Japan (the former Union of Soviet Socialist Republics (USSR) having slipped from this group) is diminishing as the circle of countries contributing considerably – and increasingly so – to GERD and R&D personnel widens. Even if we only discuss 'input' to R&D here, most of the commonly used 'output' indicators (bibliometrics, patents, international high-tech trade) show a similar phenomenon.

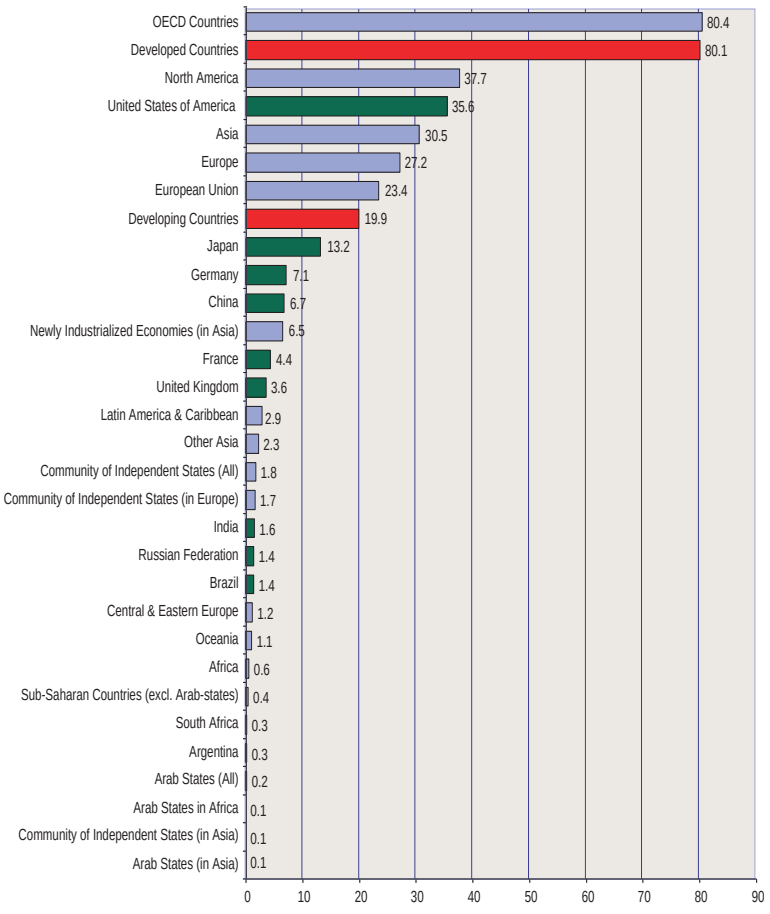
Emerging trends in financial investment in R&D

Although there was a decline in the share of global GERD between 1997 and 2000 in North America (down from 38.2% to 37.7%), the European Union (down from 25.2% to 23.4%) and Japan (down from 15.2% to 13.2%), the triad still dominates world GERD (Figures II and III). The only region to see its participation in world GERD progress is Asia; its share rose from 27.9% in 1997 to 30.5% three years later, a result all the more impressive in light of the downturn in Japan's own world share of GERD.

If we dwell for a moment on Japan, it is interesting to note that, even if growth in expenditure on R&D levelled off during the period under study, it still progressed at a faster pace than the economy as a whole (GDP rising only slightly from $PPP 3000 billion to $PPP 3151 billion). As we have seen above, the increase in GERD (up to $PPP 99 billion from $PPP 83 billion) did not prevent a slight erosion in Japan's share of world GERD.

The rise in Asia's participation in GERD is explained by significant growth in the world shares of China (6.7% as compared to 3.9% in 1997) and the 'dragons' (from 4.9% to 6.5%). These countries represent a dramatic progression in investment in R&D. In the case of China, the trend is accompanied by sustained strong economic growth, with

Figure III
Shares of world GERD in 2000. By region/principal countries



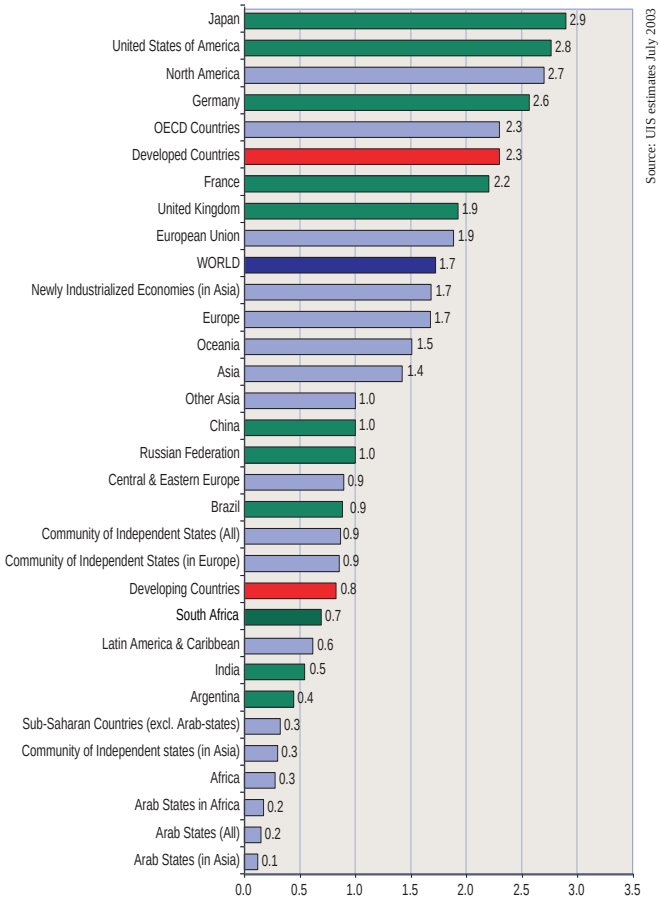


Figure IV
GERD as a percentage of GDP in 2000
By region/principal countries

GDP increasing from $PPP 3543 billion in 1997 to $PPP 5029 billion (still at current prices) only three years later. In comparison, GDP rose in the USA over the same period from $PPP 7511 billion to $PPP 8868 billion. The leap in GERD for China is equally spectacular: from $PPP 21 billion to $PPP 50 billion. With $PPP 48 billion, the 'dragons' have now fallen slightly behind China in terms of R&D investment but this amount still represents a significant increase from just under $PPP 27 billion in 1997. The 'dragon' countries have managed to withstand the financial crisis of the late 1990s and chosen to increase massively investment in R&D, despite limited growth in GDP (from $PPP 2323 billion to $PPP 2866 billion).

Turning to India, we find that its world share of GERD actually dropped slightly between 1997 and 2000, from 2.0% to 1.6%. National investment in R&D (up from just under $PPP 11 billion to $PPP 12 billion) has indeed failed to keep pace with healthy growth in GDP (from $PPP 1530 billion to $PPP 2242 billion). However, this trend may be reversed in the next few years. The Government of India has since bolstered research spending and plans further increases (see *Comparing financial resources*).

Within Europe, the Russian Federation's share is up to 1.4% from 1.0% and Central and Eastern Europe has progressed from 1.0% to 1.2%. The accession of 10 countries to the European Union in 2004, including Poland and Hungary, will naturally boost the European Union's world share.

Latin America and the Caribbean, the all-African continent and Oceania still only make a modest contribution to world GERD and their roles appear in decline (from 3.1% to 2.9% in Latin America, from 1.3% to 1.1% in Oceania and from 0.7 to 0.6% in Africa). In the Latin American and Caribbean group, about half the estimated R&D effort may be attributed to Brazil; for its part, South Africa accounts for broadly the same share as the remainder of the entire African continent. (In passing, it is interesting to note that the funding structure of South Africa differs little from the median for the OECD countries: national firms currently fund some 50% of South-African R&D, the government sector 33%, other national sources 10% and foreign funds the remainder.)

Two groupings of countries span two continents. The Arab States stretch over parts of Africa and Asia, and the CIS – the former USSR – over Europe and Asia. Whereas the Arab States' already small contribution to world GERD has declined in relative terms from 0.4% to 0.2%, a small expansion is observed in the CIS, from 1.5% to 1.8%, essentially underpinned by the recovery of the Russian Federation after a decade of absolute decline or, at best, stagnation. Nearly 85% of overall Arab GERD was performed in the following seven countries in the late 1990s: Egypt, Jordan, Kuwait, Morocco, Saudi Arabia, Syria and Tunisia, the fifteen remaining states of the Arab League together accounting for the remainder.

Several of the most R&D-intensive Arab States are geographically situated on the African continent and their R&D is strongly supported by public finance. In the past 10–15 years, R&D resources have seriously dropped in the countries of 'median Africa' and what little R&D is being performed there is essentially project-financed from abroad by international agencies, NGOs and, in exceptional cases, by industrial corporations.

In 1997, nearly 85% of all R&D performed around the world could be credited to the Member countries of the OECD. This share had dropped to around 80% by 2000, a decline explained by the retreating shares of North America, the European Union and Japan.

