A World of SCIENCE

Vol. 11, No. 1 ■ January–March 2013

The key to managing conflict and cooperation over water

Synthetic biology, a very discreet newcomer

Preserving the memory of the world

Getting out of debt

United Nations
Educational, Scientific and
Cultural Organization

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United Nations Educational, Scientific and Cultural Organization

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Vol. 11, No.1,
January–March 2013

A World of Science is a quarterly journal published in English by the Natural Sciences Sector of the United Nations Educational, Scientific and Cultural Organization (UNESCO), 1, rue Miollis, 75732 Paris Cedex 15, France

ISSN 1815-9583

Director of Publication: Gretchen Kalonji;
Editor: Susan Schneegans;
Lay-out: Mirian Querol.

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Cover photo: Indian children helping one another pump water. © S. Rajib/ UNESCO-IHE Photo Contest

Editorial photo: A dip in the holy Ganges River during a religious festival in India. The Ganges-Brahmaputra-Meghna Basin includes portions of Bangladesh, Bhutan, China, India, Myanmar and Nepal. © Arup Haldar/UNESCO-IHE Photo Contest

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We shall **sink or swim** together

'It seems intuitive', write the authors, the less water there is, the more likely it must be that people will fight over it. Well, actually, no. Researchers have found that arid climates are no more conflict-prone than humid ones. This is just one of the myths debunked in the article overleaf which inaugurates this, the International Year of Water Cooperation.

There are more surprises in store. It transpires that conflicts over water erupt in equal measure in rich and poor countries, democracies and autocracies, fortunately on rare occasions. Over the past 70 years, incidences of cooperation have actually outnumbered conflicts by two to one. And there is apparently no evidence of coming water wars, whatever the Cassandras of this world might say.

There is thus real cause for celebration. Be it a transboundary river basin or aquifer, or a water pump built for a rural village, examples of cooperation apparently abound. Which is just as well since, with demand for freshwater increasing as a corollary of demographic and economic growth, we shall have to pull together even more in future to ensure that there is enough of this fragile, finite resource to go around. That will also mean convincing the food, water and energy sectors to work together, rather than in silos. It will take strong institutions at both the national and international levels to satisfy competing demands and defuse tension when it arises, such as over proposals for shale gas extraction, mass irrigation or dam construction.

UNESCO's programme From Potential Conflict to Cooperation Potential and the UNESCO-IHE Institute for Water Education both regularly hold workshops on managing shared water bodies. Interestingly, they have discovered that the lawyers, hydrologists, engineers and economists who congregate within their walls do not speak the same language. At one workshop, each had a different definition not only of the term 'transboundary basin' but even of the word 'conflict'! It took some intense dialogue for them to start seeing these terms through one another's eyes.

Language is no barrier for the hydrologists who collaborate within the FRIEND network coordinated by UNESCO's International Hydrological Programme (UNESCO-IHP). Each of the eight FRIEND networks shares information, data and techniques, in order to monitor climate variability and change in river basins in a given region. The research produced by the European network may even lead to the adoption of a European Drought Policy.

Meanwhile, the UNESCO-IHP's Internationally Shared Waters Resource Management programme (ISARM) has assisted the United Nations in drafting the first international law on transboundary aquifers, due to be discussed in October during the UN General Assembly. In just over a decade, ISARM has mapped 400 transboundary aquifers, including five in Africa that had never been accurately studied before.

The Year is being launched at UNESCO headquarters in Paris on 11 February. Over the next 12 months, UNESCO and its partners will strive to convey four key messages. The first is that water cooperation is vital for poverty eradication and social equity; the second, that it creates economic benefits; the third, that it helps to preserve water resources and protect the environment; and, last but not least, that it builds peace. Water cooperation will also be the theme of this year's World Water Day on 22 March.

Within these pages over the coming year, we shall be profiling some of the success stories – and failures – in shared water management that can make such a difference to peoples' lives.

Gretchen Kalonji
Assistant Director-General for Natural Sciences

The **key** to managing conflict and cooperation **over water**

Dried-up pond in Bolpur, West Bengal (India) in April 2006. Quantity is one of three issues behind all water disputes.

Stanley Crawford, a former manager of an *acequia* (irrigation ditch) in New Mexico (USA), writes of two neighbours who 'have never been on good terms, … the lower neighbour commonly accusing the upper of never letting any water pass downstream to his place and then of dumping trash into it whenever he rarely does.' Such rivalries over water have been the source of disputes since the Neolithic revolution, when humans settled down to cultivate food between 8 000 and 6 000 BCE. The English language reflects these ancient roots: 'rivalry' comes from the Latin *rivalis*, meaning 'one using the same river as another.' Riparians – countries or provinces bordering the same river – are often rivals for the water they share. Today, the downstream neighbour's complaint about the upstream riparian is echoed by Syria about Turkey, Pakistan about India and Egypt about Ethiopia.

All water management serves multiple objectives and navigates among competing interests. Within a nation, these interests – domestic users, farmers, hydropower generators, recreational users, ecosystems – are often at odds and the probability of a mutually acceptable solution falls exponentially in proportion to the number of stakeholders. Add international boundaries and the chances drop yet again.

Without a mutual solution, these parties can find themselves in dispute and even violent conflict, either with each other or with state authorities. Still, water-related disputes must be considered in the broader political, ethnic and religious context. Water is rarely the single cause of conflict and hardly ever the major one but it can exacerbate existing tensions and therefore must be considered within the larger context of conflict and peace.

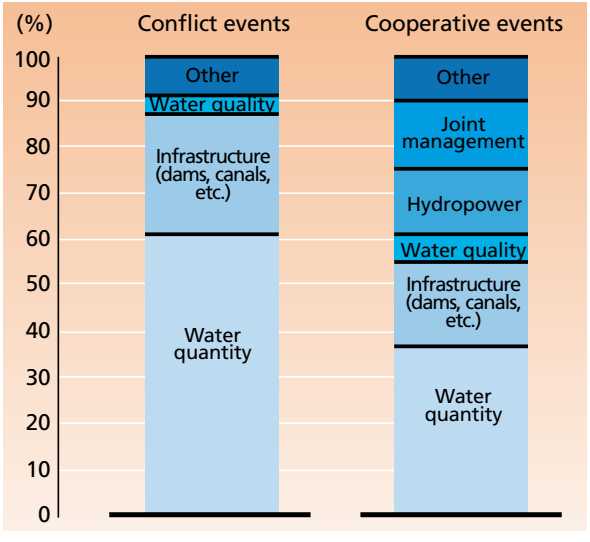
From the Middle East to New Mexico, the problems remain the same. However, so do many of the solutions. Human ingenuity has developed ways to address water shortages and cooperate in managing water resources. In fact, cooperative events between riparian states outnumbered conflicts by more than 2:1 between 1945 and 2008.

Water has also been a productive pathway for building confidence, developing cooperation and no doubt preventing conflict, even in particularly contentious basins. In some cases, water provides one of the few paths for dialogue in otherwise heated bilateral conflicts. In politically unsettled regions, water is an essential part of regional development negotiations, which serve as de facto conflict-prevention strategies.

While the underlying reasons for water-related controversy can be numerous, such as power struggles and competing development interests, all water disputes can be attributed to one or more of three issues: quantity, quality and timing *(see table and figure)*. Whether the dispute occurs at the international, national or local level, the key to understanding and preventing water-related conflicts can be found in the institutions established to manage water resources.

Strikingly, the territory of 148 nations falls within international basins and more than 30 countries are located almost entirely within these basins. The high level of interdependence is illustrated by the number of countries sharing each international basin; the dilemmas posed by basins like the Danube, shared by 19 countries, or the Nile, shared by 11 countries, can easily be imagined *(see table overleaf)*.

Sources of water-related conflit and cooperation in transboundary basins



Source: Aaron T. Wolf

No evidence of coming 'water wars'

International basins that include political boundaries of two or more countries cover around 45% of the Earth's land surface, host about 40% of the world's population and account for approximately 60% of global river flow. Moreover, the number is growing: in 1978, the United Nations listed 214 international basins; today there are 276, largely due to the internationalization of basins through political changes like the break-up of the Soviet Union and the former Yugoslavia, as well as access to better mapping technology.

Examples of water-related disputes

Location	Main Issue	Observation
Cauvery River	Quantity	The dispute on India's Cauvery River sprang from the allocation of water between the downstream State of Tamil Nadu, which had been using the river's water for irrigation, and upstream Karnataka, which wanted to increase irrigated agriculture. The parties did not accept a tribunal's adjudication of the water dispute, leading to violence and death along the river.
Okavango Basin	Quantity	In the Okavango River basin, Botswana's claims for water to sustain the delta and its lucrative ecotourism industry contribute to a dispute with upstream Namibia, which wants to pipe water passing through the Caprivi Strip to supply its capital city with drinking water.
Mekong Basin	Quantity	Following construction of Thailand's Pak Mun Dam, more than 25 000 people were affected by drastic reductions in upstream fisheries and other livelihood problems. Affected communities have struggled for reparations since the dam was completed in 1994.
Incomati River	Quality and quantity	Dams in the South African part of the Incomati River Basin reduced freshwater flows and increased salt levels in Mozambique's Incomati Estuary. This altered the estuary's ecosystem and led to the disappearance of salt-intolerant plants and animals that are important for people's livelihoods.
Rhine River	Quality	Rotterdam's harbour had to be dredged frequently to remove contaminated sludge deposited by the Rhine River. The cost was enormous and consequently led to controversy over compensation and responsibility among Rhine users. Whereas, in this case, negotiations led to a peaceful solution, in areas that lack the Rhine's dispute resolution framework, siltation problems could lead to disputes between upstream and downstream users, such as those in Central America's Lempa River Basin.
Syr Darya	Timing	Relations between Kazakhstan, Kyrgyzstan and Uzbekistan, all riparians of the Syr Darya River, a major tributary of the disappearing Aral Sea, exemplify the problems caused by water-flow timing. At the time of the Soviet Union, the central government balanced upstream Kyrgyzstan's use of hydropower to generate heat in the winter with water needs for spring and summer irrigation in downstream Uzbekistan and Kazakhstan. Today, the parties sporadically breach agreements that exchange upstream flows of alternate heating sources (natural gas, coal and fuel oil) for downstream irrigation.

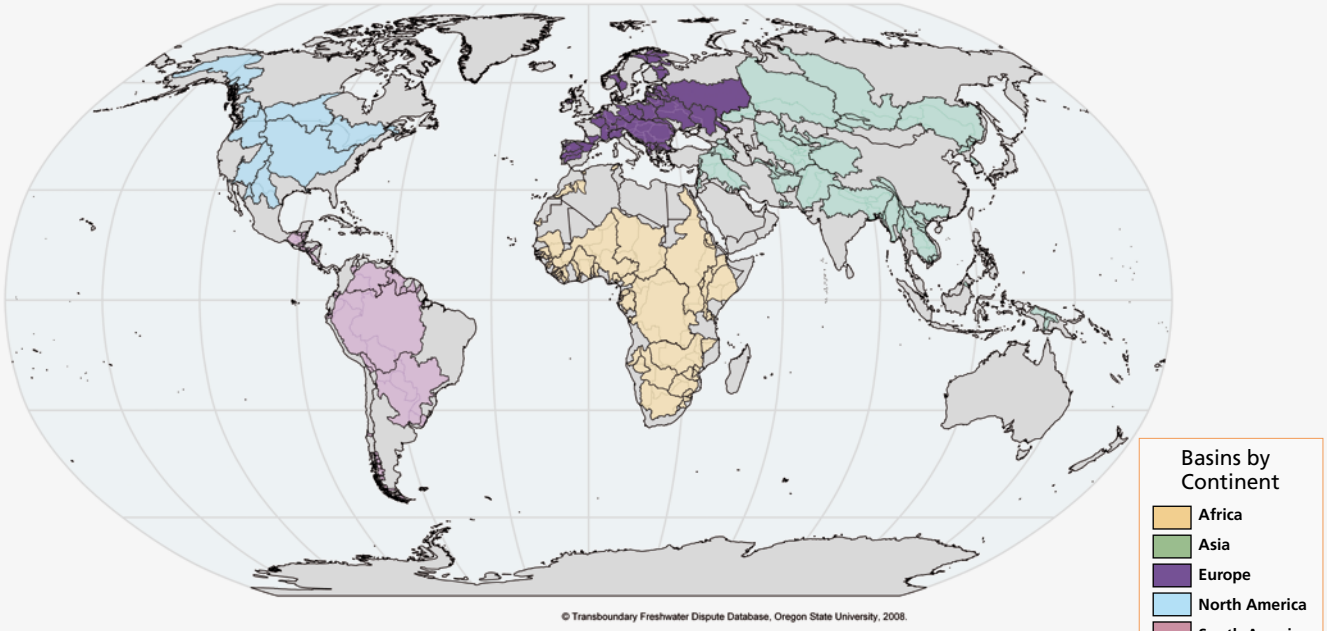
An antelope in the Okavango Delta in Botswana in 2005. Botswana shares the Okavango Basin with Angola, Namibia and Zimbabwe. Botswana's claims for water to sustain the delta and its lucrative ecotourism industry contribute to a dispute with upstream Namibia, which wants to pipe water passing through the Caprivi Strip to supply its capital city with drinking water.

Source: Turton et al. (eds) [2003] Transboundary Rivers, Sovereignty and Development – Hydropolitical Drivers in the Okavango River Basin. Pretoria and Geneva: African Water Issues Research Unit and Green Cross International

Number of countries sharing a basin

Number of countries	International basins
3	Asi (Orontes), Awash, Benito (Ntem), Cavally, Cestos, Chiloango, Dnieper, Dniester, Drin, Ebro, Gambia, Garonne, Gash, Geba, Har Us Nur, Hari (Harirud), Helmand, Hondo, Ili (Kunes He), Incomati, Irrawaddy, Juba-Shibeli, Lake Prespa, Lake Titicaca-Poopo System, Lempa, Maputo, Maritsa, Maroni, Moa, Oueme, Pasvik, Po, Red (Song Hong), Ruvuma, Salween, Schelde, Seine, Sulak, Torne (Tornealven), Tumen, Umbeluzi, Volga, Zapaleri
4	Amur, Daugava, Elbe, Essequibo, Komoe, Lake Turkana, Limpopo, Lotagipi Swamp, Narva, Ob, Oder (Odra), Ogooue, Okavango, Orange, Senegal, Struma, Vardar
5	Indus, La Plata, Neman, Tarim, Vistula (Wista)
6	Aral Sea, Ganges-Brahmaputra-Meghna, Jordan, Kura-Araks, Mekong, Tigris, Euphrates (Shatt al Arab), Volta
8	Amazon, Lake Chad
9	Rhine, Zambezi
10	Niger
11	Nile
19	Danube

International river basins



Source: International River Basin Registry, Oregon State University: www.transboundarywaters.orst.edu/database/interriverbasinreg.html

The high number of shared rivers, combined with increasing water scarcity for growing populations, led many politicians and headlines to trumpet coming 'water wars.' In 1995, for example, former World Bank Vice-President Ismail Serageldin claimed that 'the wars of the next century will be about water.' Invariably, these warnings point to the arid and hostile Middle East, where armies have mobilized and fired shots over this scarce and precious resource. Elaborate, if misnamed, 'hydraulic imperative' theories cite water as the prime motivation for military strategies and territorial conquests, particularly in the ongoing conflict between Arabs and Israelis.