Comparing financial resources

GERD as a percentage of GDP is the most commonly used indicator for international comparisons and for defining national policies for S&T. High-income countries usually spend considerably more than 1.5% of GDP on R&D and even up to 3% in some cases, a figure which is now the European Union's policy target for 2010. Still higher ratios are observed in a number of much smaller economies, such as Israel (4.4%) and Sweden (3.8%). India has set itself a target which would place it among the nations of the world which devote the greatest share of GDP to R&D: it plans

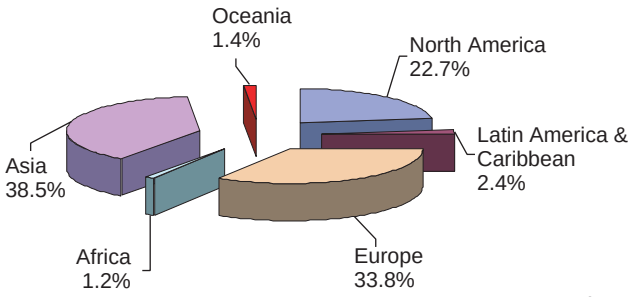


Figure V
World researchers in 2000
By region

to hoist research spending to 2% of GDP by 2007, according to a national policy document published in 2003. Indicative of India's commitment, GERD had already climbed to 1.08% of GDP by 2002.

In 2000, approximately 1.7% of world GDP was devoted to R&D, compared to 1.6% in 1997 (Figure IV). The all-OECD ratio for 2000 was around 2.3% and that of the European Union approximately 1.9%, compared to 2.2% and 1.8% respectively in the previous analysis. Within the group of OECD countries, the median GERD/GDP ratio hovered around 1.8%, approximately the level of Canada.

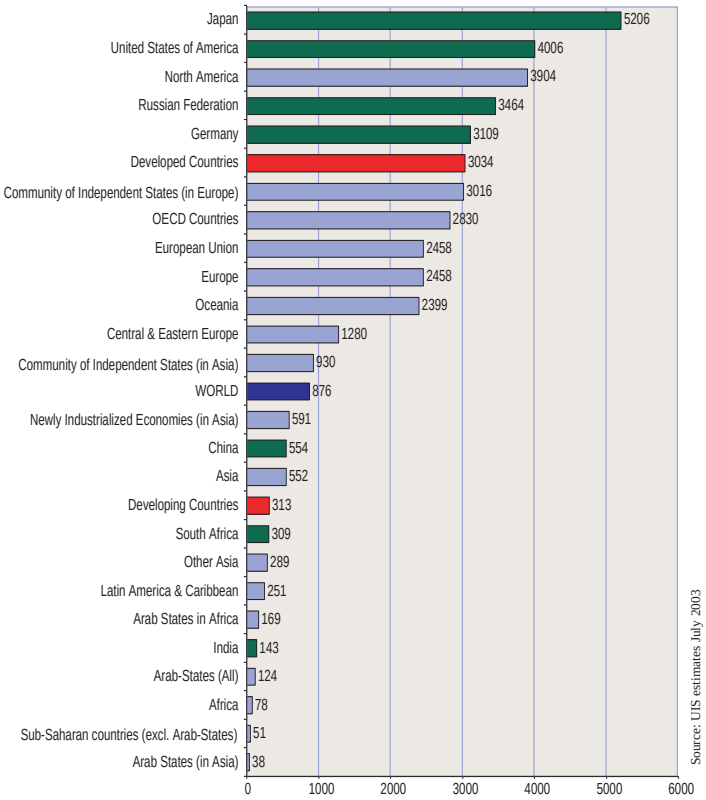
The great majority of countries around the world, however, still spend only a tiny fraction of GDP on R&D. For most of these, the GERD/GDP ratio was even smaller in 2000 than in 1997. There are winds of change in Africa, however, where governments recently reaffirmed their determination to raise spending on R&D to 1% of GDP (see p.8).

Spending on R&D in Latin America and the Caribbean broadly represented some 0.6% of the region's GDP in 2000, an increase of one decimal point over the previous study, with a median intensity of around 0.27% (the level of Costa Rica). Brazil reported the highest GERD/GDP ratio for Latin America (just under 0.9% in 1999), closely followed by Cuba (0.8%). The figure for Mexico, the region's only OECD member, was 0.4% in 1999.

Be it north or south of the Sahara, Africa remains by far the least R&D-intensive of the continents. Sub-Saharan Africa allocates only 0.3% of its resources to R&D, the most R&D-oriented country being South Africa (0.7%). The Arab States (in Africa and Asia combined) devote only 0.2% of their resources to R&D. This low figure merits a more detailed look to ascertain to what extent the overall Arab GDP is inflated by the values of important petroleum production figures (although not all the states concerned are oil producers). In point of fact however, the presence of researchers from the Arab region, albeit negligible by international standards, is still about three times higher (0.6%) than the region's share of world GERD.

Regional ratios are, of course, directly biased by the weight of the major countries (Brazil, South Africa, China, Japan, etc.), which can cloak the reality of other countries in the same region.

Figure VI
Researchers per million inhabitants in 2000
By region/principal countries



Standing up to be counted

There were some 876 research scientists and engineers (RSE) per million inhabitants worldwide in 2000, down from 985 in 1997. This overall decline is explained by the rapid population growth in the developing countries, for which the number of RSE fell from 347 to 313 per million between 1997 and 2000. The indicator remains unchanged in the developed regions over the same period. We are seeing a very low presence of RSE in the Arab States and, above all, in Africa (Figure VI).

Japan is the most R&D-intensive of the major players in R&D, outstripping both the USA and the Russian Federation. Again, there are large disparities both between and within regions.

Conditions that favour brain drain

Expenses per researcher (Figure VII) in a country are composed of three elements: his/her own salary, the salaries of technical and support staff, and the average amount of capital and other expenses per researcher, with the total salary element typically representing more than half of the total – and often up to two-thirds or more – depending on the sector or the discipline of R&D.

The UIS figures for GERD per researcher in absolute terms, as well as relative to GDP per capita, suggest several important issues for governments wishing to build up effective and sustainable R&D systems in terms of salaries

and a proper working environment that provides access to capital equipment, instruments and other research facilities. What is certain is that countries which pay RSE low salaries – certainly in terms of GDP per capita when compared with other countries – are the first to fall victim to brain drain.

A new phenomenon

In a new twist, we are seeing the phenomenon of 'brain drain' not of people but of jobs: a Deloitte survey of 600 firms in Western Europe and North America in October 2003[3], for example, shows that 14% of these firms have R&D activities in China, a figure that is expected to rise to 20% in three years' time. This trend is reflected in the share of foreign expenditure in total Chinese R&D expenditure.

It can reasonably be expected that private companies will increasingly set up research activities abroad, including in a wider spectrum of developing countries. This is not yet clearly visible from the current data but will no doubt show up in the future.

There's no turning back

It is clear that the problems of collecting truly comparative data and making sense of them are huge for the many countries which play only a minor role in S&T.

Yet the stakes are high. No single country has succeeded in achieving and sustaining high levels of prosperity and comfort without investing in S&T and exploiting them. The effort therefore must be sustained. As we have seen in the foregoing, even the most straightforward of input data can offer a solid base for policy-making and point to very real trends in development. More often than not, alas, these trends are only too indicative of the snail's pace at which we are progressing towards the overall goal of equitable global development.

Gunnar Westholm[4], Bertrand Tchatchoua[5]
and Peter Tindemans[6]

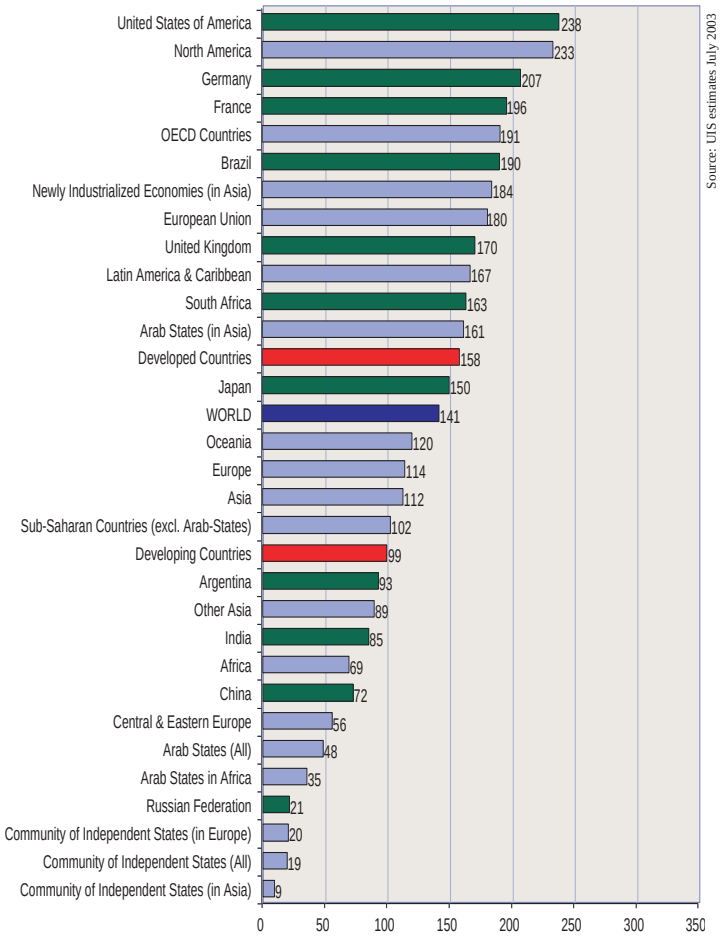


Figure VII
GERD per researcher in 2000 (in thousands $PPP)
By region/principal countries

1. Data for some countries may be for 1999. Similarly, data for 1997 may be for 1996 in some cases: www.unesco.org/uis
2. Purchasing power parities
3. www.deloitte.com
4. UNESCO consultant, former OECD statistician
5. Statistician at UIS
6. Science policy analyst, former OECD Megascience Forum Chair

'Science is becoming a world system'

Caroline Wagner, Research Fellow at the non-profit think tank RAND, notes a 50% increase in the number of articles being internationally co-authored in the ten years to 1997, henceforth 15% of the total. 'Science is becoming a world system', she claims. All regions have developed their international collaboration, with the notable exception of the Middle East. As many as 50 countries could now be labelled 'scientifically proficient', according to Wagner, who estimates that the global network of scientific collaboration consisted of 128 core countries in 2000.

Wagner made these observations in her paper entitled *Can the Global Network of Science Contribute to Development?,* presented to the IDRC-UNESCO meeting in April 2003 on *Future Directions for National Reviews of Science, Technology and Innovation in Developing Countries*.

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Keeping tabs on **human genetic data**

Human genetic data tell us a great deal and promise to tell us much more. Yet, like many other aspects of the ongoing genetic revolution, they pose as many problems as they resolve. Many people fear they lend themselves to uses that are contrary to justice and civil liberties, and open the door to discrimination by employers, insurance companies and others. The *International Declaration on Human Genetic Data* adopted by UNESCO's General Conference on 16 October addresses these concerns. By establishing ethical principles governing the collection, processing, storage and use of human genetic data, the *Declaration* should guide states in formulating national legislation and policies which respect human dignity and fundamental freedoms, while giving due consideration to freedom of thought and expression, including freedom of research.

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Strollers in Iceland's capital, Reykjavik. Iceland is one of several countries which have decided to undertake a genetic census of their entire population

Collected from biological samples (blood, tissue, saliva, sperm, etc.), human genetic data are playing an increasingly important role in our lives. They are already providing answers to questions asked by judges and police: proof of paternity, identity of a sex criminal or of an accident victim. To varying degrees, they are also answering medical questions: genetic tests can already predict such diseases as the degenerative, hereditary Huntington's chorea. Other, less conclusive tests – indicating only a predisposition – provide invaluable information for prevention. Research based on human genetic data is extremely promising and likely to lead to more tests of increasing reliability, as well as to new approaches for understanding and treating innumerable diseases.

As a result, human genetic data banks are multiplying. Given that today even the smallest hospitals possess, if not processed genetic data, at least a collection of DNA samples ready for processing, it is difficult to know how many banks exist. The largest, of them have already gone beyond the mark of one million data. The trend is irreversible and entire countries – Iceland and Estonia soon, Latvia and Tonga thereafter – have decided to undertake a genetic census of their entire population.

One issue is that of property. Common sense suggests that my blood, my saliva, etc, belong to me. But do they no longer belong to me once they have been extracted from my body? Without claiming an absolute property right, do I not at least have a say in what use is made of my cells or a product derived from my cells? Sometimes, this right is recognized: in the use of embryonic stem cells, certain legislations authorize research but demand the consent of the couple who, in the course of fertility treatments, provided one of their multiple embryos.

It had become urgent to establish ethical guidelines. UNESCO, which had already drawn up the *Universal Declaration on the Human Genome and Human Rights*, adopted in 1997 – therefore undertook the drafting of an international instrument on human genetic data through its International Bioethics Committee (IBC). The *Declaration* adopted in October is the result of the IBC's deliberations but also of an extensive international consultation. Discussions on the *Declaration*'s content continued right up until its adoption, to take into account the widest possible range of situations, including unequal scientific development but also more or less developed legislation in this domain.

The option of a declaration, which is not a legally binding instrument, was chosen in favour of a convention to facilitate consensus and allow for adaptations in a domain where the variety of situations covered, and the complexity of the subject, is constantly evolving with new scientific discoveries. The respect of international laws protecting human rights is the principal safeguard and a recurring theme evoked each time the *Declaration* allows exceptions or restrictions to the major principles it sets out.

For example, the *Declaration* emphasizes at the collection stage, 'prior, free, informed and express consent, without inducement by financial or other personal gain' of the person providing the data. Limitations are possible but 'should only be prescribed for compelling reasons by domestic law, consistent with the international law of human rights.' The right to withdraw consent is affirmed, 'unless such data are irretrievably unlinked to an identifiable person.'

The *Declaration* considers that data collected for one purpose should not be used for another purpose incompatible with the original consent. When a husband gives a sperm sample to help police investigating his wife's rape, for example, he believes that the sample (used in a process of elimination) will be destroyed, along with the genetic data extracted from it. In many cases, he is wrong: the data end up in police files where suspects, non-suspects and even victims are thrown together, simply for technical reasons.

The key issue at the processing stage is confidentiality. The *Declaration* stipulates that genetic data linked to an identifiable person may neither be disclosed nor made accessible to third parties, in particular employers, insurance companies, educational institutions and families, except for an important public interest reason in cases restrictively provided for by domestic law that is consistent with the international law of human rights. 'The privacy of an individual participating in a study using human genetic data, proteomic data or biological samples should be protected and the data should be treated as confidential,' states the text.

On sharing benefits, the *Declaration* affirms, 'In accordance with domestic law or policy and international agreements, benefits resulting from the use of human genetic data, proteomic data or biological samples collected for medical and scientific research should be shared with society as a whole and the international community.'

The *Declaration* proposes that independent, multidisciplinary and pluralist ethics committees be promoted and established at national, regional, local or institutional levels. It also calls for bilateral and multilateral agreements to enable developing countries to build their capacity to share scientific information and generate knowledge concerning human genetic data.

Pierre Gaillard[7]

Read the Declaration *at: www.unesco.org/shs/bioethics*

Africa vows to step up investment in R&D

The Ministers of S&T of 20 African countries have reaffirmed their commitment to increasing public spending on R&D to at least 1% of GDP within five years. This endorsement is enshrined in the* Declaration *and* Outline of A Plan of Action *adopted by the First NEPAD Ministerial Conference on S&T in Johannesburg (South Africa) on 3–7 November. Were the 1% target to be realized, it would constitute a mini-revolution for the African continent, where South Africa is currently the only country to devote as much as 0.7% of the public purse to R&D.

The Conference was hosted by the NEPAD secretariat in collaboration with the South African Ministry of Art, Culture, Science and Technology, represented by the Minister, Dr Ben Ngubane. A Council of Ministers of S&T within NEPAD was established by the conference, of which Dr Ngubane was elected first President

In his welcoming remarks, Professor Wiseman Nkuhlu, President of NEPAD's Steering Committee, described the objective of NEPAD's S&T initiative as being to lay the foundations of a continental forum which would develop a strategy and plan of action for S&T. Such a plan, he said, would need to identify both projects and a calendar for their execution, as well as necessary actions at the national, regional and continental levels.

Walter Erdelen, Assistant Director-General for Natural Sciences at UNESCO, applauded this approach. He urged NEPAD to make the African Ministerial Conference on S&T a permanent mechanism, in order to harmonize S&T policy both between countries and between the different sectors of the economy (industry, education, research, etc). Recalling the high priority UNESCO accords NEPAD, he offered to work hand in hand with the NEPAD Secretariat to design and implement NEPAD's plan of action for S&T.

One of the problems African scientists face is that of being cut off from the economic system. Ministers discussed ways of developing university–industry partnerships, technology incubators, innovation hubs and the like. In the *Declaration*, they undertake to promote a dialogue between stakeholders in S&T and to elaborate an appropriate regulatory and policy environment, including intellectual property protection, to encourage private investment in R&D. They also plan to develop and adopt common sets of indicators to benchmark their national and regional systems of innovation. The *Outline of A Plan of Action* is to serve as the basis for the elaboration of NEPAD's Commercial Project for S&T between now and November 2004.

Ministers resolve to build consensus and strategies to address concerns emerging with advances in new technologies, including biotechnology, nanotechnology and ICTs. They undertake to improve bilateral and multilateral co-operation and to put in place national and regional programmes promoting public understanding of S&T and their role in development.

Rural Zimbabwe in 1998. The NEPAD Declaration *identifies food insecurity, malnutrition, homelessness, unemployment, lack of affordable energy sources and the fight against disease (especially HIV/AIDS, tuberculosis and malaria) as priority areas for scientific research and technological innovation, the ultimate goals being to promote sustainable development and eradicate poverty*

7. UNESCO Bureau of public Information

They also undertake to improve enrolment levels and the standard of teaching in science, mathematics and engineering.

Bience Gawanas, a lawyer and the African Union's Commissioner for Social Services, and Acting Commissioner for Human Resources, Science and Technology, pinpointed brain drain as a serious challenge for African countries. The continent had lost a large number of highly trained experts in S&T, she said, and would need to tackle the problem of poor working conditions head-on if it wanted to retain talent.

Regional centres of excellence are a key NEPAD strategy for staunching brain drain. They concentrate limited resources in a single centre which is then in a position to make world-class equipment and facilities available to scientists and engineers from all participating countries. Professor Nkuhlu noted that the strategy was beginning to pay dividends. NEPAD had already attracted resources for S&T from development partners, he recalled, including C$ 30 million in funding only weeks earlier from the Canadian Fund for Africa for the International Livestock Research Institute headquartered in Nairobi (Kenya). The institute is set to become the first centre of excellence in the biological sciences to be supported by NEPAD, thereby enabling national agricultural institutions, including universities, to benefit from the centre's state-of-the-art facilities. Canada is also providing a grant of 3,850,000 South African rands (approximately C$ 783,000) to support the NEPAD Secretariat via its International Development Research Centre.