The only problem with this scenario is a lack of evidence. In 1951–1953 and again in 1964–1966, Israel and Syria exchanged fire over the latter's project to divert the Jordan River but the final exchange, featuring assaults by both tanks and aircraft, stopped construction and effectively ended water-related tensions between the two states. Nevertheless, the 1967 war broke out less than a year later. Water had little, if any, impact on the military's strategic thinking in subsequent Israelo-Arab violence, including the 1967, 1973 and 1982 wars, yet water was an underlying source of political stress and one of the most difficult topics in subsequent negotiations. In other words, even though the wars were not fought over water, allocation agreements were an impediment to peace.

> The historical record proves that international water disputes do get resolved, even among enemies and even as conflict erupts over other issues.

While water supplies and infrastructure have often served as military tools or targets, no states have gone to war specifically over water resources since the city-states of Lagash and Umma fought each other in the Tigris–Euphrates Basin in 2500 BCE. Instead, according to FAO, more than 3 600 water treaties were signed from 805 to 1984 CE. Whereas most were related to navigation, over time, a growing number addressed water management, including flood control, hydropower projects or allocations in international basins. Since 1820, more than 680 water treaties and other water-related agreements have been signed, with more than half of these concluded in the past 50 years.

Researchers at Oregon State University have compiled a dataset of every reported interaction, be it conflictive or cooperative, between two or more nations where water was the driver of the interaction. Their analysis highlighted four key findings.

First, despite the potential for dispute in international basins, the incidence of acute conflict over international water resources is overwhelmed by the rate of cooperation. The last 60 years (1948–2008) have seen only 44 acute disputes (those involving violence), 30 of which occurred between Israel and one of its neighbours. The total number of water-related events between nations of any magnitude is also weighted towards cooperation: 759 conflict-related events versus 1 705 cooperative ones, implying that violence over water is neither strategically rational, nor hydrographically effective, nor economically viable.

Second, despite the fiery rhetoric of politicians – aimed more often at their own constituencies than at the enemy – most actions taken over water are mild. Of all the events, some 40% fall between mild verbal support and mild verbal hostility. If the next level on either side – official verbal support and official verbal hostility – is added into the equation, the share of verbal events reaches about 60% of the total. Thus, almost two-thirds of all events are verbal only and more than two-thirds of these led to no official sanction.

Third, there are more issues of cooperation than of conflict. The distribution of cooperative events covers a broad spectrum, including water quantity, quality, economic development, hydropower and joint management. In contrast, almost 90% of the conflict-laden events relate to quantity and infrastructure. Furthermore, almost all extensive military acts fall within these two categories.

Fourth, despite the lack of violence, water acts as both an irritant and a unifier. As an irritant, water can make good relations bad and bad relations worse. Despite the complexity, however, international waters can act as a unifier in basins with relatively strong institutions.

The historical record proves that international water disputes do get resolved, even among enemies and even as conflicts erupt over other issues. Some of the world's most vociferous enemies have negotiated water agreements or are in the process of doing so and the institutions they have created often prove to be resilient, even when relations are strained.

The Mekong Committee, for example, established by the governments of Cambodia, Laos, Thailand and Vietnam as an intergovernmental agency in 1957, exchanged data and information on water resources development throughout the Vietnam War (1955–1975). Israel and Jordan have held secret 'picnic table' talks on managing the Jordan River following the unsuccessful Johnston negotiations of 1953–1955, even though they were at war from the time of Israel's independence in 1948 until the 1994 peace treaty (*see box overleaf*). The Indus River Commission set up under the Indus Waters Treaty between India and Pakistan in 1960 survived two major Indo-Pakistani wars in 1965 and 1971. All 11 Nile Basin riparian countries are also currently involved in senior government-level negotiations to develop the basin cooperatively, despite continuing disagreement between upstream and downstream states.

In Southern Africa, a number of river basin agreements were signed when the region was embroiled in a series of local wars in the 1970s and 1980s, including the 'people's war' in South Africa and civil wars in Mozambique and Angola. Although negotiations were complex, the agreements were rare moments of peaceful cooperation between many of the countries. After most of the wars and the apartheid era had ended, water proved to be one of the foundations for cooperation in the region. In fact, the 1995 Protocol on Shared Watercourse Systems was the first protocol to be signed within the Southern African Development Community.

If internationally shared water is not to blame, what is the problem?

If shared water does not lead to violence between nations, what then is the problem? In fact, complications can cause water issues to exacerbate tensions, such as the time lag between the start of water disputes and final agreements. In general, riparians develop projects unilaterally within their own territories in an attempt to avoid the political intricacies posed by sharing resources. At some point, one of the riparians (usually the most powerful one) will begin a project that affects at least one of its neighbours.

Without relations or institutions conducive to conflict resolution, unilateral action can heighten tensions and regional instability, requiring years or decades to resolve: the Indus Waters Treaty took 10 years of negotiations, the Indo-Bangladesh Ganges Water Treaty (1996) 30 years and the Israel-Jordan Treaty of Peace (1994) 40 years. Water was the last and most contentious issue negotiated in the 1994 peace treaty between Israel and Jordan and was relegated to 'final status' negotiations between Israel and the Palestinians, along with difficult issues like refugees and the status of Jerusalem. During this long process, water quality and quantity can degrade until the health of dependent populations and ecosystems is damaged or destroyed. The problem worsens as the dispute intensifies; the ecosystems of the lower Nile, the lower Jordan and the tributaries of the Aral Sea have effectively been written off as unfortunate products of human intractability.

Unilateral action can heighten tensions and regional instability, requiring years or decades to resolve.

When unilateral development initiatives produce international tensions, it becomes more difficult to support cooperative behaviour. As mistrust between riparians grows, threats and disputes rage across boundaries, as seen in India and Pakistan or Canada and the USA. Even if they do not degenerate into open conflict, mistrust and tensions can hamper regional development by impeding joint projects and mutually beneficial infrastructure. One of the most important sources of water for both Israelis and Palestinians, the Mountain Aquifer, is threatened by pollution from untreated sewage. The existing conflict has impeded donor initiatives to build wastewater treatment plants in Palestine, setting the stage for a vicious circle as groundwater pollution increases regional water scarcity and, in turn, exacerbates the Israeli–Palestinian conflict.

Disputes within nations

The literature on transboundary waters often treats political entities as homogeneous monoliths: 'Canada feels...', it states, or 'Jordan wants....' Recently, analysts have identified the pitfalls of this approach, showing how subsets of national actors have

different values and priorities for water management. In fact, the history of water-related violence includes incidents between tribes, water use sectors, rural and urban populations and states or provinces. Some research even suggests that, as the geographic scale drops, the likelihood and intensity of violence increases. Throughout the world, local water issues revolve around core values that often date back generations. Irrigators, indigenous populations and environmentalists, for example, all may view water as tied to their way of life, which is increasingly threatened by new uses for cities and hydropower.

Internal water conflicts have led to fighting between downstream and upstream users along the Cauvery River in India and between Native Americans and European settlers. In 1934, the landlocked State of Arizona commissioned a navy (consisting of one ferryboat) and sent its state militia to stop a dam and diversion project on the Colorado River.

Water-related disputes can also engender civil disobedience, acts of sabotage and violent protest. In the Indian state of Orissa, 30 000 farmers clashed with police in December 2007 because the government had decided to allow a large number of industries to source water from the Hirakud Dam, while the farmers depended on this water for irrigation. Fifty protesters were injured in the confrontation with police. From 1907 to 1913 in California's Owens Valley (USA), farmers repeatedly bombed an aqueduct diverting water to the burgeoning city of Los Angeles.

National instability can also be provoked by poor or inequitable water services management. Disputes arise over system connections for suburban or rural areas, service liability

Water-sharing among Israelis, Jordanians and Palestinians

The most severe water scarcity in the world is found in the Middle East. The deficit is particularly alarming in the Jordan River Basin and the adjacent West Bank aquifers, where Israeli, Palestinian and Jordanian water claims intersect. In Gaza and the West Bank, the annual availability of water is well below 100 m^3 of renewable water per person, whereas Israel has less than 300 m^3 and Jordan around 100 m^3. A country is generally characterized as water scarce if the availability falls below 1 000 m^3.

Population growth, a result of both a high birth rate among Palestinians and Jordanians and of immigration to Israel, is putting increasingly severe pressure on the already scarce water resources and raises the risk of water-related conflicts. Complicating matters is the comparatively large share of the available water that goes to Israeli settlers in the West Bank and Gaza compared with the share accessible by the Palestinians.

Despite fears of water-related violence, Israel and Palestine, as well as Israel and Jordan, have maintained basic cooperation over their shared waters. This persisted even after the second *intifada* began in September 2000. Low-level water cooperation between Israel and Jordan, under UN auspices, extends back to the early 1950s, even though both countries were formally at war at the time. This interaction helped build trust and a shared set of rules and norms which were later formalized within the peace agreement between Israel and Jordan in 1994. As stipulated in that agreement, a Joint Water Committee for coordination and problem-solving was established that helped resolve disagreements over allocations.

A 1995 interim agreement regulates Israeli–Palestinian water issues such as protection of water and sewage systems. The Joint Water Committee and its subcommittees have continued to meet despite the violence of recent years. For the Palestinians, the existing agreement is unsatisfactory, from both a rights and an availability perspective. Talks towards a final agreement are part of the overall negotiating process and, given the political stalemate and ongoing violence, are not likely to be completed any time soon. Nevertheless, there is agreement between Israelis and Palestinians that cooperation over their shared water is indispensable.

Two main policy recommendations can be drawn from this case. *First*, water cooperation is intimately linked to politics, a highly complex process influenced by both domestic and international considerations. If donors fail to analyse the political context thoroughly, they are unlikely to understand how water is sometimes subordinate to more important political priorities and used as a political tool.

Second, donor agencies and international organizations can play an important role if they are prepared to provide long-term support for establishing cooperation over shared water. Donors typically want to see tangible results within a short time frame. Yet, it is essential to understand the risks involved, that occasional setbacks will occur and that the rewards are unlikely to materialize quickly. Donors will need to engage in 'process financing' that supports not an ordinary development project with a cycle of 2–4 years but rather a process that can span 10–25 years. In the Israeli–Jordanian case, the UN Truce Supervision Organization, which worked as an 'umbrella' for discussions on water coordination in spite of the absence of a peace agreement, played a critical role.

Although more conflicts of interest are likely to arise in future over the waters in the Jordan River Basin, with proper support, water management offers a window of opportunity for broader cooperation in this troubled part of the world.

*Anders Jägerskog**

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Photo: Wikipedia Commons/Beivushtang

Jordan River

and especially prices. In most countries, the state is responsible for providing drinking water. Even if concessions are transferred to private companies, the state usually remains responsible for the service. Disputes over water supply management therefore usually arise between communities and state authorities (*see box*). Protests are particularly likely when the public suspects that water services are managed in a corrupt manner or that public resources are being diverted for private gain.

Local instability

Those regions of the world that rely heavily on declining water supplies for irrigation overlap significantly with those that currently concern the security community: the Middle East, North Africa and Central Asia. When access to irrigation water is cut off, groups of unemployed, disgruntled men may be forced away from the countryside into the city, contributing to political instability. When migration is cross-boundary, it can contribute to interstate tensions.

Water problems can thus contribute to local instability, which in turn can destabilize a nation or an entire region. In this indirect way, water contributes to international and national disputes, even though the parties are not fighting explicitly over water. During the 30 years that Israel occupied the Gaza Strip, for example, water quality deteriorated steadily, saltwater intruded into local wells and water-related diseases took a toll on the residents. In 1987, the second *intifada* began in the Gaza Strip and the uprising quickly spread throughout the West Bank. While it would be simplistic to claim that deteriorating water quality caused the violence, it undoubtedly exacerbated an already tenuous situation by damaging health and livelihoods.

An examination of relations between India and Bangladesh demonstrates that, in turn, local instabilities can spring from international water disputes and exacerbate international tensions. In the 1960s, India built a dam at Farakka, diverting a portion of the Ganges from Bangladesh to flush silt from Calcutta's seaport some 160 km to the south. In Bangladesh, the reduced flow depleted surface water and groundwater, impeded navigation, increased salinity, degraded fisheries and endangered water supplies and public health, leading some Bangladeshis to migrate – many of them, ironically, to India.

So, while no 'water wars' have occurred, the lack of clean fresh water or the competition over access to water resources has occasionally led to intense political instability that resulted in acute violence on a small scale.

The Cochabamba conflict over privatization of water services

Issues of water supply management can lead to violent conflict, as demonstrated by the confrontations that erupted in 2000 in Cochabamba, Bolivia's third-largest city, following the privatization of the city's water utility. Cochabamba had long suffered from water scarcity and insufficient, irregular provision of water services. Hoping for improved services and higher connection rates, the Bolivian government signed a 40-year concession contract in September 1999 with the international private water consortium Aguas del Tunari (AdT).

By January 2000, drinking water tariffs had increased sharply and some households were having to devote a significant share of their monthly income to paying for water services. Consumers felt they were simply paying more for the same poor services and responded with strikes, roadblocks and other forms of civil protest that shut the city down for four days in February 2000.

While higher water bills triggered the protests, some people also opposed a law threatening public control of rural water systems. Long-standing water scarcity had encouraged the development of well-established alternative sources of supply. In rural municipalities surrounding Cochabamba, farmer cooperatives drilled their own wells and used an informal market for water based on an ancient system of property rights. Under the concession contract, AdT was granted the exclusive use of water resources in Cochabamba, as well as any future sources needed to supply city consumers. It was also granted the exclusive right to provide water services and to require potential consumers to connect to its system. The rural population feared it would lose its traditional water rights and that AdT would charge people for water from their own wells.