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Rebuilding **Iraq's universities**

A multi-million dollar initiative to rebuild and revitalize Iraq's once thriving universities was launched on 13 October in Doha (Qatar). The International Fund for Higher Education in Iraq is to provide both immediate and longer-term assistance, closely co-ordinated with Iraqi universities themselves to ensure that priority needs are the first to be addressed.

UNESCO's Director-General was in Doha to launch the fund together with Her Highness Sheikha Mozah Bint Nasser Al Missned, First Lady of Qatar, Chairperson of the Qatar Foundation for Education, Science and Community Development and UNESCO Special Envoy for Basic and Higher Education.

Administered by UNESCO and governed by the Fund Directorate chaired by the Qatar Foundation, the Fund is open to all interested donors for contributions in cash or in kind. The state of Qatar has provided a first donation of US$ 15 million to the Fund. Several other countries have expressed interest in participating in the initiative.

After so many years of economic hardship, the impact of war-related damage on Iraqi universities has been devastating. While levels of damage vary widely across the country, enormous investment will be required to serve the needs of some 300,000 students from Iraq's 20 universities and 47 technical colleges and institutes. The total cost of reconstruction and rehabilitation of higher education facilities is expected to top US$ 2 billion.

Medical students in Baghdad in better days. This photograph dates from 1983

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Mondialogo challenges students to **engineer a better world**

The Germano–American automobile company DaimlerChrysler and UNESCO launched the Mondialogo Engineering Awards on 16 October to challenge young engineers and technologists to find solutions for a better world.

Through the awards, Mondialogo will be looking for students who are keen to use their knowledge and expertise to improve living conditions durably in developing countries. Students from over 6,000 universities in developed and developing countries will be encouraged to work together on sustainable development projects.

Students are invited to focus their project on any one of the following themes: water supply, food production and processing, housing and shelter, sanitation and waste management, medicine and health care, energy development, transportation and mobility, communication, industry and manufacturing, development of natural resources, emergency and disaster response and reconstruction.

An international jury will select the top entries and decide on the final attribution of the 20 Mondialogo Engineering Awards in March 2005, each of which carries a purse of € 15,000.

To register for the Award and find a project partner: www.mondialogo.org

Islam and Science author among UNESCO laureates

Pervez Amirali Hoodbhoy is a passionate believer in the value of understanding science. He is also a nuclear and high-energy physics specialist at the Department of Physics, Quaid-e-Azam University, in Islamabad (Pakistan) and this year's winner of the Kalinga Prize for the Popularization of Science. Professor Hoodbhoy is notably the author of *Islam and Science: Religious Orthodoxy and the Battle for Rationality* (ZED Books, London, 1991). He has also produced three major television series on science and a documentary film on Pakistan and India under the Nuclear Shadow.

Professor Hoodbhoy was joined in Budapest on World Science Day for Peace and Development (10 November) by the recipients of five other UNESCO science prizes, at an award ceremony organized at the closing of the first World Science Forum (8–10 November).

In Budapest, Antonio Peña Diaz was awarded UNESCO's Carlos J. Finlay Prize for Microbiology. An active promoter of modern biophysical techniques in Mexico, Professor Peña Diaz has published books and newspaper articles on science policy. In 1994, he was appointed the first Emeritus Professor of the Cellular Physiology Institute, National Autonomous University of Mexico (UNAM).

The Javed Husain Prize for Young Scientists was awarded to Ravi Silva of Sri Lanka, Professor of Solid State Electronics at the University of Surrey (United Kingdom). Aged only 34, he leads the Large Area Electronics and Nanotechnology Research Group, which is part of the university's Advanced Technology Institute. He also recently set up a Nano-electronics Centre at the university.

The Sultan Qaboos Prize for Environmental Preservation was awarded jointly to the Venezuelan Centre for Ecology and to Norwegian biodiversity specialist Peter Johan Schei (see *A World of Scienc*e, Vol. 1, No. 5 for details).

The Institut Pasteur – UNESCO Medal was awarded to Fadila Boulahbal for her contribution to making the Algerian national programme against tuberculosis a success by creating a national network of tuberculosis laboratories. In 1970, Professor Boulahbal was made head of the Laboratory of Tuberculosis and Mycobacteria at the Pasteur Institute in Algiers. Thanks to her efforts, the laboratory became a WHO Collaborative Centre for tuberculosis in 1984.

The UNESCO Science Prize was awarded to Somchart Soponronnarit of Thailand for his research on renewable energy and drying technology. The award particularly recognizes his contribution to the creation of a fluidized bed paddy dryer and cyclonic rice husk furnace, as well as a recent 'heat pump dryer', which have been used and commercialized widely in Thailand and elsewhere.

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Lídia Brito
On NEPAD in general and

The New Partnership for Africa's Development (NEPAD) is a programme of the African Union, which groups some 53 countries; NEPAD has been endorsed by the United Nations as the framework within which the international community should concentrate its efforts for Africa's development. Mozambique assumed the one-year Presidency of the African Union in July 2003.

Lídia Brito is Minister for Higher Education, Science and Technology of Mozambique. Here, she speaks about the goals of NEPAD in general and Mozambique's own drive to develop S&T in particular.

What motivated the creation of NEPAD?

NEPAD was launched in 2001 as an initiative of leading African statesmen who believed that the time had come for Africa to address its development challenges by defining its own development agenda. It is a partnership at two levels. Internally, it includes all African nations which subscribe to this new agenda. Externally, it is a partnership between Africa and the rest of the world, in particular those nations that control the means to help Africa uplift itself. Through NEPAD, Africa has been able to place itself prominently on the political agenda of the G8.

Lídia Brito

Mozambique in particular

The African Union is the successor of the Organization of African Unity (OAU). The creation of the African Union in 2002 shows that the African leadership itself realizes itself that, in order to resolve the problems their peoples face, they have to create a united front, a power block not dissimilar to those other pan-continental blocks emerging in the Americas and in Europe. However, Africa is still far removed from the level of co-ordination and integration attained by the European Union for example.

What bearing will Mozambique's Presidency of the African Union have on NEPAD's S&T agenda?

NEPAD and the African Union have different origins. Currently, NEPAD is a programme of the African Union under the latter's Assembly. NEPAD's Steering Committee consists of the personal representatives of the five initiating presidents (NDLR: of Algeria, Egypt, Nigeria, Senegal and South Africa). Mozambique is not a member of this group. However, as President of the African Union, Mozambique is a member of the Heads of State and Government Implementation Committee (HSIC) that comprises three states per region of the African Union, as mandated by the OAU Summit of July 2001 and ratified by the African Union Summit of July 2002. The HSIC's main function is to set policies and priorities and define the Programme of Action. The HSIC is expected to meet three times a year. It reports annually to the African Union Summit.

The Steering Committee develops the Terms of Reference for identified programmes and projects, and oversees the NEPAD Secretariat, which co-ordinates implementation of projects and programmes approved by the HSIC.

Over the next year, how does Mozambique intend to define the S&T cluster within NEPAD?

It is clear to us that a lot remains to be done with regard to the S&T agenda of NEPAD. We believe it is essential that NEPAD constitute a mechanism of synergy that will serve its individual members by integrating the scientists of different countries in regional and continental networks that enhance social relevance and scientific quality for the benefit of all involved. These networks should not be exclusively academic but rather embedded in society so that they become part of hubs that speed up innovation in society in general. This is what Mozambique is defending in relation to a S&T agenda within NEPAD.

The Council of Ministers approved Mozambique's S&T Policy on 22 July. What are your priorities and the time-scale for realizing these?

The Policy consists of an action plan covering four major areas: research, education, the productive sector and the communication, or dissemination, of S&T information and data. The action plan, as it stands, has a time-span of five years and a total budget of US$ 18.8 million.

The major slot, US$ 10 million, will go towards building a science museum network. At the moment, Mozambique has basically three small science museums: one on ethnology in Nampula in the North of the country, one on natural history in Maputo, the capital, and a third on geology, also in Maputo. As you can see, the network is restricted in scope and geography. All have relatively old collections and are characterized by a classical museum approach. The Natural History Museum has regionally important collections but has had many difficulties in conserving these. Interactivity does not exist. There are no museums to help people understand national traditional techniques or industrial technologies and no exhibits to acquaint people with modern technologies. Our strategy entails using the existing museums as a starting point by adding the interactive component, including virtual collections. Later on, we will proceed with creating other thematic science museums throughout the country.

The museums might be a flagship of the policy and even consume most of its budget but they are not its core. The policy is based on the assumption that each of the four components I mentioned earlier should be strengthened internally and that the interconnections between each of them should be improved.

What does the plan foresee for formal education?

We need to build the capacity of schools to teach S&T at different levels, for instance through the microscience kits UNESCO has developed, in combination with actions that reinforce the pivotal role of schools in community development.

One of the reasons why pupils drop out is that they consider the curriculum of little relevance to their daily life. The S&T policy wants to change this by dedicating US$ 500,000 in 2004–2005 to hooking up schools to rural and health extension services in such a way that these schools become motors of technological innovation.

Extension services should train and assist teachers in key areas such as nutrition, hygiene, health, agricultural production and basic industrial skills. In turn, teachers should transfer this knowledge to the communities in which they work, either indirectly via the children or directly to their parents. The experiments conducted in Sofala province, in the centre of the country, indicate that teachers can exercise this role successfully, for instance by promoting improvements in nutritional habits. To take these experiments further is a key innovation in Mozambique's approach to education and the relation between education and community development.

You spoke earlier of the need to enhance the social relevance and quality of R&D? How do you plan to translate this objective at the national level?

The S&T policy also intends to reinforce the national scientific research system and its relations with the rest of society. For that reason, the government wants to create stakeholder-managed competitive funds worth a total of just over US$ 4.1 million in at least four priority areas to be defined following an assessment by major national stakeholders, bearing in mind our country's position in the region, its options for development and the needs of its population. Within this system, sectoral scientific councils composed of scientists and research clients from civil society and the productive sector will allocate funds through a bidding process. In this way, we hope to achieve two things simultaneously. Firstly, those in need of the application will be able to influence the research agenda. This will make science more relevant to economic growth and poverty alleviation. Secondly, competition will force scientists to improve the quality of their work.

Although the increasing rate of authorship of international scientific publications shows that Mozambique's scientists are producing scientifically acceptable results, international competition is getting stronger. In a context of integration at different levels – regional through the Southern African Development Community (SADC) and continental through NEPAD and the African Union – Mozambique will have to achieve at least the same level of excellence as its neighbours, although the resources at our disposal are far fewer than those of most of them.

Won't Mozambique's limited resources make it difficult to disseminate S&T information to rural areas?

I have already mentioned that one action in the area of dissemination, concerns the revitalization and expansion of the national museum network. The plan also devotes US$1 million to supporting community radio programmes and on markets. Technological innovation depends on the availability of information and on market conditions. Community radios can play a key role in both fields, especially as their penetration is much deeper than other means of communication and independent of, for example, the conditions of roads – during the rainy season, when agriculture is most intensive, many roads are inaccessible. Moreover, community radios use local languages. Radio programmes, for instance, can transmit information on technologies for plant protection or on new tools, provide weather forecasts, etc. And they can disseminate market information. This is important because, independently of the scale of his or her production, a producer will only invest time, effort and money when he or she has minimal guarantees of a return on that investment. Market information, therefore, is crucial to the success of technological innovation, as it will make the market more transparent and strengthen the position of producers in their negotiations with traders.

Does this action plan imply a greater allocation of financial resources to S&T than previously?

Mozambique is a poor country. Despite that, the total budget for research equals 0.6% of GDP and a further 6.5% goes to education. The level of investment proposed by the S&T policy requires additional inputs for which we are, unfortunately, highly dependent on donors. Thus, in the end it will not only depend upon us, the Government of Mozambique, but also on our international partners, which components we will be able to implement when and to what extent.

Last but not least, what are Mozambique's plans for celebrating World Science Day for Peace and Development on 10 November?

Mozambique celebrated the first World Science Day last year. At the time, we wove several provincial and national initiatives into a single nationwide programme. This year, we are organizing a science fair. At the fair, over 40 Mozambican scientists will show samples of their output at a session illustrated by more than 100 posters. There will also be presentations, debates and roundtables on different topics related to science, research and development. This will be combined with a trade fair where various research entities will have a chance to display their activities. The trade fair will also involve the participation of enterprises exhibiting the S&T component of their work. The entire event will take place on the commercial fairgrounds in Maputo. In this way, we hope to take science to the public.

We had hoped to be able to use World Science Day as a platform for relaunching the Maths-by-Internet competition on a national scale. However, for various reasons, we have been unable to finalize the programme in time. Now we hope to launch the competition in February.

Interview by Susan Schneegans and Folar Osotimehin

The **floating** university

On 20 September 2003, the *Professor Logachev* berthed in St Petersburg (Russia) harbour at the end of a Sub-Arctic research cruise that had taken it to ports of call in Copenhagen (Denmark), Tromsø (Norway), Reykjavik (Iceland), Nuuk (Greenland) and Dublin (Ireland). The students and senior scientists who disembarked here had just spent ten weeks studying the deep sea with the help of sophisticated acoustic and televisual imaging equipment and samples taken from the seabed.

Over the past 13 summers, more than 600 undergraduate and post-graduate students from 25 countries have taken part in cruises like this one. Under the guidance of senior scientists from international academic, governmental and industrial backgrounds, students conduct cutting-edge marine research in the Mediterranean and Black Seas, and in the North Atlantic Ocean. Many will go on to become research leaders.

The Training–through–Research programme was launched in 1991 by UNESCO and the European Science Foundation. For the past eight years, it has been sponsored by UNESCO's Intergovernmental Oceanographic Commission (IOC). What makes it different from other on-the-job training exercises is that students go through the entire cycle: from being provided with knowledge on the subject of their research to data collection, laboratory analyses and, ultimately, the presentation and publication of the research results. The UNESCO Chair in Marine Geosciences at Moscow State University serves as the programme's training arm.

In addition to providing students with advanced training in marine science, the programme contributes to knowledge of ocean margins, a new frontier where many exciting discoveries have been made over the past decade or so.

Living on the edge

The 'floating university' conducts research in a zone which marks the transition between land and the deep sea, the 'ocean margin.' This zone may vary from one hundred to several hundred kilometres in width, depending on the morphology of the seabed.

Ocean margins harbour most of the world's marine biodiversity, making them crucial for fisheries. Yet many of the ecosystems at the ocean margin are poorly known. Take the deep-sea, cold-water coral reefs for example, which are found at depths of several hundred metres to 1 km; able to do without sunlight (photosynthesis), they rely on chemosynthesis for their life energy. Researchers only now acknowledge the existence of the Great European Barrier Reef, which occupies the frontier between the outer shelf and the deep sea.

The ocean margins are home to myriads of microbes and bacteria which use fluids originating from the geosphere (geofluids) as the source of chemical energy in their life cycle. Resent research has shown that these micro-organisms are 'housekeepers' of the Earth's climate. On the seabed, they consume most of the methane and other hydrocarbon gases rising from the geosphere through the hydrosphere into the atmosphere, thereby limiting any rise in the Earth's temperature. But the amount of 'greenhouse gases' escaping into the atmosphere is now reaching inacceptable limits: air pollution in Europe soared to new heights last summer. According to the WMO, the summer of 2003 was yet another

Deep-sea corals live in water of approximately 4°C. If deep-water coral reefs are valued today for their ability to absorb hydrocarbon gases and nourish fish populations, they were long neglected and have been decimated in recent decades by large-scale trawling. Known at the Norwegian margins as early as the 18th century, deep-sea corals only began attracting attention in the 1990s with the advent of oil exploration at ocean margins, in parallel to growing understanding of the need to protect the ecosystems of the high seas

climatic anomaly and the hottest in the 143 years for which records have been kept. Glacier records tell the same story. In the pre-industrial world, atmospheric CO_2 concentrations oscillated on roughly 100,000-year cycles between 180 parts per million by volume (ppmv) during glacial periods and 280 ppmv during the warmer interglacial periods. We are today at an unprecedented 370 ppmv and this is showing signs of rising.

Ocean margins are attracting increasingly intense interest from researchers and industry. Little over a decade ago, it was discovered that they contain huge, largely untold reserves of energy sources like methane gas. At this stage, we still do not know the true extent of these energy resources, nor even whether it will be possible to exploit them commercially in the near future.

It is also at the ocean margins that you find the recently discovered carbonate mounds. These 'rolling hills' may be 200–300 m high. Some researchers believe that carbonate mounds act as natural beacons, pinpointing the spot where hydrocarbons lie buried beneath the surface. Others are less categorical; they point to the fact that carbonate mounds are the result of microbial activity which disintegrates hydrocarbon gases and accumulates carbonates. These same carbonate mounds may also be found in mountainous areas on land which were originally under the sea. On land, the mounds are known to geologists as 'stromatolites', one of the oldest indications of life on Earth.

Ocean margins provide an important record of global change on various temporal and spatial scales. In recognition of their specific role, the European Commission has established the Ocean Margin Deep-water Research Consortium, which overseas a dozen projects studying European margins.

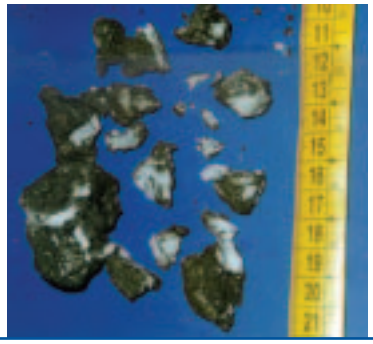
Students on board the Professor Logachev *studying carbonate chimneys recovered from the Gulf of Cadiz*

The mysterious past and uncertain future of gas hydrates

By some estimates, methane in gas hydrates has an energy potential equivalent to twice the known reserves of oil, coal and gas combined. Reserves of methane seem to be abundant at the ocean margins in many parts of the world, including Alaska, Antarctica, Europe, the Gulf of Mexico and the USA. The Training–through–Research programme was among the first to begin a detailed investigation of this phenomenon on the European Margin.

Methane is stored as a 'gas hydrate' trapped inside frozen water molecules. Under certain conditions – combining low temperatures and high-pressure on the seabed –, gas hydrates will solidify, forming what look like jagged rocks.