Farmers from surrounding municipalities joined the protest in Cochabamba, which spread to other parts of Bolivia. Months of civil unrest came to a head in April 2000, when the government declared a state of siege for the whole country and sent soldiers into Cochabamba. Several days of violence left more than 100 people injured and one person dead. The protests eased only after the government agreed to revoke AdT's concession and return the utility's management to the municipality.

Performance continued to be unsatisfactory, however, with many neighbourhoods having only occasional services and the valley's groundwater table continuing to sink. Although many view the concession's cancellation as a victory for the people, it did not solve their water problems.

Meanwhile, AdT filed a complaint against the Bolivian government in the World Bank's trade court, the International Centre for Settlement of Investment Disputes, in 2001. According to the *San Francisco Chronicle,* the consortium was demanding US$25 million in compensation for the cancelled contract. However, after several years of an arbitration process that was accompanied by continuous international protest, the AdT consortium decided to withdraw the claim on a no-pay basis. In return, Bolivia has absolved the foreign investors of any potential liability.

Source: compiled by authors

Photo: Cordinadora del Agua

A woman appeals to the police on her way to wash clothes during the Cochabamba conflict.

© Yann Arthus-Bertrand

Irrigated gardens in Jordan's Wadi Rum desert. Many analysts assume that water scarcity drives people to conflict, yet arid climates are no more conflict-prone than humid ones.

Strong institutions can make all the difference

Many analysts who write about water politics assume that scarcity of such a critical resource drives people to conflict. It seems intuitive: the less water there is, the more dearly it is held and the more likely it is that people will fight over it. Systematic research on indicators for transboundary water conflict, however, did not find any statistically significant physical parameters: arid climates were no more conflict-prone than humid ones and international cooperation actually increased during droughts. In fact, almost no single variable proved causal: democracies were as susceptible to conflict as autocracies, rich countries as much so as poor ones, densely populated countries as much so as sparsely populated ones and large countries as much so as small ones.

When Oregon State University researchers looked closely at water management practices in arid countries, they found institutional capacity was the key to success. Naturally arid countries cooperate on water: to live in a water-scarce environment, people adapt to it by developing institutional strategies: formal treaties, informal working groups or generally warm relations. The researchers also found that the likelihood of conflict increased significantly if two factors came into play. *First*, conflict is more likely if the basin's physical or political setting undergoes a large or rapid change, such as the construction of a dam, an irrigation scheme or territorial realignment. *Second*, conflict is more likely if existing institutions are unable to absorb and effectively manage that change.

In international river basins, water management typically fails to manage conflicts when there is no treaty spelling out each nation's rights and responsibilities.

Institutions responsible for managing water resources have to be strong to balance conflicting interests over allocation and to manage water scarcity, which is often the result of previous mismanagement. These institutions can even become a matter of dispute themselves. In international river basins, water management typically fails to manage conflicts when there is no treaty spelling out each nation's rights and responsibilities with regard to the shared river, nor any implicit agreements or cooperative arrangements.

Similarly, at the national and local levels, it is not the lack of water that leads to conflict but the way it is governed and managed. Many countries need stronger policies to regulate water use and enable equitable and sustainable management. Especially in developing countries, water management institutions often lack the human, technical and financial resources to develop comprehensive management plans and ensure their implementation.

Moreover, in many countries, decision-making authority is spread among different institutions responsible for agriculture, fisheries, water supply, regional development, tourism, transport or conservation and environment, so that different management approaches serve contradictory objectives. Formal and customary management practices can also be contradictory, as demonstrated for example in the Achamayo River Basin in Junin (Peru), where peasants claim territorial and riparian water rights on the grounds of mythical and historical accounts, in clear contradiction with the official water licence system enacted by state law.

In countries without a formal system of water use permits or adequate enforcement and monitoring, more powerful water users can override the customary rights of local communities. If institutions allocate water inequitably between social groups, the risk of public protest and conflict increases. In South Africa, the apartheid regime allocated water to favour the white minority. This 'ecological marginalization' heightened the black population's grievances and contributed to social instability, which ultimately precipitated the regime's downfall.

Institutions can also distribute costs and benefits unequally: revenues from major water infrastructure projects, such as large dams or irrigation schemes, usually benefit only a small elite, leaving local communities to cope with the resulting environmental and social impact, often with little compensation.

The various parties to water conflicts often have differing perceptions regarding legal rights, the technical nature of the problem, the cost of solving it and the allocation of costs among stakeholders. Reliable sources of information acceptable to all stakeholders are therefore essential for any joint effort. This not only enables water-sharing parties to make decisions based on a common understanding; it also helps build trust.

A reliable database, including meteorological, hydrological and socio-economic data, is a fundamental tool for deliberate and farsighted water management. Hydrological and meteorological data collected upstream are crucial for decision-making downstream. In emergencies like floods, this information is essential to protect human and environmental health. Tensions between different water users can emerge when information is not exchanged. Disparities in stakeholders' capacity to generate, interpret and legitimize data can lead to mistrust of those with better information and support systems. In the Incomati and Maputo River Basins, the South African monopoly over data generation created such discomfort in downstream Mozambique that the basins' Piggs Peak Agreement broke down; Mozambique used this negotiation impasse to start developing its own data.

Cooperative mechanisms can solve smoldering disputes

Most disputes are resolved peacefully and cooperatively, even if the negotiation process is lengthy. Cooperative water management mechanisms can anticipate conflict and solve smoldering disputes, provided that all stakeholders are included in the decision-making process and given the necessary information, trained staff and financial support to act as equal partners. Cooperative management mechanisms can reduce conflict potential by:

- providing a forum for joint negotiations, thus ensuring that all existing and potentially conflicting interests are taken into account during decision-making;
- considering different perspectives and interests to reveal new management options and offer win–win solutions;
- building trust and confidence through collaboration and joint fact-finding; and
- making decisions that are much more likely to be accepted by all stakeholders, even if consensus cannot be reached.

At the local level, traditional community-based mechanisms are already well-suited to specific local conditions and are thus more easily adopted by the community. Examples include the *chaffa* committee, which is a traditional water management institution of the Boran people in the Horn of Africa, or the Arvari Parliament, an informal decision-making and conflict-resolution body based on traditional customs of the small Arvari River in Rajasthan (India).

River basin commissions which include representatives from all riparian states have been successful in managing these shared water resources but, especially in transboundary basins, achieving cooperation has been a drawn-out and costly process. Recognizing this, the World Bank committed to facilitating the Nile Basin Initiative negotiation process for 20 years.

Capacity-building in data generation and analysis, sustainable water management planning, conflict resolution techniques or stakeholder participation should target water management institutions, local non-governmental organizations, water users' associations or religious groups. At the international level, strengthening less powerful riparians' negotiating skills can help prevent conflict. At the local level, strengthening the capacity of excluded, marginalized or weaker groups to articulate and negotiate their interests helps involve them in cooperative water management. The Every River Has Its People Project in the Okavango River basin, for instance, aims to increase participation by communities and other local stakeholders in decision-making and basin management through education and training.

Preventing severe conflicts requires transparent decision-making and informing (or explicitly consulting) all stakeholders, such as downstream states or societies, before implementing management decisions. The process of identifying all relevant stakeholders and their positions is crucial to estimating, and consequently managing, the risks of conflict. Without extensive and regular public participation, the general public might reject infrastructure project proposals. For example, the decision to build the Hainburg Dam on the Danube River was announced in 1983 after only limited public participation. Environmental groups and other civil society organizations, supported by the general public, occupied the project site and managed to stop the dam's construction. Subsequently, the site became a national park. In a more recent example, Laos undertook in July 2012 to suspend construction of a dam on the Mekong River in order to make changes to the design after its neighbours and environmental groups raised concerns during the consultation process. Laos has just announced, however, that it is resuming construction, despite remaining objections. Opponents of the scheme have yet to react (*see box overleaf*).

Cooperative water management requires time and commitment. Extensive stakeholder participation might not always be feasible; in some cases, it may not even be advisable. On any scale of water management, if the level of dispute is too high and the disparities are too great, conflicting parties are not likely to reach consensus and might even refuse to participate

Travellers near the town of Bafoulabé, 90 km north of the Manantali Dam in Mali. The dam was built on the Senegal River in 1989. It is co-owned and co-managed by three of the river's four riparians: Mali, Mauritania and Senegal, via the Organisation pour la mise en valeur du fleuve Sénégal. Through this institutional framework, the three countries share the costs and benefits of this multipurpose dam. The lake formed by the dam allows commercial fishing, irrigates surrounding land and provides much of the region with hydroelectric power. While the dam has also had a socio-economic cost – its construction displaced 10 000 people and affected traditional agriculture dependent upon seasonal flooding –, conflict between the riparian countries has been avoided, thanks to this cooperative mechanism.

Photo: Jacques Taberlet/Wikipedia Commons

in cooperative management. In such cases, confidence and consensus-building measures, such as joint training or joint fact-finding, will support cooperative decision-making.

Conflict transformation measures involving a neutral third party, such as mediation, facilitation or arbitration, are helpful in cases with open disputes over water resources management. Related parties, such as elders, women or water experts, have successfully initiated cooperation when the conflicting groups could not meet. The women-led Wajir Peace Initiative, for example, helped reduce violent conflict between pastoralists in Kenya, where access to water was one issue in the conflict. In certain highly contentious cases like that of the Nile Basin, an 'elite model' that seeks consensus between high-level representatives before encouraging broader participation has enjoyed some success in developing a shared vision for basin management and joint projects. Effectively integrating public participation is now the key challenge for long-term implementation of cooperative mechanisms negotiated by the elite.

Tomorrow's disputes may look very different from today's

As exploitation of the world's water supplies increases, quality is becoming a more serious problem than quantity and water use is shifting to less traditional sources like deep fossil aquifers, wastewater reclamation and interbasin transfers. Conflict, too, is becoming less traditional, driven increasingly by internal or local pressures or, more subtly, by poverty and instability. These changes suggest that tomorrow's water disputes may look very different from today's.

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This article is an updated and abridged version of that published in State of the World 2005 *by the Worldwatch Institute, later reproduced with permission in a handbook for professionals produced by UNESCO's International Hydrological Programme in 2010, entitled* Sharing Water: Sharing Benefits.

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An unfolding story on the Mekong River

Mainstream dams on the Mekong

Source: Challenge Program on Water and Food, Mekong River Commission

The Mekong River is the seventh-longest in Asia. Taking its source from the Tibetan Plateau, it flows through China, Myanmar, Laos, Thailand, Cambodia and Vietnam.

In 1995, the four latter countries established the Mekong River Commission under the Mekong Agreement to coordinate sustainable use of the Mekong's resources. A year later, China and Myanmar became 'dialogue partners' of the Commission.

There are currently three dams on the Mekong River, with another two under construction. All are situated in the upper reaches *(see map)*. In recent years, 14 other dams have been proposed by riparian countries, most of which concern the lower reaches *(see map)*.

A *Strategic Environmental Assessment* (2010) commissioned by the Mekong River Commission found that the proposed dams would block crucial fish migration and cause permanent damage to the river's ecology. The report recommended a 10-year deferral of all Mekong mainstream dams, pending further studies.

In early 2011, the Mekong River Commission announced that member countries had been unable to reach a consensus on the Laotian project to build the Xayaburi Dam for power generation. Cambodia and Vietnam had expressed concern about the dam's impact on fish migration and sediment flow downstream.

The Laotian government subsequently awarded the project to a Thai company, before announcing in July 2012 that it would be interrupting construction in order to modify the design in response to the concerns expressed by its neighbours and environmental groups.

On 6 November 2012, Laos announced that it had finished making changes to the design and that it would be pressing ahead with construction of the dam.

Photo: Wikipedia Commonss

Floating market of Cần Thơ in Vietnam in the Mekong Delta

Developed countries to double biodiversity funding

The agreement adopted by the Parties to the Convention on Biological Diversity (CBD) at their 11th meeting in Hyderabad (India) on 8–19 October foresees doubling aid to developing countries by 2015 and shines the spotlight on the high seas.

The developed countries were under pressure in Hyderabad to put a figure on the ambitious targets adopted at the previous meeting of the Parties in the city of Nagoya in Aichi Prefecture (Japan) in 2010. In the end, the delegates arrived at a compromise: the final agreement does not cite any specific figure but commits the developed countries to doubling their public and private contributions to developing countries by 2015, in order to help them reach the targets agreed to in Nagoya. Average national spending on biodiversity between 2006 and 2010 will be used as the baseline figure with which to calculate the increase.

All countries agreed to increase their domestic expenditure on biodiversity protection substantially by 2015 and to review these targets by 2014. For the first time, the Global Environment facility (GEF), the CBD's financial mechanism, was provided with an assessment of the financial means required by developing countries to implement the Convention.

The meeting saw the launch of the Hyderabad Call for Biodiversity Champions. This initiative will accept pledges from governments and organizations in support of the Strategic Plan for Biodiversity 2011–2020 adopted in Nagoya and its Aichi Biodiversity Targets. The Government of India set the ball rolling in Hyderabad by pledging over US$50 million for the initiative.

Countries also adopted new measures to factor biodiversity into environmental impact assessments linked to development projects like the construction of infrastructure.

They agreed to send key scientific information to the United Nations describing 48 specific ecologically or biologically significant areas within territorial waters, economic exclusive zones and areas beyond national jurisdiction. These areas had been described by experts from regional governments, organizations and initiatives at two regional workshops held in 2011 in Nadi (Fiji) for the Western South Pacific and in 2012 in Recife (Brazil) for the Wider Caribbean and Western Mid-Atlantic. For the first time, scientists had worked together to catalogue predictable habitats for whales, tuna and other highly migratory species in the open ocean, as well as fragile ecosystems like hydrothermal vents in the deep sea, according to seven criteria adopted by Parties to the CBD in 2009. Many of these areas transcend national boundaries.

The first report reveals 26 richly diverse and productive areas in the Western South Pacific, one of which is the Tonga Trench, the most important breeding location for the endangered Oceania population of humpback whales. Another example is a zone in the South Equatorial Current which has the highest saturation rate of aragonite ($CaCO_3$) in the ocean, suggesting that the impact of ocean acidification will be slowest here and recovery potentially the quickest.

Among the 22 areas described by the second report figure the Mesoamerican Reef, a continuous barrier reef over 1000 km long, and the Saba Bank, a submerged atoll which is the largest actively growing atoll in the Caribbean and one of the world's largest, measuring 1 850 km^2. A third zone is the Sargasso Sea in the Mid-Atlantic, also described by the High Seas Ocean Gems project.

Over the next two years, workshops will cover additional ocean basins. However, the areas described by the scientific experts will not trigger any automatic protection.

Many governments are calling for a new legal instrument under the UN Convention on the Law of the Sea governing the conservation and sustainable use of marine biodiversity beyond national jurisdiction. At Rio+20 last June, governments agreed to decide on whether or not to proceed with a new instrument by 2014 at the latest.

On the sidelines in Hyderabad, UNESCO participated in the second meeting of the Aichi Targets Heads of Agencies Task Force, an informal mechanism grouping both UN agencies and other partners like relevant conventions (CBD, Ramsar, etc), IUCN or the World Bank. Task Force members agreed that individual organizations would assist in implementing specific provisions of the Strategic Plan for Biodiversity. UNESCO contributes in particular to the clusters corresponding to Strategic Goal A (underlying causes of biodiversity loss) through its work in the areas of education and culture; Strategic Goal B (reducing direct pressures) through education; Strategic Goal C (improving the status of biodiversity) by promoting conservation and sustainable and equitable use of biodiversity in biosphere reserves and World Heritage sites; and Strategic Goal E (knowledge and participatory planning) through its work in the sciences and in promoting local and indigenous knowledge systems and communities.

UNESCO co-organized several side events. The International Conference on Biodiversity and Education for Sustainable Development on 13–14 October was piloted by the Centre for Environment Education based in India, UNESCO and other agencies; it produced an outcome document (*see page 24*) which was presented jointly by the Indian Minister of Environment and Forests and the French Minister of Environment on 17 October.

© Atoll Ecosystem Project/Ministry of Housing & Environment (Baa Atoll), Maldives

On 15 October, the first UNESCO biosphere reserve in the Maldives, Baa Atoll, was profiled during a side event on sustaining coral communities in the face of climate change and other challenges. The Minister of Environment of the Maldives drew applause for suggesting that the entire island nation should be declared a biosphere reserve.

Other side events took stock of the CBD–UNESCO joint programme on Biological and Cultural Diversity dating from 2010 and the role that indigenous and local knowledge can play in global environmental assessments. A panel discussion on the intergenerational transfer of knowledge for climate change adaptation and the relevance of UNESCO's networks of protected sites for biodiversity conservation was organized jointly by UNESCO, the German development agency (GIZ) and the Wildlife Institute of India. The government launched a *Compendium of Indian Biosphere Reserves* (*see page 24*) during this event to mark the designation of Achankamar–Amarkantak Biosphere Reserve last year.

A side event on New Models of Engaging Local Communities in the Stewardship of Protected Areas: Lessons from World Heritage was organized by the GEF Small Grants Programme implemented by UNDP, UNESCO and others. Discussion focused on the Community Management of Protected Areas Conservation Programme and on the landscape approach to conserving globally significant protected areas. Fresh from their week at a camp in the Sundarbans World Heritage site in India, courtesy of UNESCO, CBD, GIZ, IUCN and WWF, 35 young people from more than 20 marine World Heritage sites in 12 countries shared their impressions with conference delegates at a youth forum formatted specially for them by the same sponsors.

Another UNESCO workshop on 10–12 October explored ways of systematically mapping human relationships with nature and biodiversity to help policy-makers make informed decisions.

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Australia creates world's largest marine protected area

The Great Barrier Reef, a World Heritage property, is to become part of the world's largest network of marine parks.

On 16 November, Australian Environment Minister Tony Burke announced the creation of a protected zone spanning 3.1 million km^2, with the addition of 2.3 million km^2 of marine reserves. The new network will include the Coral Sea, which encompasses the Great Barrier Reef. The government plans to place restrictions on fishing and oil and gas exploration in the zone.

New marine reserves have been proclaimed in five of Australia's six large marine regions (*see map*), the reserves in the Southeast Marine Region dating from 2007. These reserves are home to many migratory and threatened species, including the albatross, grey nurse shark, hawksbill turtle, blue whale, southern right whale, southern blue-fin tuna and black cod.

The new network represents the culmination of a 20-year planning process. Mr Burke said on 14 June that, in the past 12 months, the government had consulted representatives of marine industries and tourism, environmental groups and members of the public in 250 meetings across the country. 'Our aim is to protect our unique marine environment, while supporting coastal communities and marine industries around the country,' he said. On 16 November, Tony Burke announced that the government would be allocating around A$100 million in fisheries adjustment assistance to support the creation of the marine network.

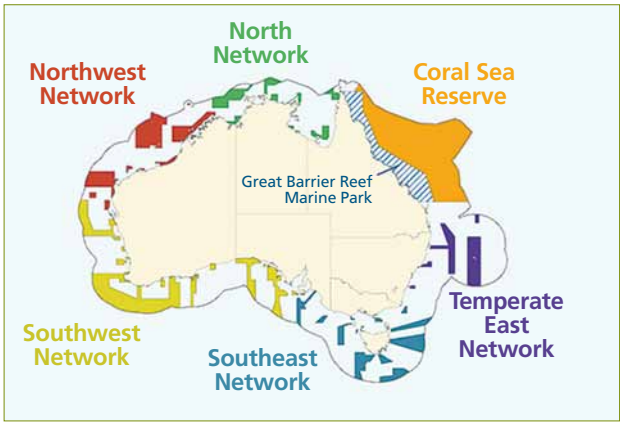
In no-take zones, all commercial and recreational fishing will be prohibited. Other areas will allow tourist recreation like diving but not fishing. The most permissive zones will permit both game fishing and commercial fishing. Oil and gas exploration off Margaret River on Australia's southwest coast will be prohibited through the creation of an exclusion zone, as desired by the local community. The management plans for the new reserves will come into effect in July 2014.

The Great Barrier Reef has come under intense scrutiny in recent months. In March, UNESCO expedited a team of experts to investigate possible damage to the reef system caused by coal, oil and gas exploration. On 5 June, Tony Burke suspended a mining permit granted a week earlier by the State of Queensland to the Alpha Coal mine project, a joint venture between Hancock Coal and Indian giants GVK. The federal government then lifted the ban on 23 August but associated this move with strict conditions for the environmental protection of the reef.

The Great Barrier Reef stretches 2 000 km along the coast of the State of Queensland, making it is the largest coral reef ecosystem in the world. In early October, scientists published a study which concluded that more than half of the reef system had been destroyed over the past 27 years. The researchers estimated that cyclones were responsible for nearly half the loss, the endemic crown of thorns starfish, which eats coral, for a further 40% and acidification and warming waters for the remainder. In an interview with the BBC news service, co-author John Gunn from the Australian Institute of Marine Science cautioned, 'remember, these changes are happening before the major impacts of climate change have kicked in.'

Later the same month, scientists announced that they had found healthy coral habitats at a depth of 30–120 m beneath badly damaged parts of the Great Barrier Reef. Some of the coral species discovered in deep waters also live in shallow waters, suggesting that the deeper waters may provide a refuge for them.

In November, Australian researchers announced plans to sequence the genome of several coral species in the hope of identifying ways to reduce their extreme vulnerability to climate change.



Source: www.environment.gov.au/marinereserves

Australia's new Commonwealth network of marine reserves

Two of Australia's Pacific neighbours have also announced the creation of vast marine parks this year. At the Pacific Islands Forum in August, the Cook Islands unveiled plans to create a protected zone spanning nearly 1.1 million km^2 and New Caledonia a zone spanning 1.4 million km^2.

The fact that nearly 5 million km^2 of additional marine protected areas have been designated in the Pacific Ocean within months of Rio+20 not only demonstrates that countries are taking energetic steps to conserve marine biodiversity. It also shows that they have integrated the need for networks of large, connected areas that respect the integrity of ecosystems.

For details: http://whc.unesco.org; www.environment.gov.au/marinereserves

Fewer creatures under the sea

Previous estimates of there being well over 1 million marine species appear 'improbable,' says a team of 120 taxonomists led by Ward Appeltans of UNESCO's Intergovernmental Oceanographic Commission (UNESCO-IOC). They have just published a study based on the World Register of Marine Species (WoRMS), a database hosted by the Flanders Marine Institute in Oostende (Belgium) which the team of taxonomists helped to launch.

The researchers report between 220 000 and 230 000 known marine eukaryotes, a vast group encompassing most marine species, with the notable exception of bacteria, archaea and viruses. Eukaryotes are single-celled or multicellular organisms whose cells contain a nucleus enclosed within a membrane. A large variety of life forms fit this description, including the single-celled protozoa, fungi, plants, animals and algae, the latter having the particularity of coming in both unicellular (e.g. dinoflagellates) and multicellular forms (e.g. giant kelp).

Statistical modelling based on past rates of species discovery suggests that the total number of eukaryotic species in the world's oceans amounts to between 320 000 and 760 000. The higher value is close to the 120 taxonomists' own estimations of between 704 000 and 972 000. This suggests that between one-third and two-thirds of marine species remain to be described.

'Scientists have been describing species in the ocean – and on land – for more than 250 years but there has never been a central place where everything gets recorded,' says Appeltans. 'The only thing a scientist needs to do is publish a paper. As a result, many species have been described more than once – we found that this was the case for 40% of known species. This leads to a lot of confusion over species names. By centralizing information and making it accessible to all scientists, WoRMS should help to remedy the problem.'

'Having a taxonomic reference database like WoRMS will also help with assessments of the status of marine biodiversity,' adds Appeltans, such as the World Ocean Assessment due out in 2014 and those of the new Intergovernmental Platform on Biodiversity and Ecosystem Services. It will also help improve the data quality of global observation systems like the Ocean Biogeographic Information System managed by the UNESCO-IOC.'

The register comes at a time when species discovery is accelerating. More marine species have been described in the past decade (20 000) than in any previous decade. On average, 37% of species in over 100 recent field studies around the world might be new to science. If species continue being discovered at the current rate, most marine species will have been identified by the end of the century.

The study was published on 15 November in *Current Biology*.

For details: w.appeltans@unesco.org; www.cell.com; see also the blog: www.go.nature.com/qew2qq

Nigeria to establish international biotech institute

UNESCO Director-General Irina Bokova and Nigerian Minister of Education Ruqayyatu Ahmed Rufa'i signed an agreement on 15 October for the establishment of an International Institute for Biotechnology at the University of Nigeria in Nsukka which will function under the auspices of UNESCO.

The University of Nigeria was a logical choice for the new centre, as it already hosts a centre of the National Biotechnology Development Agency. In addition, the university has a long history in agricultural and medical biotechnology.

The centre will provide high-level training, education and research in biotechnology, in particular as relates to food security, the conservation of harvested crops, gene banks for seeds and other bio-tissues, as well as the control of tropical diseases. The centre will organize and host international conferences and training programmes in the sub-region, in collaboration with other universities and research institutes in Nigeria and beyond.

'The Government of Nigeria has placed a premium on the establishment of this centre, in order to harness African and global expertise, as well as competencies to address regional problems of global concern,' said the Minister of Education. 'Whereas the centre's immediate focus will be sub-regional and regional, its scope will ultimately be international. We are optimistic that the centre will soon become not only a reference institution in the field of biotechnology but will contribute to national and international capacity-building, research and development and also foster the economic empowerment of the people.'

The presence of two Nigerian parliamentarians in the delegation to the signing ceremony testified to the broad level of support for this initiative in Nigeria. Biotechnology was one of 13 priority areas identified in the *Nigeria Vision 20:20* document, which is Nigeria's blueprint for national development. The target of the *Nigeria vision:20:20* is for Nigeria to join the world's 20 most powerful economies by 2020. Nigeria established a National Biotechnology Agency in 2001 to implement the

country's new biotechnology policy (*UNESCO Science Report 2010*, p. 309). A biosafety law governing the introduction of genetically modified crops has been approved by Parliament and now awaits the presidential seal.

The newly created institute is UNESCO's second category 2 centre in biotechnology after the Regional Centre for Biotechnology Education, Training and Research, launched in New Delhi in 2006. UNESCO's International Basic Sciences Programme (IBSP) was directly involved in creating both centres and plans to foster scientific networking between Nsukka and New Delhi, beginning with knowledge-sharing and joint research and training programmes, in order to create a partnership in biotechnology between the Asian and African scientific communities.

The first meeting of the Nsukka centre's Board of Governors took place at UNESCO headquarters on 16 October. The Board agreed on a list of nominees to the International Scientific Advisory Board and on the procedure for selecting the centre's first Executive Director. It also decided to set up an Academic Committee to ensure the smooth running of the centre. The International Scientific Advisory Board is due to meet for the first time in Nsukka in early February.

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Science ministers to speak **with one voice**

Science ministers from the subregion 'recognize that it is important for Southeast Europe to speak with one voice' at the European level, in order to further their common objective of integrating the European Research Area.

Meeting in Sarajevo on 23 November for a Ministerial Roundtable on Science, Technology and Innovation, organized jointly by the Ministry of Civil Affairs of Bosnia and Herzegovina and UNESCO's Venice office, the ministers issued a *Joint Declaration*, in which they recognize the need to coordinate their positions prior to meetings at the European Commission in Brussels, in order to push through their macro-regional agendas.

The *Declaration* was endorsed by ministers and high-ranking officials from 11 countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Former Yugoslav Republic of Macedonia, Moldova, Montenegro, Romania, Serbia and Turkey.

The science ministers vow to usher in a new era of collaboration by harmonizing their policies and sharing research infrastructure, in order to compete more effectively with wealthy countries in the European Union and beyond. Five key areas have been identified for collaboration: infrastructure, policy, research statistics, research networking and science journalism. The *Declaration* outlines a roadmap for developing priorities at both national and regional levels and for enhancing the science–policy–society interface.

The ministers recognize the relevance of UNESCO's work and the European Union's Framework Programmes and other funding schemes for developing scientific collaboration and synergies among Southeast European countries. They also acknowledge UNESCO's continuous support and encouragement, which has notably resulted in the creation of four scientific collaborative networks in fields of high regional importance: astronomy; human genetics and biotechnology, risk assessment and mitigation and; mathematical and theoretical physics. The Astronomical Observatory of Rozhen in Bulgaria, for instance, is shared by researchers throughout the subregion.

The ministers also said they welcomed the opportunity afforded them by UNESCO to meet periodically to discuss major policy issues with regard to science, technology and innovation and higher education. Indeed, this was the eighth high-level meeting organized by UNESCO's Venice Office in the past 12 years, within the Venice Process.

The Venice Process was launched by UNESCO in 2001 to rebuild scientific cooperation within the subregion and with the rest of Europe after the breakup of Yugoslavia, in order to prepare countries for integration into the European Research Area.