Gas hydrates are notoriously unstable. When sudden changes in sea level, underwater earthquakes, landslides or other geohazards change the pressure and/or temperature, gas hydrates evaporate quickly. This prompts the release of an immense volume of greenhouse gases into the atmosphere – methane is a greenhouse gas ten times more powerful than carbon dioxide. It is thought that massive releases of methane in the distant past could have accelerated global warming and precipitated the end of the last ice age. This is one reason why the Training–through–Research programme is interested in geohazards.



Students lose no time in measuring gas hydrates once they have been brought to the surface because these 'disappear into thin air' within seconds unless put in a freezer for further analysis

The subject of my studies is mud volcanoes at the ocean margin of Morocco. On board the *Professor Logachev* [in 2002], I admired the quality of interpretation of this phenomenon, the secrets of which are not yet well understood by researchers. With the assistance of the TTR programme, I have an opportunity to continue my studies and carry out research in a domain that requires heavy equipment and considerable resources, otherwise unavailable to me.

Merouane Rachidi, post-graduate student, University Mohammed V (Rabat, Morocco)

At present, it is not technically feasible to exploit gas hydrates on a large scale. There are also concerns that deep-sea exploitation of hydrates could destabilize the ocean floor and release large volumes of methane into the atmosphere.

The potential of mud volcanoes for oil exploration

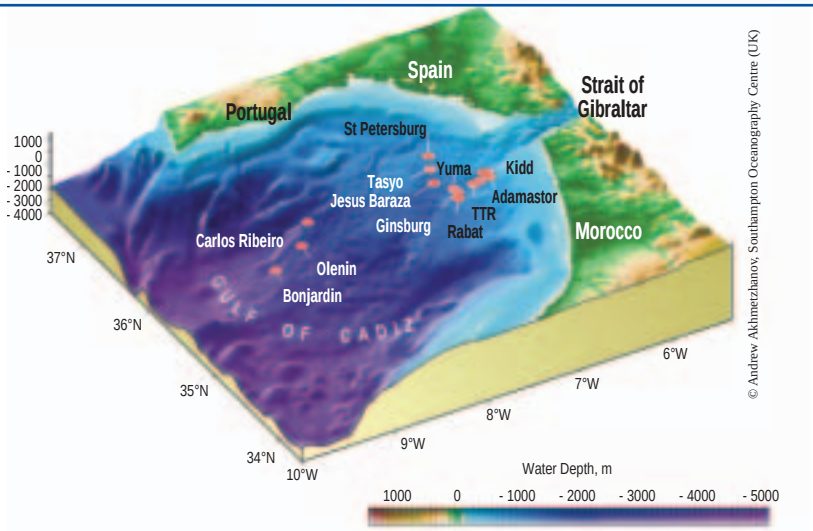
Mud volcanoes are another focus of the Training–through–Research programme. These exist both on land and at sea. Tectonic movements within the Earth's crust build up pressure. When this pressure becomes too intense, deeply buried mud bursts through the upper layers of the sedimentary cover, transporting fragments of deep-seated rocks and hydrocarbon gases. In the ocean, these fragments settle on the seabed. Studying them provides key insights into an area's geological history. Certain fragments may even contain organic matter indicative of the area's hydrocarbon potential.

As early as 1991, the Training–through–Research programme discovered the first mud volcanoes in the Black Sea. Many others have since been discovered and studied along the European and African margins in the Mediterranean Sea and the Atlantic Ocean.

Coming to grips with an underwater world

The Training–through–Research programme focuses on emerging global issues. In the area of oil exploration, research seeks to determine the source of geofluids and the level of maturity of organic matter located in deep-formed hydrocarbons. Scientists then attempt to develop palaeo-environmental reconstructions based on palaeontological and other records. A wide range of interdisciplinary research methods are used encompassing the geophysical and the biogeochemical. The collected data serve to assess the ocean margins' petroleum potential.

Several special issues of international scientific journals and a wealth of research articles on geofluids, gas hydrates, carbonate mounds, geohazards and sand bodies (the latter represent potential reservoirs for hydrocarbon deposits) at



Major mud volcanoes discovered in the Gulf of Cadiz, which lies between Europe and Africa, during the 1999 and 2000 cruises on board the Professor Logachev

ocean margins have been published by participants in the research cruises since 1991, most of these co-authored by students.

Meeting the costs of deep-sea research

Deep-sea research is a costly business. The secret of the programme's success lies in co-funding involving research groups from many European countries. Notably, Russia contributes to costs by providing a well-equipped research vessel, the *Professor Logachev*, a crew and technical staff to operate the sophisticated equipment. The seed contribution provided by the UNESCO-IOC attracts funds for field operations from mostly European universities, from oil prospecting companies and national geological surveys, as well as from projects funded by the European Commission. The funds available to the programme are always earmarked for research of specific interest to the sponsors, which hail mostly from Eastern and Western Europe.

Students examine an oil pellicle in the crater of a mud volcano in the Kerch peninsula (Ukraine). Found both on the seabed and on land, mud volcanoes are normally of a conic shape with a crater at the centre surrounded by a rim. Under the sea, mud volcanoes are generally a few hundred metres in height and width, although young ones will be smaller. Some are active and still growing – mud and gases erupt periodically into the water – but many are inactive or dormant, the shifting seabed and currents having partly destroyed them

The complex interaction between the geosphere and biosphere

The concept of the biosphere was first introduced by E. Suess in 1875 and further developed by V. Vernadsky (1926), who considered the ensemble of living organisms (or biota) as the geological force at the surface of the Earth which influenced virtually all geological processes.

Recent research, in particular that on ocean margins and mid-ocean ridges, has demonstrated that the interaction between the geosphere and the biosphere is of a more complex nature: fluids seeping from the Earth's crust into the oceans – or from the geosphere to the hydrosphere – contribute substantively to the entire Life System on Earth. The concept of interaction between the geosphere and the biosphere has set the stage for new disciplines such as biogeology, biogeochemistry and geomicrobiology, which open up truly novel research avenues.

There are not enough experts in marine resource exploration today, despite the fact that governments, academia, universities and the private sector all need to be able to call on them. The situation is particularly worrying in developing countries where, with the odd exception, there is no critical mass of specialists trained to the point of being able to interpret research results and advise their governments and other stakeholders on matters related to the exploitation of deep-sea resources within their exclusive economic zones.

The harsh realities of sponsorship prevent the Training–through–Research programme from inviting a greater number of participants from non-contributing countries. This said, every effort is made to involve young researchers from developing countries, who represent about 10% of total students on board. Over the past decade, students have come from some 25 countries, including Algeria, Bangladesh, Brazil, Bulgaria, Chile, Georgia, Morocco, Saudi Arabia, Tunisia and Ukraine, in addition to the USA and practically all countries in Europe, including land-locked Switzerland. The organizers ensure that all governments contribute what they can to the programme, be it scientific knowledge, sophisticated equipment, funding, personnel or free port calls, and that their young scientists all walk away from the cruise having gained from the experience.

Within the TTR programme, we learn about the ocean and its resources. We also study how hydro-carbon fluids nourish the biota on the seabed and are transformed by the latter, thus contributing to global chemical cycles, etc. I came to the programme as a young student but, during my last cruise, I was a Co-chief Scientist conducting research and sharing my knowledge with younger students.

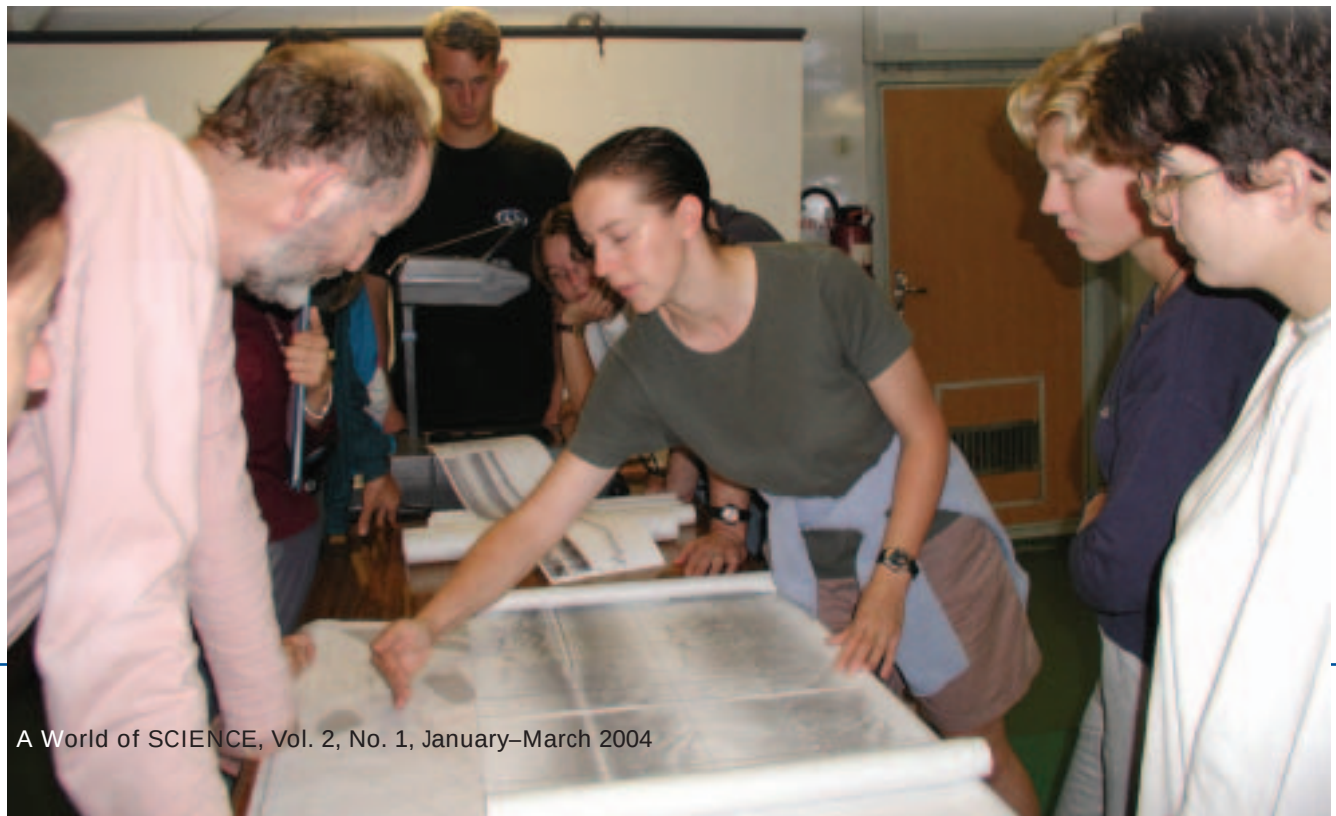
Alina Stadnitskaya, PhD student at Royal Netherlands Institute for Sea Research (Den Burg)