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A UNESCO Chair in climate science and policy

Students and faculty gathered at TERI University in New Delhi (India) on 9 November for the inauguration of a UNESCO Chair in Climate Science and Policy.

The Chairholder is Prof. Veerabhadran Ramanathan. He will be responsible for building research capacity to develop solutions for climate mitigation and adaptation. TERI University specializes in sustainable development and already runs an interdisciplinary Masters programme in Climate Science and Policy.

Inaugurating the Chair with the University's Vice-Chancellor, Leena Srivastava, was UNESCO Director-General Irina Bokova. She reaffirmed the importance of interdisciplinarity for sustainability and recalled that sustainability 'calls for connecting knowledge with policy and strengthening the science–policy interface.'

The Director-General also stressed the importance of building a deeper convergence between the climate change and biodiversity agendas.

In accepting the Chair, Prof. Ramanathan chose to formulate his areas of interest as questions: 'Is humanity's interaction with nature sustainable? Is our knowledge of skills advancing enough to lessen the environmental impact of human activities? How will South Asia look in a world that is 2–4°C warmer than today and is it prepared for this? How many cities in South Asia are prepared to deal with major events like Hurricane Sandy, which struck the Caribbean and east coast of North America in October? Prof. Ramanathan

pledged to pursue scientific discourse on these issues and to put new ideas into practice in the field.

The university's roots can be traced back to 1998, when TERI School of Advanced Studies was founded as a non-profit, independent research institute specializing in scientific and policy research in the realms of energy, environment and sustainable development. The institute was subsequently renamed TERI University in 2006, in order to disseminate the vast reservoir of knowledge generated by the institute to the younger generation and cross-fertilize the knowledge of professors with the ideas of clever young minds.

In his capacity as Chair of the Intergovernmental Panel on Climate Change, the University's Chancellor, Dr Rajendra Pachauri, shared the Nobel Peace Prize in 2007 with US Vice-President Al Gore.

For details: www.teriuniversity.ac.in; (in New Delhi) r.boojh@unesco.org

Tsunami warning system put to the test

A simulated tsunami struck the western and eastern coasts of the Mediterranean Sea and the North-eastern Atlantic shoreline on 27 and 28 November. The exercise was organized under the umbrella of the UNESCO-IOC to test the Tsunami Early Warning and Mitigation System for the Northeastern Atlantic, Mediterranean and Connected Seas.

Eighteen of the system's 39 member countries participated in the exercise: Cape Verde, Croatia, Denmark, Egypt, Finland, France, Germany, Greece, Ireland, Italy, Lebanon, Malta, Monaco, Netherlands, Portugal, Spain, Sweden and Turkey.

Four regional centres were mobilized for the exercise, each proposing a different scenario. The National Observatory of Athens sent five warning messages by fax, email and via the Global Telecommunications System (GST). Its scenario was based on an earthquake and tsunami that devastated the Aegean coastlines on 9 July 1956.

The *Centre d'alerte aux tsunamis*, hosted by the French Atomic and Alternative Energies Commission, based its scenario on a powerful earthquake off the Algerian coast. Four messages were sent by fax, email and GST to Member States. They were also transmitted to civil protection authorities in France.

The scenario developed by the Kandili Observatory of Istanbul's Seismic Research Institute in Turkey was inspired by an earthquake which struck Crete on 8 August 1303, causing deadly floods in the Eastern Mediterranean. Twelve messages were sent to member states' focal points.

Lastly, the Portuguese Sea and Atmosphere Institute based its scenario on an earthquake and tsunami that struck west of Gibraltar in 1755. During this exercise, six messages were successfully sent to member states.

The Greek, French and Turkish centres have been operational since mid-2012, whereas the Portuguese centre is still under development.

The Northeastern Atlantic system is one of four such warning systems coordinated by the UNESCO-IOC. The others are situated in the Indian and Pacific Oceans and in the Caribbean. That for the North Atlantic is the last to undergo this kind of test.

For details: www.neamtic.ioc-unesco.org

UNESCO launches survey of STI policy instruments

On 6–8 November, UNESCO's Division for Science Policy and Capacity-Building ran a two-day workshop in Harare (Zimbabwe) to introduce countries to a survey developed within a new project to build a Global Observatory of Science, Technology and Innovation (STI) Policy Instruments (GO→SPIN).

The survey consists of an exhaustive questionnaire on a country's STI programmes, policies and infrastructure, including the legal framework. The survey was presented to 39 government representatives from Botswana, Malawi, Mozambique, Zambia and the host country.

The information provided by Botswana, Malawi, Zambia and Zimbabwe will be included in the GO→SPIN platform, a vast interactive database. Moreover, these four countries plan to use the survey to map their STI landscape for inclusion in UNESCO's series of Country Profiles in Science, Engineering, Technology and Innovation. The series is being launched within UNESCO's new STI Global Assessment Programme (STIGAP).

Other African countries will discover the GO→SPIN survey at subregional training workshops this year, beginning in Dakar (Senegal) in February for French-speaking countries. The workshops in Harare and Dakar are both being funded by the Spanish government.

The African Observatory of Science, Technology and Innovation (AOSTI) is hosted by Equatorial Guinea. It collaborates closely with the UNESCO Institute for Statistics (UIS) and was invited by UNESCO to the Harare seminar to work on harmonizing data and analysis.

AOSTI is currently preparing the second *African Innovation Outlook*, which will survey 28 countries. The workplan for the first *Outlook* was devised by the African Science, Technology and Innovation Indicators (ASTII) initiative. As a member of ASTII's Advisory Committee, the UIS participates actively in all ASTII workshops.

In Brazzaville (Rep. Congo) on 12–15 November, the fifth African Ministerial Conference on Science and Technology (AMCOST V) invited AOSTI to collaborate with the UNESCO GO→SPIN and STIGAP initiatives.

UNESCO has been a member of the AMCOST Steering Committee since May 2008.

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Eric Hoffman

‘Genetic pollution is permanent’


© Friends of the Earth

Synthetic biology was one of the themes discussed at the Assises du vivant, a forum organized jointly by UNESCO and the French NGO Vivagora in Paris on 30 November. Synthetic biology is still in its infancy but it has great ambitions: to create entirely new life forms. Borrowing techniques from engineering, the synthetic biologist assembles different parts (genes) to build an entirely new circuit. At the Assises du vivant, one proponent suggested that synthetic bacteria could be designed to glow whenever they detected explosives in the soil, alerting to buried anti-personnel mines. Others cited the potential for synthetic biofuels, biodegradable plastics and cancer drugs. But some participants were more circumspect. ‘Have the necessary safeguards been put in place? ’, they asked. ‘Could existing organisms not fulfill the same role? Do we know how existing species will interact with these new life forms of our own creation? And what guarantee is there that they will function in the way we intended? We put these questions to Eric Hoffman, a science and technology policy expert with the US branch of the NGO Friends of the Earth.

Does synthetic biology ever involve assembling elements other than genes?

Synthetic biology is really an umbrella term to describe a number of technologies, some of which are simple extensions of ‘conventional’ genetic engineering, while others are a much more extreme departure. For example, some in the field of ‘xenobiology’ hope to create organisms with an entirely new genetic make-up as a way to prevent these organisms from spreading their genes in the wild. Instead of having DNA and RNA, like all living things on Earth, they would instead have ‘XNA’, for xeno-nucleic acids, meaning ‘foreign’ or ‘alien.’

Others even hope to create ‘protocell,’ or life-from-scratch using inanimate chemicals. This would truly be a synthetic form of biology. It should be noted that both of these ideas, and many from the synthetic biology industry, are still theories and that little has been proven to work. There have been some major scientific advances in the field but there has been an equal amount of hype.

Why do you say that synthetic biologists want to turn microbes into living chemical factories?

Synthetic biologists speak of turning microbes into ‘living chemical factories’ that can be engineered to produce substances they would not produce naturally. Equating a factory with a living and evolving organism is both inadequate and problematic.

Synthetic biologists are now partnering with the world’s largest companies in cosmetics, food ingredients and pharmaceuticals to produce compounds naturally found in plants through genetically engineered microbes. Products already in development include flavourings like vanilla, liquorice and saffron, sweeteners like stevia, oils like jojoba, tyre rubber and medicines.

Are there already products on the market?

Yes, a number of products from synthetic biology are already on the market, with more expected to be introduced in 2013. These products are generating over US$1.6 billion in annual sales. For example, Amyris Biotechnologies in the USA is producing squalene, a moisturizer often found in cosmetics, through its synthetic yeast; it already controls 12% of the global squalene market. The pharmaceutical giant, Roche, is already producing compounds found in star anice through synthetic biology for use in influenza medication. There are also some flavourings and fragrances on the market, including citrus flavourings. Swiss-based company Evolva plans to introduce a synthetic version of vanilla in the coming year which they plan to market as ‘natural vanilla,’ pitting their synthetic microbes against farmers in Madagascar.

Interestingly, the synthetic biology community promised the public that their technology would produce cheap, abundant biofuels to help end climate change. It quickly became apparent that producing biofuels on an industrial scale was much more difficult than originally planned, so companies are quietly switching over to these high-value, low-volume products like cosmetic oils and fragrances. One thing we know for sure is that our climate crisis will not be solved by producing cheaper hand moisturizers or vanilla ice cream.

Do engineered microbes need to ‘eat’ to survive?

Microbial production processes depend on industrial-scale supplies of feedstocks, notably sugars derived from agricultural and forest biomass. Since 86% of the world’s biomass is found in the tropics, increased demand for biomass to feed billions of synthetic microbes could have an enormous impact on forests and biodiversity in the tropics, as well as on the livelihood and food security of smallholder farmers, forest-dwellers, livestock-keepers and fishing communities.

Land, water and fertilizers are already in short supply for food production. Industry groups argue that widespread application of synthetic biology will enable a new ‘bioeconomy,’ to emerge in which products previously made from fossil petroleum will be fermented by engineered microbes feeding on living biomass. However, shifting this land away from agriculture to produce biomass for synthetic microbes to fill cars in the USA, Europe and rapidly developing economies around the world would be unsustainable and unjust.

Is it true that most synthetic organisms regularly swap genes?

The organisms that are the focus of most synthetic biology work so far are yeast, *Escherichia coli*, algae and viruses. Each of these

swap genes regularly in nature in one of three ways: either by passing on genes from the same or similar species, by picking up wild DNA in the environment left over from dead organisms, or from viruses.

Could these synthetic organisms 'escape' from the lab and contaminate other species?

They undoubtedly will escape into the environment, especially if being reared on an industrial scale. And if they escape, they will swap genes with wild organisms, which will lead to genetic contamination. Unlike other types of pollution, genetic pollution is permanent and impossible to clean up.

Take algae for example. Algae are being targeted largely for biofuels production. Synthetic biologists are re-engineering algae so they that produce more oil than they would naturally and so that oil resembles petroleum or other types of fuels. Much of this work will take place in open ponds, since it would be too expensive and difficult to grow algae indoors. Raising algae in an open pond means they are being released into the environment, since algae can get out of the pond in many ways, including by being blown in the slightest breeze, getting into workers' lungs or by spilling into local waterways.

Once out, the algae could find an ecological niche and thrive; they might even take over an ecosystem as a new class of invasive species. One could also imagine these algae, engineered to produce oil in great quantities, continuing to produce oil in a local river or lake and thereby becoming a new source of oil pollution.

Once out in the environment, these algae may swap genes with wild-type algae and pass on these traits to future generations. The industry claims its algae are safe and wouldn't survive in the wild but, unfortunately, no-one has conducted an environmental assessment on genetically engineered or synthetically engineered algae to prove this claim. We should assume these synthetic organisms to be dangerous until the technology's proponents prove them to be safe.

Should we be afraid of engineered viruses escaping into the environment?

Synthetic biology techniques have already been used to re-create the 1918 Spanish Influenza virus and the smallpox virus in a lab, both of which were proven to work. Eventually, it might be possible to create new, more virulent forms of diseases using synthetic biology.

We know today that biotechnology labs are not always safe and that workers can get sick from genetically engineered viruses. Synthetic biology only raises the level of risk, since more novel organisms can be created and, through the growing 'do-it-yourself biology' community, people are using synthetic biology tools in their basements and garages to create novel organisms.

Unfortunately, most of the work on viruses being conducted by pharmaceutical companies is kept secret as 'confidential business information,' so it is difficult, if not impossible, for the public and workers to know what exactly is being created and how risky these new viruses might be.

Have any impact assessments at all been done of synthetic organisms?

No, none to date. Nor do there seem to be any planned. Part of the problem is that our risk assessment models for 'conventional' genetic engineering are quickly becoming outdated and no one really knows how best to conduct such risk assessments when it comes to products and organisms of synthetic biology.

Another part of the problem is that governments are not investing money in risk assessment. The US government is spending hundreds of millions of dollars to support developments in synthetic biology but none of this has gone to risk assessment. This is illogical and dangerous.

Lastly, since a lot of the work being done on synthetic biology is kept secret as 'confidential business information,' even if a risk assessment has been conducted, its findings might be kept from the public. We thus have no way of knowing how risky (or not) these new organisms are for our environment and health.

Are there any regulations governing the development of synthetic biology?

There are currently no national or international regulations in place to govern developments in synthetic biology. There are rules and regulations for genetic engineering but these are quickly becoming outdated and are unable to deal with the rapid developments taking place in synthetic biology and other biotechnologies. The only rule in the USA is a voluntary guideline for DNA synthesis companies to screen orders that could be used to produce a biological weapon – but this is completely voluntary.

The UN Convention on Biological Diversity (CBD) has begun to look at the risks synthetic biology poses to the conservation and sustainable use of biodiversity. The meeting of the CBD in Hyderabad (India) last October urged Parties to the Convention to apply the precautionary principle when dealing with synthetic biology and requested that further studies be conducted to assess what risks exist. The Biological Weapons Convention is also starting to look more closely at synthetic biology and its potential use as a weapon.

Do you see a role for UNESCO?

Yes, UNESCO could help to develop international guidelines around synthetic biology. To begin with, UNESCO could bring governments together to develop a new international convention on the evaluation of new technologies.

Synthetic biology is just one new emerging technology that poses many risks to human health, the environment and social justice. Geoengineering, nanotechnology and many others also raise similar and new concerns that are not being properly assessed in a timely manner. New technologies are running full-speed ahead as our laws and regulations lag behind. Such a new convention would create a political and scientific environment for the timely and sound evaluation of new technologies in a way that is democratic and transparent.