Every year, the research teams' results are presented to post-cruise conferences and other fora, such as the international Ocean Margin Research Conference last September in Paris (France). At the invitation of the European Commission's Ocean Margin Consortium, the IOC and Division of Earth Sciences of UNESCO co-sponsored the latter event. One of the invited lectures was a summary of research on board the *Professor Logachev* over the years.

Alexei Suzyumov[8]

8. UNESCO Programme Specialist: a.suzyumov@unesco.org

On board the Professor Logachev, *students discuss freshly obtained seismic data with Dr Neil Kenyon of Southampton Oceanography Centre (UK), the programme's co-ordinator*



Margaret's **story**

Margaret Mathenge

Margaret Mathenge is poised to become the first Samburu woman to hold a Master's Degree in Science. With UNESCO support, she is currently preparing a thesis on the *Physico-chemical and microbiological characteristics of NyiriNyiri*, a traditional Samburu meat dish, at Egerton University in Kenya. Her accomplishment is a testimony both to her own ability and courage, and to the men and women who have stood by her at each of the crossroads in her brief existence.

Beaten and neglected by her father, Margaret hoped she would never live to see her twelfth birthday. Until the day the first woman teacher walked into her school. 'She had no man to command her. Men young and old treated her with respect – even my father. She became a symbol of what I wanted to be.'

For decades, UNESCO has been striving to mainstream women's rights and the education of girls and women. The task is immense. At the same time, UNESCO is trying to satisfy growing donor requirements for results-based programming – not something which is always easy to accommodate, since not all results are immediately tangible. The following account shows some of the positive secondary effects of educating women. This is Margaret's story.

Margaret was born in the village of Morijo in 1972, some 80 km from the town of Maralal in Samburu District in Northern Kenya. The Samburu tribal community remains a male-dominated society.

The fifth of ten siblings, Margaret grew up in a climate of domestic and tribal violence. The area was often raided by the rival Turkana tribe on expeditions to steal cattle. School would be interrupted by the raids, which would force the Samburu to abandon their homes and take refuge in the forest. Whenever the Samburu had forewarning, the bodies of Turkanas would litter the ground, later to be eaten by dogs and hyenas. At home, Margaret's polygamist father, James, used to beat her mother and siblings on the slightest pretext, such as for dropping a spoon.

At the time of Margaret's birth, there was only one iron-roofed house in the village, which served as catholic church, school and police administration. Starting out from a small grass thatched cubicle that doubled as the family home, Margaret's mother Mary ran a small business selling *posho* (maizeflour), sugar, *shukas*[9], tealeaves and blankets. With the proceeds, she was able to build a two-room home with an iron roof for the family.

Margaret loved school. For the first three years, village children sat under a tree. Classes were taught in English but the children communicated among themselves in either Kiswahili or Samburu. School also provided Margaret with a respite from life at home, dominated by violence and a myriad of household chores, including fetching water over 10 km away.

Things deteriorated when Margaret's mother left her father, moving onto a piece of land bought for her by her brothers in Laikipia. Margaret and her elder sister Esther were left in their father's 'care'. 'I had no ambition at this time', says Margaret.

She no longer wished to die young

'This changed when the first female teacher was posted to our school. She lived alone in her small house, had her own money and was the first woman I knew who could make her own decisions. She showed me pictures of beautiful buildings and cars, told me about high school and college. I realized I wanted to experience life beyond Morijo, to see roads that were passable even after heavy rain, to see women who could drive cars and women who were bosses.' Margaret's teacher told her that the key to her own success had been education and refusing to marry before completing her schooling, that when the time came, Margaret could also choose her own husband.

From that time on, Margaret 'had a dream and worked even harder at school'. She no longer wished to die young.

Hard times

In 1984, James joined Mary in Laikipia for what was supposed to be a short visit. He stayed away for a year and a half. Once the girls had exhausted the family food stocks, they were taken in by neighbouring families. They had to leave school that year to mind the livestock with other girls of their age.

When drought hit the region in 1984–1985, food became scarce, so the sisters set up a small business. Starting with

9. Red, white and blue sheets of tied cloth that the Samburu use to cover themselves

These Masai girls in the Rift Valley belong to an ethnic group related to the Samburu. Although Kenya has attained gender parity in primary education and is expected to achieve the same in secondary education by 2005, the road to education can be long for girls from pastoralist tribes, many of whom are married off when they reach puberty

a few bags of *posho* and sugar loaned to them by a truck driver, Esther and Margaret began trading food for hides and skins. With their earnings, they were able to feed their adoptive families. When James returned, he took over the business and bought himself a second-hand Toyota Landcruiser with his daughters' savings, leaving them only enough to buy a single school uniform each.

Barefoot, Margaret returned to school after an 18-month absence, all the more determined to make a success of her life.

The end of primary school and the beginning of married life

In her last year of primary school, Margaret looked on as all the girls in her class were married off forcibly to older village men. Each time, the ceremony was preceded by an excision of the young bride's external genital organs. Margaret was overwhelmed with a feeling of helplessness. But when her father gave consent for Esther to marry a soldier, Margaret alerted her mother in time to hide the girl. His ambitions thwarted, James vented his fury on Margaret – but this was to be the last beating. Margaret ran away and was taken in by a teacher's wife. Shortly thereafter, her father married a girl in class six.

Margaret came top of her class for the year eight Kenya Certificate of Primary Education examination in 1986. This secured her a place at the low-cost private catholic school of St Theresa's, which covered the districts of Samburu, Marsabit, Turkana and Isiolo.

Margaret spent an anxious first term. 'I tried to learn as much as I could because deep down I knew there was no way I was going to complete my schooling, since my mother could not afford to pay all the school fees'. Her heart in her mouth, Margaret confided her fears in the Headmistress, Sister Lawrence Nava, after the first term examinations. To her astonishment, the Headmistress offered to pay Margaret's school fees, as well as pocket money and the bus fare to and from her mother's home in Laikipia – on condition that Margaret give her father a wide berth until the end of her schooling.

It took a few years of coming top of her class for Margaret to realize that the only remaining obstacle between herself and university was her own lack of ambition.

At age 20, Margaret was the only Samburu woman to be accepted at Maseno University College. Upon graduating, she embarked upon a teaching career at Kisima Girls Secondary School. 'I always wanted to go on to higher education but sacrificed this ambition to pay my three younger brothers' primary and secondary school fees.[10]

It was at this time that she met and married Mugo Mathenge. After the birth of a son and daughter, the young couple decided she should pursue her education.

Enrolment in tertiary education in Kenya in 1990 and 2000 (%)

	1990				2000			
	Total	Male	Female	GPI (F/M)	Total	Male	Female	GPI (F/M)
Kenya	1.6	2.4	0.9	0.38	2.9	3.3	2.5	0.77
Sub-Saharan Africa	1.6	2.4	0.9	0.38	2.5	3.3	1.3	0.48
South and West Asia	4.7	5.6	3.8	0.68	6.6	8.5	4.6	0.55
GPI = gender parity index								

N.B A ratio of 0.98–1.02 is considered gender parity. Source: UNESCO (2003) Education for All 2003/4 *(Table 8)*

A thesis inspired by childhood memories

Margaret applied for a Master's Degree in Food Science from Egerton University. Her thesis proposal was inspired by the hardships of her childhood and her experience of women as food-providers. Memories of childhood food insecurity still vivid, Margaret chose to focus her thesis on *Physico-chemical and microbiological characteristics of NyiriNyiri*, a Samburu meat product preserved by deep fat-frying. Using this method, Samburu women are able to preserve meat for up to six months, even in the very hot climate of Northern Kenya.

In September 2002, Margaret approached UNESCO's Nairobi office for sponsorship, having learnt that the office supported training in the biological sciences with a poverty-alleviating scope. Among other suggestions, I proposed that Margaret include a strategy for dissemination of the results, so that her research would directly benefit the people in her area. Margaret consequently added a training session to her project proposal. This will entail her instructing 12 Samburu women on how to prepare *NyiriNyiri* so that it stays edible for longer. The 12 women will then go to 12 villages to teach the women there better ways of preserving the meat.