UNESCO could also direct its International Bioethics Committee to study the implications of synthetic biology for human genetics. Many prominent synthetic biologists talk about how this technology could be used to reengineer the human genome and microbiome. UNESCO could state publically that such interventions are contrary to human dignity, as affirmed by Article 24 of the *Universal Declaration on the Human Genome and Human Rights*.

Interview by Susan Schneegans

Preserving the memory of the world

The Suez Canal's history is recorded in the Memory of the World Register. Here, the canal is seen under construction by French engineers, in a photo taken in Ismalia (Egypt) between 1861 and 1863.

UNESCO's Memory of the World programme has just fêted its 20th anniversary with the publication of a commemorative volume, *Memory of the World: the Treasures that Record our History from 1700 BC to the Present Day*. Over the past two decades, a wealth of irreplaceable historical documents have been inscribed in the Memory of the World Register to underscore their importance for humanity as a whole and guard against collective amnesia. These documents include manuscripts on medicine, astronomy and mathematics, photos, drawings and maps, as well as patents for inventions which marked a turning point in human civilization, like the first automobile. Here, we summarize some of the marvels of human ingenuity portrayed in this anniversary volume.

Medicine and pharmacology

The *Huang Di Nei Jing* (黄帝内经), or *Yellow Emperor's Inner Canon*, is the earliest and most important written work of traditional Chinese medicine. Compiled over 2 200 years ago, it was the first medical text to depart from the old shamanistic beliefs that disease was caused by demonic influences. It expounds the concept of health with the philosophical thinking of Taoism and Confucianism, perceiving disease as being closely related to diet, emotion, lifestyle, environment, age and heredity. It also emphasizes the unity of humanity and nature and the holistic idea of body and mind.

The book is written in a conversational style, with the Yellow Emperor (Huang Di) raising questions on medical issues to which his sage physicians, Qibo and Leigong, reply. They prescribe methods of diagnosis and treatment for a large number of 'modern' diseases, including malaria, gout, diabetes, coronary heart disease, rheumatic arthritis and cerebrovascular problems.

The *Vienna Dioscurides* (Austria) is the oldest and most famous copy of a work written in the 1st century CE by Dioscorides, a Greek physician, pharmacologist and botanist. *De Materia Medica* was copied in the early 6th century for Juliana Anicia, daughter of Flavius Anicius Olybrius, emperor of the Western Roman Empire, in recognition of her patronage in building a church in Constantinople (today Istanbul). In 1519, the Holy Roman Emperor Maximilian II bought the book for the Habsburg Imperial Library in Austria. *De Materia Medica* was used by medical practitioners for 1000 years.

The *works of Ibn Sina* in the Süleymaniye Manuscript Library (Turkey) total 263 separate titles. Ibn Sina (980–1038) was born in what is now Uzbekistan and died in Iran. The most eminent scientist, philosopher, pharmacologist, theorist, poet and politician of his time, he is often known as a physician under the Latin name of Avicenna. Ibn Sina's works gradually filtered to Europe where they were received with the same enthusiasm as at home. *Al-Qanun Fi'l Tibb* (*The Canon of Medicine*) was used between 1400 and 1600 as the main medical text in various medical schools in Europe; by this route, much classical Greek medical knowledge was reintroduced into Europe, after being lost during the European Dark Ages.

The National Library of China's copy of **Huang Di Nei Jing**, *produced in 1339 using woodblock printing*

The *Donguibogam* (Korea) is a 25-volume encyclopedia from 1613 synthesizing 2000 years of traditional medical knowledge and clinical experience not only from Korea but also from China. It posited the notion of 'right living' as preventative medicine. The *Donguibogam* was compiled by the royal physician Heo Jun on the instructions of King Seonjo for wide distribution to the king's subjects. The king's interest in their health has led

some to view the work as an early form of public-health policy. The book was set using movable wooden type and is arranged into five chapters: *Naegyeong* (Overview of the Inner Body); *Oehyeong* (External Appearance); *Japbyeong* (Various Diseases); *Tang-aek* (Liquid Medications); and Acupuncture.

The 500 texts of the *Tamil medical manuscript collection* (India) are written on palm leaves and reflect the ancient Siddha and Ayurvedic systems of medicine practiced by the yogis. Dried palm leaves were used as writing material in India for over two millennia. The manuscripts examine the nature and symptoms of diseases, together with the preparation of remedies. They explain how to obtain medicines – including powders and pastes – from herbs, herbal roots, leaves, flowers, barks and fruits. Some manuscripts deal specifically with illnesses in women and children; there are also 35 on alchemy.

The term 'codex' is used to describe a handwritten book dating from Antiquity to the European Renaissance, usually made up of sheets of paper or vellum[5] but sometimes in scroll form. The *Collection of Mexican Codices* is a set of 161 pictorial documents which are the only surviving examples of the pre-Hispanic reading and writing system peculiar to Mesoamerican cultures. The codices offer insights into the socio-economic, political, religious and cultural organization of the pre-Hispanic peoples. The partial map of the Aztec capital Tenochtitlan outlines urban planning, land ownership and land census information.

The *Chilam Balam* books dating from the 18th century contain historic, calendric, botanical and medical information, almanacs and prophesies written in the Mayan language of Yucatán. Botanical and medical documents dating from the mid-16th century were prompted by the Spaniards' desire to learn about local plants and contemporary plant and herbal remedies.

Photo: Wikipedia Commons

The Techaloyan de Cuajimalpaz Codex *describes a meeting held between 1685 and 1703 of the leading townspeople of San Pedro Cuajimalpaz, who were both indigenous and European. They met to confirm the territorial limits of their town, using agricultural lands, woodlands and buildings to demarcate property lines. The codex was written in the Náhuatl language of the Aztecs using the Latin alphabet. For nearly 200 years, the townspeople used the codex to prove their right to their lands.*

Astronomy and mathematics

Written by the renowned Iranian scientist, abu-Rayhan al-Biruni (973–1048), the *Book of Instruction in the Elements of the Art of Astrology* (*Al-Tafhim li Awa'il Sana'at al-Tanjim,* 1029) is the oldest Persian text on mathematics and astrology. Using precise mathematical calculations, this work brought astronomical rigour to traditional astrology and contributed to the revolution in astronomy during the European Renaissance (15th–17th centuries).

The book was written at the request of Rayhanah, daughter of Hussein (or Hassan) Khwarizmi. It is structured around 530 questions and answers supplied by an imaginary student and professor. Al-Biruni begins with the principles of geometry and arithmetic before proceeding to astronomy and chronology then, after introducing the use of the astrolabe *(pictured)*, to the principles of astrology.

Astronomy, mathematics and medicine were the core disciplines of Islamic science in the Ottoman Empire, with many works being written on these subjects in Turkish, Arabic and Persian. The *Library of the Kandilli Observatory and Earthquake Research Institute manuscripts* in Turkey represent a collection of 1339 works in these disciplines and others, including astrology and geography, which date from the 11th to the early 20th century. Among its treasures is a calendar in Persian prepared in 1489–1490 and presented to Sultan Beyazit. Other calendar scrolls are designed by month of the year, with details of the partial and total eclipses of both the Sun and Moon.

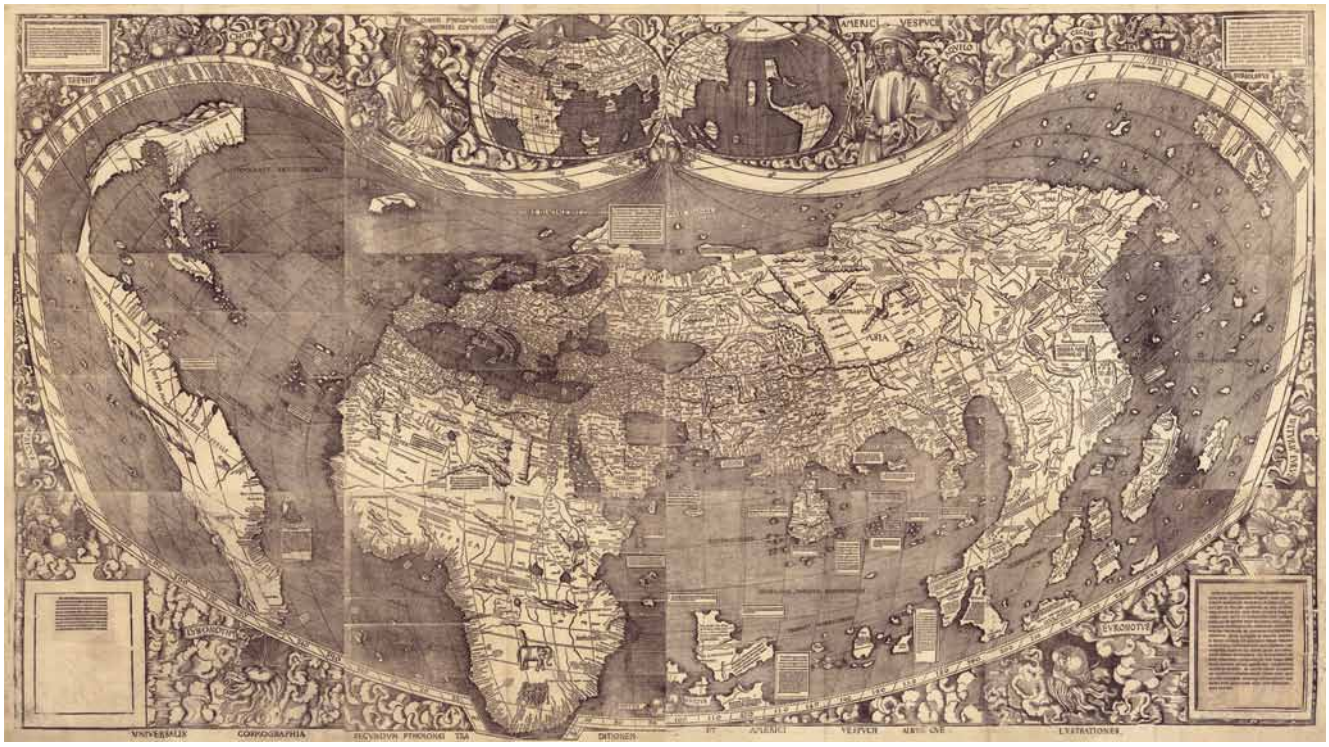
Nicolaus Copernicus' masterpiece De revolutionibus libri sex (c. 1520) presents his theory that the planets orbit the Sun (heliocentric theory), at a time when the accepted theory was that the Sun orbited the Earth, the geocentric theory devised by Ptolemy.[6] Copernicus (Poland, 1473–1543) also proposes that the Earth moves around its axis (explaining the existence of day and night) and around the Sun on an annual basis. Copernicus studied in Poland and at several Italian universities. A scientist, humanist, philologist, doctor and pioneer in the practical study of economics, he is considered one of the fathers of the Renaissance.

Andrew Dunn/ Wikipedia Commons

18th century Persian astrolabe representing the night sky. It was used to locate the positions of the Sun, Moon, stars and planets and predict their movement.

Maps

Written on parchment in the first half of the 5th century, the *Tabula Peutingeriana* (Austria) is the only existing map of the road system for the *cursus publicus*, the Roman Empire's public transportation system. It covers all the provinces under Roman rule and the eastern territories conquered by Alexander the Great. Much information about the topography and historical geography



Waldseemüller's 1507 map depicting a large and separate western hemisphere which he named America

relating to archaeological sites in Europe, Africa and Asia is only known through the *Tabula Peutingeriana*.

In 1507, German map-maker Martin Waldseemüller produced the *first world map to depict correctly the European discoveries in the New World.* Up until then, Europe had adopted Ptolemy's view of a three-continent world made up of Europe, Africa and Asia.

Waldseemüller decided to name the new world 'America,' in honour of Italian explorer and cartographer Amerigo Vespucci (1454–1512). Vespucci had sailed on several Portuguese exploratory voyages of the coast of the New World between 1499 and 1502, only to find that it extended much farther south than previously thought. Vespucci was credited with the discovery that the new land was not part of Asia but a separate landmass. Waldseemüller's map also used the most up-to-date and detailed information about Africa gleaned from the Portuguese navigators' recent expeditions.[7]

Standardization

The *Linné collection* (Denmark) honours Swedish physician and botanist Carl von Linné (1707–1778). He created the binomial system of scientific nomenclature for all living organisms that is still in use today. Using a form of botanical Latin that he devised himself, he attributed a genus name for organisms of similar characteristics and a species name which defined a unique organism, such as *Panthera leo* (lion) and *Panthera tigris* (tiger). He divided the Animal Kingdom into *Mammalia, Aves* (birds), *Amphibia, Pisces* (fish), *Insecta* (including crustaceans) and *Vermes* (including molluscs). Today, the internationally recognized starting point for botanical names is his *Species Plantarum* (1753) and, for zoological names, *Systema Naturæ* (1758).

The *decimal metric system* (France) was introduced after the French Revolution (1789), providing the basis for today's international decimal system. It emerged from the 18th-century intellectual movement of the Enlightenment and its emphasis on the supremacy of reason. Before its introduction, there was no agreed principle for calculating weights and measures in France: one foot, for example, was measured at an estimated 20 different lengths across the country.

In 1790, the politician Talleyrand proposed adopting a new universal system. The new measures were officially approved in 1799 but were not uniformly popular in France; even the Emperor Napoleon once banned the system. They finally became compulsory in 1840. The collection includes laws and standard measurements. The standard metre, for example, was built in platinum, as it was less susceptible to shifts in temperature than other metals. A platinum weight was also made for a standard kilogram measurement, a gram being defined as the mass of 1 cm^3 of water at its temperature of maximum density.

Inventions and engineering

The 42-line *Gutenberg Bible* was completed around 1456 by Johannes Gutenberg and is probably the first European printed book using movable type. Printing with movable letters was also invented independently in Korea. Gutenberg produced movable metal type via a hand mould, the setting of the text in type and a printing press. From his printing office in Mainz (Germany), the new technology of book printing spread all over Europe and the world, radically changing the dissemination of information and ideas. It is thought that about180 copies of the *Gutenberg Bible* were printed, 40 on vellum and the remainder on paper. For this, 100 000 types had to be cast. It took three years to print the 180 *Bibles*, a period in which a copyist working by hand would have completed a single one.

The *Memory of the Suez Canal* records the history of the canal which revolutionized navigation and trade between Europe and both East Africa and Asia by offering an alternative route to sailing around the Cape of Good Hope (South Africa).