Margaret is currently implementing her research project in the food microbiology laboratory of the Department of Dairy and Food Science and Technology at Egerton University.

Ditte Dahl Lisbjerb[11]

For further information: susan.nkinyangi@unesco.unon.org

10. Since the introduction of free primary education in Kenya in January 2003 (covering tuition but neither the cost of uniforms nor examination fees), primary enrolment has risen from 5.9 million to 7.2 million
11. Associate Expert in the biological sciences in UNESCO's Nairobi office from 2000 to 2002

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Raising the American flag at UNESCO for the first time in 19 years on 29 September in the presence of Laura Bush

Governing **Bodies**

On 16 October, the General Conference approved UNESCO's programme and budget for the sciences in 2004–2005. Below are some highlights.

Two new projects involving UNESCO's IHP and MAB programmes are included under 'land–water interactions'. Both will integrate sustainability into country policies, target Millennium Development Goals and feed into the World Water Assessment Programme hosted by UNESCO.

The first project concerns the marshy and forested **Palessia region** shared by Belarus, Ukraine and Poland. Transborder activities will strive to preserve the biological diversity and freshwater resources of a region threatened by the draining of the marshes between the 1960s and 1980s, and by radioactive contamination over part of its territory since the explosion of the Chernobyl nuclear power plant in 1986. The second project concerns the Sustainable Integrated Management and Development of Arid and Semi-arid Regions of Southern Africa (**SIMDAS**). Proposed by 14 SADC countries, SIMDAS has been developed by scientists and others from the region who will implement the project with UNESCO's help and guidance. SIMDAS will address health and environmental problems, energy insecurity and communication difficulties, with emphasis on the design of community-based projects focusing on the role of rural women.

The **International Basic Sciences Programme** (IBSP) was adopted. Expected to be fully operational by 2005, it will: promote excellence in national science and the transfer and sharing of information; provide Member States with international scientific expertise; and foster awareness of science by society at large. The IBSP adopts a region-specific approach, the central role being played by existing centres of excellence or benchmark institutions in the basic sciences and science education.

An **international centre on qanats** and historical hydraulic structures in Yazd (Islamic Republic of Iran) is to be set up under the auspices of UNESCO. Employed since ancient times, qanats are underground galleries that tap and continuously convey groundwater. They have proved to be an extraordinarily sustainable traditional technology.

An ***International Declaration on Human Genetic Data*** was adopted (see p. 7). Moreover, the name of the International Geological Correlation Programme (IGCP) was changed to the **International Geoscience Programme** (the familiar acronym remaining the same) and the General Conference threw its support behind the **Earth Charter** and an **International Year of Physics in 2005** to mark the centenary of Albert Einstein's theory of relativity.

*The **Communiqué** issued at the close of the Ministerial Roundtable on Towards Knowledge Societies on 10 October is published in UNESCO's report on* Science in the Information Society*: www.unesco.org/wsis*

Diary

8–10 January
International Chemistry Olympiads International Consultation on their future development. UNESCO and National Commission for Latvia. Riga: an.pokrovsky@unesco.org www.unesco.org/science/bes

13–17 January
Ocean Surface CO_2, Data Integration and Database Development Workshop organized by International Ocean Carbon Coordination Project to reach agreement on data formats for ocean carbon measurements from ships of opportunity and set up regional partnerships for data sharing to construct maps of ocean surface CO_2 for each ocean basin. Tsukuba (Japan): http://ioc.unesco.org/ioccp

17–22 January
Biological Sciences, Development and Society. IUBS 28th General Assembly and International Conference. Cairo, (Egypt): secretariat@iubs.org or s.arico@unesco.org

26–30 January
Building S&T Capacity for Effective Management and Sustainable Use of Biodiversity in Dryland Biosphere Reserves in West Africa. UNESCO-MAB/UNEP-GEF project launch. Includes roundtable on Biosphere Reserves as sustainable development laboratories for NEPAD attended by Ministers of Environment of Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger and Senegal. Room XIII, UNESCO HQ: www.unesco.org/mab, mab@unesco.org

29–31 January
North Atlantic and Labrador Sea Margin Architecture and Sedimentary Processes, Intl conf. and 12th post-cruise meeting of UNESCO-IOC's Training–through–Research programme. Organized and hosted by Geological Survey of Denmark and Greenland: tni@geus.dk

2–6 February
Pacific Islands Regional Ocean Forum, Will plan strategic actions under Pacific Islands Regional Ocean Policy. University of South Pacific, Suva (Fiji): c.summerhayes@unesco.org

9–20 February
Conf. of Parties to Convention on Biological Diversity, 7th meeting (COP 7). Kuala Lumpur (Malaysia): www.biodiv.org/meetings/cop-07/

11 February
Earth Sciences for Society Intl Conf. co-organized by UNESCO and IUGS to inform all UNESCO Delegates of intl activities in Earth sciences and their impact on society, and to request support for planned UN-wide Intl Year of Planet Earth (2006). Within 32nd Session of Scientific Board of IGCP (9–13 February), UNESCO HQ, Salle XII: www.unesco.org/earthsciences

2–5 March
1st Global Biotechnology Forum. Organized by UNIDO and Govt of Chile. UNESCO will present teaching kits on genetically modified organisms. Concepción: www.unido.org/biotech

7–20 March
Effects of Pollutants on Atmospheric Environment, UNESCO-IHP Training course for Asia–Pacific, Nagoya University (Japan): ishizaka@ihas.nagoya-u.ac.jp, in Jakarta: g.arduino@unesco.org, www.ihas.nagoya-u.ac.jp/ihp/ 13ihptc.html

29–31 March
Fifth Global Ministerial Environment Forum, and 8th special session, UNEP Governing Council . Jeju Biosphere Reserve (Rep. of Korea): www.2004unepkorea.org

31 March–3 April
Quantitative Ecosystem Indicators for Fisheries Management SCOR– IOC intl symposium, will review existing indicators and consider potential new indicators reflecting the exploitation and state of marine ecosystems: www.ecosystemindicators.org/

School pupils everywhere are invited to enter an art contest on 'Living in space' (6–10 years), an essay contest on 'Space in our lives' (11–15 years) and science fiction writing contest on any outer-space theme (16–19 years). The contests are co-organized by UNESCO (within its Space Education Programme), EURISY and the Norwegian Space Centre. For details on how to enter, go to www.unesco.org/science/earthsciences/sep.htm, or write to Yolanda Berenguer either at y.berenguer @unesco.org or via the Editor.

New Releases

Towards Integrated Management of Alexandria's Coastal Heritage
CSI Papers 14. By S. Morcos, N. Tongring,Y. Halim, M. El-Abbadi and H. Awad. A joint endeavour by the University of Alexandria, Supreme Council of Antiquities (Egypt), Governorate of Alexandria and UNESCO. Exists in English (and in Arabic soon), 79 pp.
Discusses efforts since 1997 to preserve Alexandria's past while allowing the modern city to develop. Studies have been conducted on how to stabilize Qait Bey Citadel without endangering the nearby Pharos Lighthouse site, on the feasibility of establishing an underwater archaeological museum and on how to control marine pollution and manage wastewater in the Eastern Harbour, site of a series of recent archaeological discoveries.
View at: www.unesco.org/csi/pub/papers2/alex.htm, or request a free copy from either: *cairo@unesco.org or www.unesco.org/csi/pub/PubOrderForm.rtf*

Small is Working: Technology for Poverty Reduction
90-minute video (PAL) and 60-page booklet co-published by UNESCO, Intermediate Technology Development Group and Television Trust for the Environment (€ 14.80), ISBN: 92-3-103910-5, English only.
The use of low-cost, small-scale technologies in developing countries was promoted in the 1960s by E F Schumacher, who published *Small is Beautiful: a Study of Economics as if People Mattered* in 1973. The current booklet and video show how smaller-scale and intermediate technology can reduce poverty and foster sustainable development.

Rays of Hope: Renewable Energy in the Pacific
Video and booklet published by UNESCO Division of Basic Sciences and Engineering, UNESCO Publishing.
Pacific islanders have been using renewable energies for millennia, sailing around the region on wind power, cooking with biomass fuel and drying crops the sun. Now, within international co-operation, they are extending the range of renewable energies to include hydropower, solar photovoltaic systems for lighting and water pumping, solar water heating, improved cooking stoves and coconut oil as a substitute for diesel. The Pacific states stand a real chance of becoming the world's first 'renewable energy economies'. Their survival, however, will also depend on international agreements to limit greenhouse gas emissions, responsible for global warming, climate change and sea-level rise.

Science in the Information Society
By Lisbeth Fog. Exists in English and French, 88 p., UNESCO contribution to World Summit on the Information Society (2003 and 2005), examines policy issues concerning open access, data preservation, electronic publishing etc., including recommendations from the S&T communities and Ministers: www.unesco.org/wsis

Study Abroad 2004–2005
32nd edition, 647 pp, ISBN: UNESCO 92-3-003888-1, € 18.50, UNESCO Publishing. Student guide (in English, French and Spanish) on study programmes around the world, distance education, national education systems, course languages, school fees, immigration requirements, scholarships and other forms of financial aid. A database that can be searched by country or domain of study free of charge is available at: www.unesco.org/studyabroad. A site interface allows authorized institutions and organizations to enter data directly.

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UNESCO natural sciences portal: **www.unesco.org/science**

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