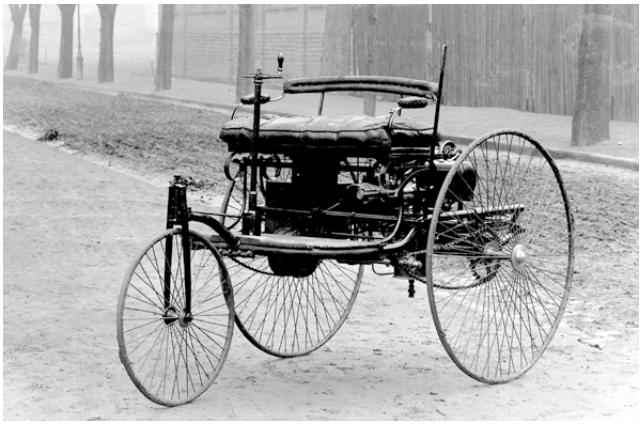
In 1854, French engineer and diplomat Ferdinand de Lesseps persuaded the Egyptian government to build a canal running from Port Said on the Mediterranean coast to the Gulf of Suez at the head of the Red Sea. De Lesseps became the first president of the company set up to build the canal and operate it for 99 years before handing over ownership to the Egyptian government.

When the canal opened in 1869, it was the longest in the world, at 164 km. Under the terms of the Convention of Constantinople (1888), signed six years after the British occupied Egypt, the canal was officially opened to vessels of any nationality without discrimination in times of peace and war; the British were to maintain joint control over the canal with Egypt until 1961.

In 1956, however, President Nasser of Egypt nationalized the canal in what is known as the Suez Crisis, which involved not only Egypt and Britain but also the USA, Soviet Union, France and Israel. The canal was closed again during the Egyptian–Israeli conflicts of 1967 and 1973, before finally reopening in 1975. Today, it is 193 km long and is currently being deepened and widened to double its capacity.

The *archive of Nikola Tesla* (1856–1943) in Serbia honours the man who pioneered alternating current electricity, the cornerstone of modern electricity generation and the long-distance transmission and use of electrical power.

The Goettingen copy[8] inscribed on the Register is one of only four Gutenburg Bibles *printed on vellum to have survived. Most were printed on paper. Each printed copy was embellished with hand-drawn illustrations.*



Carl Benz's 'vehicle with gas engine operation' patented in 1886

Tesla's synchronous electric motor provides 95% of the world's electric motive power for driving machinery.

He also invented the Tesla coil, a transformer which is an essential part of all contemporary high-frequency devices. The plasma production technique he invented only recently became vital for the production of computer chips. The remote control was another of his inventions. He also discovered the principle of the logical 'i' circuit, without which contemporary computers would be impossible.

Last but not least in our selection, the *Benz patent of 1886 for a 'vehicle with gas engine operation'* (Germany) was submitted by Carl Benz. It marks the invention of the automobile with an internal combustion engine running on liquid fuel. The patent refers to a self-propelled vehicle for the conveyance of 'one to four persons' with a 'small gasoline engine of whatever type' which obtains its gasoline 'from an apparatus carried on board in which gasoline derived from ligroin or other volatile substances is produced.'

Digitizing for posterity

In 2009, UNESCO and the US Library of Congress launched the World Digital Library, a project developed in association with six major libraries from Brazil, China, Egypt, Russia and the USA. National libraries and other institutions can regularly add content by uploading digitized copies of fragile historic documents in their possession. The Mexican codices, for example, are scattered around the world but many can be consulted online in the World Digital Library.

Compiled by Susan Schneegans

To order Memory of the World, *see page 24*
For details of the programme: j.springer@unesco.org;
http://tinyurl.com/7ouqzb6;
World Digital Library: wdl.org

5 *Vellum is a type of thick paper made from an animal skin, usually that of a calf or goat.*
6 *Astronomer, astrologer, geographer and mathematician (died 168 CE) who lived in Egypt under Roman rule but wrote in Greek.*
7 *Today, the map is housed in the US Library of Congress, which hosts the open access World Digital Library supported by UNESCO: www.wdl.org*
8 *This copy can be consulted at: www.gutenbergdigital.de*

Getting **out of debt**

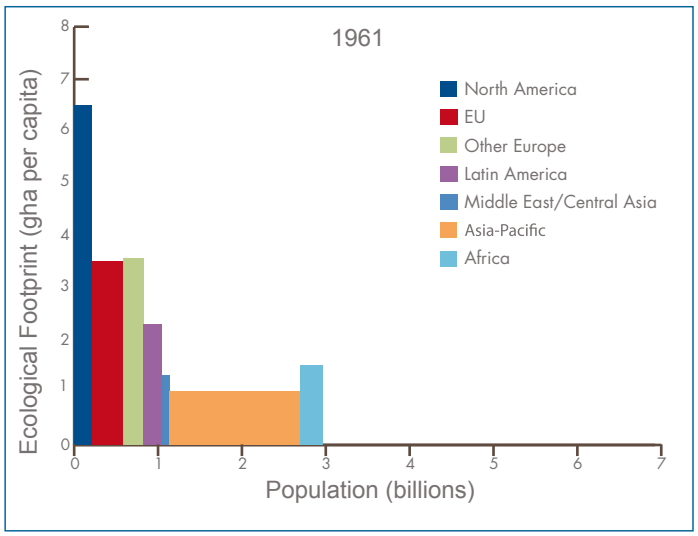
The other side of paradise: dumped rubbish in a Turkish bay on the Aegean coast that is popular with pleasure boats

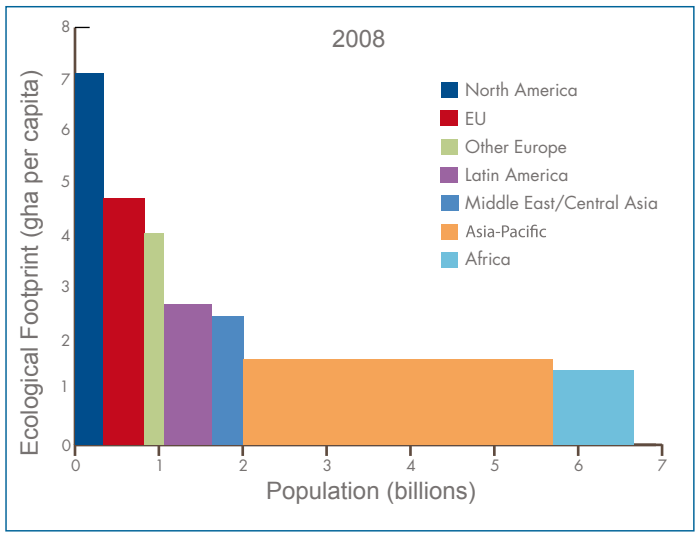
In less than 50 years, residents of the Mediterranean region have nearly tripled their demand for natural resources and ecological services. As a result, all 24 countries bordering the Mediterranean Sea have become ecological debtors. These are the alarming findings of *Mediterranean Ecological Footprint Trends*, a report launched by Global Footprint Network on 1–2 October at a conference organized jointly with UNESCO's Regional Bureau for Science and Culture in Europe (Venice, Italy) on Securing Competitiveness for the Mediterranean. Participants from the governments and universities of 15 Mediterranean countries[9] were in Venice to debate the implications of the report's findings for the region's economic prosperity and political stability.

One question raised by participants concerned the extent to which the growing scarcity of natural resources in North Africa and the Middle East had fuelled the economic crisis which triggered the Arab Spring in 2011. 'The security issue is closely tied to ecological and demographic time bombs', observed one participant. 'If a country cannot satisfy its population's most basic needs, social unrest will logically follow. Even conflicts that are ostensibly based on religious differences may stem from growing competition for finite resources like land and water.'

You cannot manage what you cannot measure

It has been said that you cannot manage what you cannot measure. The ecological footprint has been devised by Global Footprint Network to help governments everywhere measure the state of their ecological assets in the form of natural resources and ecosystem services, in order to manage them





Source: Global Footprint Network (2012) Mediterranean Ecological Footprint Trends

Between 1961 and 2008, both Europe and the region encompassing the Middle East and Central Asia experienced the greatest increase in their ecological footprint: +1.2 gha and +1.1 gha per person respectively; population growth in Europe was much slower (+29%), however, than in the Middle East/Central Asia (+330%). In Asia–Pacific, the figures were +0.6 gha per person and population growth of 136%. Latin America experienced a similar trend, with population growth of 156% and a rise in per-capita consumption of 0.4 gha per person. In North America, which has the biggest ecological footprint of any region, both per-capita consumption (+0.6 gha per person) and the population (+63%) progressed. Africa was the only region where per-capita consumption dropped (-0.1 gha per person), despite rapid population growth (+255%).

better over the longer term. To gauge a country's ecological balance sheet, you compare supply (biocapacity) with demand (ecological footprint). If demand outstrips supply, the country is considered as running an ecological deficit.

Global Footprint Network has calculated that there were 1.8 global hectares per person of biocapacity (forests, croplands, urban land, grazing lands, etc) on the planet in 2008. Between 1961 and 2008, the world's ecological footprint rose modestly from 2.4 to 2.7 global hectares (gha) per person but the world nevertheless developed an ecological deficit, as its per-capita biocapacity almost halved over the same period from 3.2 gha in 1961.

The situation deteriorated much faster in the Mediterranean than the global average, with the region's ecological footprint increasing from 2.1 to 3.1 gha per person. At the same time, the region's per-capita biocapacity decreased from 1.5 to 1.3 gha per person. This caused the region to shift from having a small ecological deficit in 1961 to a 150% deficit in 2008.

What went wrong? As early as 1961, 18 out of 24 Mediterranean countries were already experiencing an ecological deficit but this was offset by imports of products grown outside the region. Between 1961 and 2008, the Mediterranean region's population doubled from 242 million to 478 million, effectively outstripping productivity gains in agriculture. A second aggravating factor came into play from 1971 onwards, when the world entered a period of overconsumption defined as 'global overshoot.' With the implacable logic of economics, this surge in demand for a finite supply of commodities pushed up prices on international markets.

From ecological creditors to debtors

The six countries around the Mediterranean Basin with an ecological credit in 1961 were Algeria, Morocco, Libya, Syria, Tunisia and Turkey. All had shifted to debtor status by 2008 *(see map overleaf)*. It is this finding which led some participants in the Venice conference to speculate as to the influence of this ecological deficit on the Arab Spring.

All the other Mediterranean countries saw their ecological deficit rise, with Cyprus experiencing the largest increase and Jordan the smallest.

By 2008, the five Mediterranean countries with the highest total ecological deficits were Italy, Spain, France, Turkey and Egypt. However, three of these countries also supplied nearly half of the region's biocapacity: France (31%), Turkey (15%) and Italy (11%). The study concluded that the higher the income of a country, the greater its demand for ecological resources and services.

Blessed with a relatively low population density and favourable climate, France, Croatia and Slovenia enjoyed the highest per-capita biocapacity in 2008, whereas Cyprus, Jordan and Palestine counted the lowest.

In terms of the per-capita ecological footprint, the Former Yugoslav Republic of Macedonia topped the list in 2008, followed by Slovenia and Greece. At the other end of the scale with the lightest footprint came Morocco, Montenegro and Palestine.

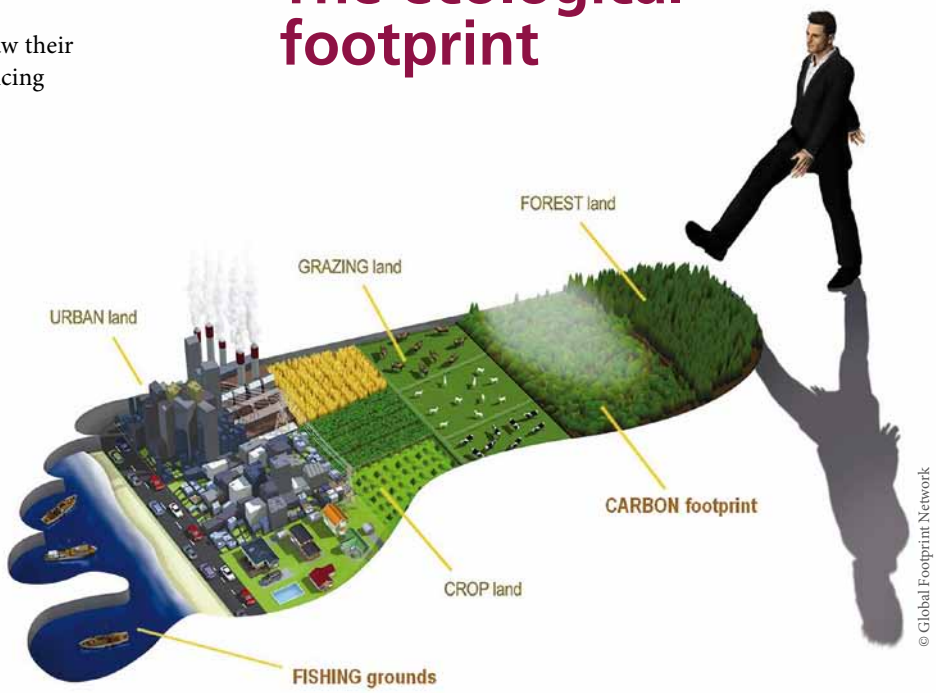
The role of trade in offsetting an ecological deficit

Countries meet their ecological deficit through trade and by overexploiting their ecosystems. The ecological footprint associated with each country's total consumption is calculated by adding together the footprint of its imports and production then subtracting the footprint of its exports. This means that the resource use and emissions associated with producing a car that is manufactured in China but sold and used in Italy will contribute to Italy's rather than China's ecological footprint of consumption.

Between 1977 and 2008, the ecological footprint embedded in imports to the Mediterranean from the region's top ten trading partners increased fivefold, from about 30 million gha to 142 million gha, primarily because of the carbon footprint component related to electricity and fossil fuels, energy intensive commodities as well as transporting goods.

By 2008, the carbon footprint accounted for 52% of the Mediterranean region's total imports, followed by imports of resources from such assets as cropland and fishing grounds (24% each). Electricity, fossil fuels and other energy-intensive commodities were mostly imported from Germany, China and the Russian Federation, in descending order, whereas renewable resources were imported primarily from Belgium and the Netherlands, followed by Germany.

The ecological footprint



As the region's ecological footprint grew heavier through imports, the Mediterranean's major trading partners developed larger ecological deficits. Between 1977 and 2008, these trading partners also shifted in some instances from countries with ecological reserves (Canada, Argentina and Saudi Arabia) to countries with ecological deficits (Germany, Belgium, the Netherlands and China). This situation exposes the Mediterranean region to the risk of a growing dependence on exporting countries that themselves are running ever-larger ecological deficits, a situation which could spark resource disruptions in the region in the future.

However, the same situation also offers opportunity. The majority of the region's exports of ecological resources and services now go to countries that are experiencing ecological deficits, with Brazil and the Russian Federation being the primary exceptions. In an era of tightening resource constraints, Mediterranean countries that manage to improve their resource efficiency and sustain a positive ecological trade balance would benefit economically from higher commodity prices.

Twenty years to change our development model

Simply stated, the Mediterranean region is running a severe ecological deficit, a situation that will only worsen unless effective resource management becomes central to policy-making.

Many of the measures taken recently by Greece, Italy and other Mediterranean countries to redress their public finances are likely to undermine the health of these countries' ecological assets and mortgage their long-term security. For example, in a letter[10] to the International Monetary Fund dated 6 January 2012, the World Wildlife Fund (WWF) cited eight measures imposed on Greece by its creditors since May 2010 which WWF considered as being little more than 'sticking plasters' which, 'far from healing wounds, are in fact exacerbating them while storing up longer-term environmental remediation costs.'

These eight measures were the: scrapping of Greece's 'green fund' and its absorption into the main state budget; axing of

Helping schools calculate their ecological footprint

UNESCO Programme Specialist Philippe Pypaert visited some of UNESCO's associated schools in Italy in 2010 and 2011 to show 11–14 year-olds how to calculate their ecological footprint. At Pio X Secondary School in Treviso, for example, he helped the class define an annual action plan for reducing the school's ecological footprint for energy and transportation in particular.

The children learned that the first step would be for them to assess their current level of consumption, expressed in global hectares per pupil. This could be done by collecting basic data, such as the school's electricity or gas bills. This information would then be stored in a database prior to being fed into a special online calculator designed to quantify their ecological footprint.

The next step would be for the children to propose ways of reducing their ecological footprint, such as by turning lights off when they left a room, encouraging the school to buy low-consumption light bulbs, or preferring public transport to a car on their way to school.

Ideally, these measurements would be repeated every year, so that classes could follow the school's progress and test the efficiency of proposed solutions over time.

Through these exchanges, pupils came to realize that local and national authorities could take similar measures on a grander scale, such as by improving the public transport system (local) or developing a clean energy policy (national). This realization should help prepare pupils for their future role as active, responsible citizens.

UNESCO's Venice Office and Global Footprint Network have been inspired by the Scottish government's Schools Global Footprint website to devise a platform of their own where schools from the entire region will be able to find everything they need to calculate their ecological footprint. Once up and running, this online platform will not only provide a calculator designed especially for the purpose and teacher's handbook. It will also feature teaching resources about sustainable development in general. Via the platform, teachers and their pupils will be able to learn about what other schools are doing around the world and report on their own experiences. UNESCO is currently seeking donor support to launch the online platform in 2013.

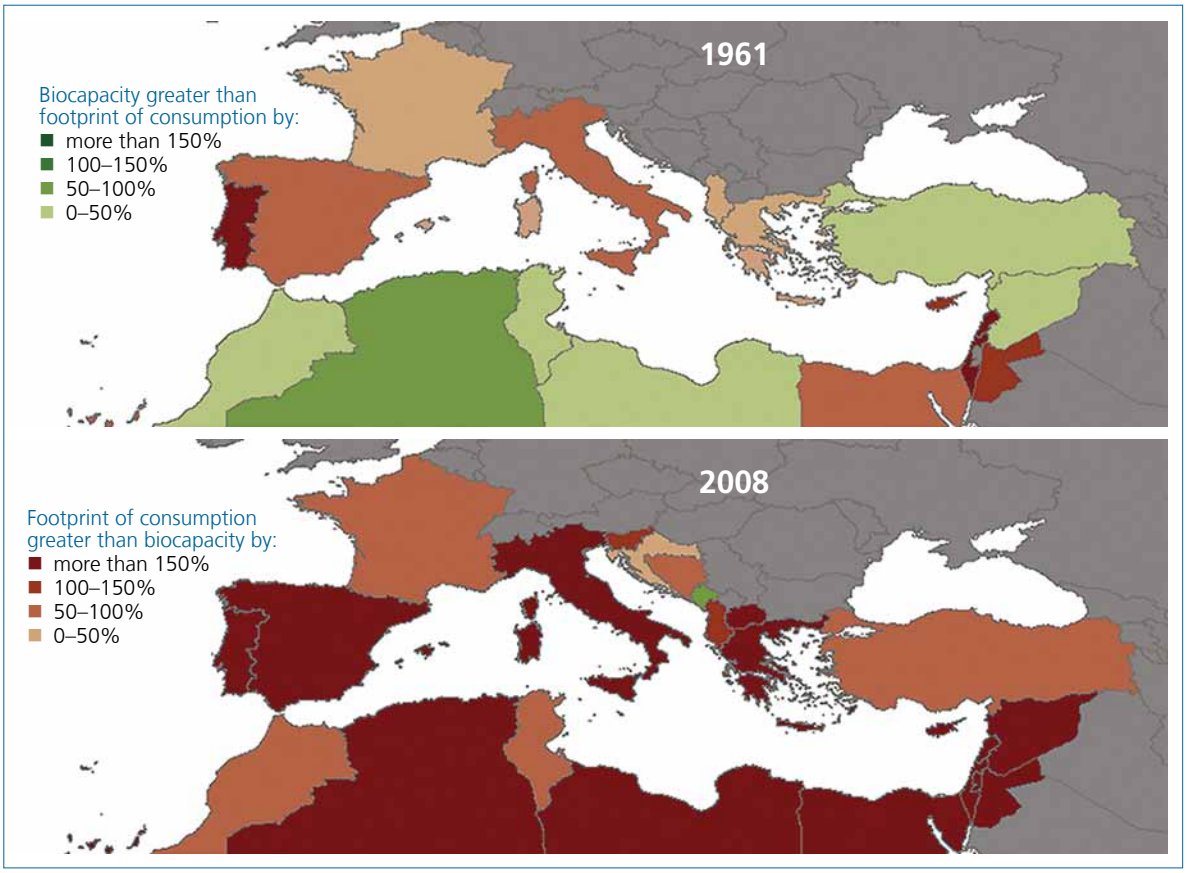
The ultimate goal is to mainstream the ecological footprint concept in secondary school curricula across the region, in order to help prepare the young for the necessary transition to a lifestyle bound by the limits of our planet's ecosystems. UNESCO plans to invite a group of international experts to translate the experiences of participating schools into generally applicable guidelines, methodologies and policy advice.

UNESCO is releasing an online handbook later this year on *Education for Sustainable Development in Biospheres Reserves and other Designated Areas*, for educators in Southeast Europe and the Mediterranean; the handbook includes a component on how businesses, individuals and groups can calculate their own ecological footprint.

See: www.educationscotland.gov.uk/schoolsglobalfootprint/about/index.asp

Discover Global Footprint Network's personal footprint calculator: www.footprintnetwork.org/en/index.php/GFN/page/personal_footprint

Schools around the Mediterranean basin interested in participating in the ecological footprint project may write to p.pypaert@unesco.org



Ecological deficit (red/pink) or ecological reserve (green) of the Mediterranean countries

environmental regulations governing permits; an emphasis on large investments with questionable environmental scrutiny; post-facto legalization of illegal developments in protected areas; the hasty and uncontrolled sale of public lands; downsizing of environmental staff employed by public authorities; dismantling of institutions for environmental governance; and questionable support going to dirty energy sources, including coal.

'It is WWF's strong belief', stated the letter, 'that the crisis unfolding in Greece and the Eurozone countries more widely […], in addition to being grounded in mismanagement of national finances, is a reflection of a deficient development model built on overconsumption and a steadily increasing ecological deficit and natural resource overexploitation.'

Europe is not alone in needing to change its development model, of course; it is a global imperative. For the past quarter-century, Global Footprint Network has calculated the day on which the planet's entire stock of renewable resources and ecological services are exhausted for a given calendar year. In 2012, humanity had spent its entire annual credit by 22 August.

Global Footprint Network[11] predicts that, if we continue on a business-as-usual path, it will take twice the ecological assets of the biosphere to meet our demands by 2030; this level of overshoot is physically impossible in the long run.

We thus have only a 15–20-year window in which to change our development model, a view shared by Earth Policy Institute founder Lester Brown in his latest book, *World on the Edge* (2011). Those countries and cities trapped in energy- and resource-intensive economies will become dangerously fragile, for they will not be able to adapt in time to emerging resource constraints. By contrast, those countries which begin making the transition to economies which work with – rather than against – nature's budget will be able to secure lasting prosperity for their citizens.

Alessandro Galli[12] and Philippe Pypaert[13]

Read the report:
http://unesdoc.unesco.org/images/0021/002183/218318e.pdf

For details: www.footprintnetwork.org;
www.unesco.org/venice
p.pypaert@unesco.org

9 *Albania, Croatia, Egypt, France, Greece, Italy, Jordan, Lebanon, Libya, FYR Macedonia, Montenegro, Morocco, Spain, Tunisia, Turkey. Participants also hailed from Denmark, Kenya, Kuwait, Switzerland, the UK and USA.*

10 *http://awsassets.panda.org/downloads/c_lagarde_imf_6_jan_2012_final_1.pdf*

11 *See Moore, D., Galli, A., Cranston, G.R., Reed, A. (2012) Projecting future human demand on the Earth's regenerative capacity.* Ecological Indicators, *16*

12 *Global Footprint Network, lead author of* Mediterranean Ecological Footprint Trends

13 *UNESCO Programme Specialist in ecological sciences in UNESCO's Venice office*

Diary

8–10 January
Water cooperation: making it happen!
Theme of annual UN-Water conf: preparing for Intl Year of Water Cooperation. Focus on water diplomacy, mediation and conflict resolution. Zaragoza (Spain): *www.un.org/waterforlifedecade*

13 January
Launch of African Network of Earth Science Institutions
to foster collaboration between universities, research institutions and related industries. Project endorsed by Geological Society of Africa and African Conf. of Vice-Chancellors and Deans of Science, Engineering and Technology. Followed by colloquium on African geology (*next entry*). Addis Ababa (Ethiopia): *sf.toteu@unesco.org; j.mengo@unesco.org*

14 January
African geology
24th colloquium, under UNESCO patronage. Addis Ababa (Ethiopia): *sf.toteu@unesco.org; s.gaines@unesco.org*

21–26 January
IPBES
Intergovernmental Platform on Biodiversity and Ecosystems Services. Bonn (Germany): *s.arico@unesco.org; www.ipbes.net*

24 January
Madrid Action Plan for Biosphere Reserves
9th Meeting of Intl Support Group on Implementation. UNESCO Paris: *m.clusener-godt@unesco.org; mab@unesco.org; http://tinyurl.com/akhurto*

31 January
Deadline for Michel Batisse Award
Deadline for submission of candidacies for biosphere reserve management award: *mab@unesco.org; www.unesco.org/mab*

11 February
Launch of Intl Year of Water Cooperation
UNESCO Paris: *www.watercooperation2013.org*

18–20 February
International Geoscience Programme
Scientific Board meeting. UNESCO Paris: *m.patzak@unesco.org*

25–27 February
World Summit on Information Society
10-year review, including on e-science. Will recommend input to post-2015 process. UNESCO, with ITU, UNDP, UNCTAD. Register online. UNESCO Paris: *http://tinyurl.com/byolaqw*

5 March
Mathematics of Planet Earth
Opening of international initiative. UNESCO Paris: *m.nalecz@unesco.org; bes@unesco.org*

11–13 March
Biosphere reserve nominations
19th meeting of Intl Advisory Committee. UNESCO (Paris): *n.raondry-rakotoarisoa@unesco.org; mab@unesco.org; www.unesco.org/mab*

18–20 March
Mining and socio-environmental sustainability in biosphere reserves
Inl seminar organized by UNESCO Paris, UNESCO Montevideo and UNESCO Brasilia, Brazilian MAB Committee, Serra do Espinhaço Biosphere Reserve (Brazil), Minas Gerais State Govt. Belo Horizonte (Brazil): *cskarez@unesco.org.uy; c.schenkel@unesco.org.br*

19–22 March
Groundwater governance
5th regional consultation, for Europe and North America, plus private sector roundtable, within GEF-UNESCO-FAO-IAH-World Bank project to develop global framework for action (see *A World of Science,* January 2012). UNESCO-IHP. The Hague (Netherlands): *m.rubio@unesco.org*

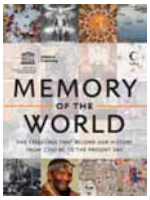
20–23 March
European geoparks
Network meeting. UNESCO Paris: *pj.mckeever@unesco.org*

22 March
World Water Day
This year's theme is water cooperation. UNESCO lead agency, in collaboration with UNECE, UNDESA: *www.watercooperation2013.org*

28 March
L'Oréal–UNESCO Awards for Women in Science
15th edition. Prize-giving ceremony for laureates and intl fellows. University of the Sorbonne, Paris (France): *s.bahri@unesco.org*

New releases

Memory of the World
The Treasures That Record Our History from 1700 BC to the Present Day
UNESCO Reference Series. UNESCO Publishing/Harper Collins. ISBN: 978-92-3-104237-9, 25.00€, English only, 608 pp.
For details, see page 20.



Compendium on Indian Biosphere Reserves
Progression during Two Decades of Conservation
Produced by UNESCO New Delhi, G.B. Pant Institute of Himalayan Environment and Development, Indian Ministry of Environment. English only, 196 pp.
Distributed to delegates at the 11th meeting of the Parties to the Convention on Biological Diversity in Hyderabad (India) on 8–19 October. Aims to stimulate interest in Indian biosphere reserves among diverse stakeholders in India and abroad. For details, see page 13 or write to (in New Delhi): r.boojh@unesco.org.
Download: http://unesdoc.unesco.org/images/0021/002166/216695E.pdf

Outcome Document on Education and Biodiversity Conservation
Document produced by the Indian Centre for Environment Education, UNESCO, UNEP, UNDP et al. English only, 14 pp.
Document adopted by the International Conference on Biodiversity and Education for Sustainable Development in Hyderabad (India) on 13–14 October, on the sidelines of the meeting of the Parties to the Convention on Biological Diversity. The document recalls that the first Aichi Target is for, 'by 2020 at the latest, people [to be] aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.' It then recommends pathways for achieving this goal. See page 13 for the background or write to b.combes@unesco.org; for the 20 Aichi Targets: www.cbd.int/sp; on the event: www.ceeindia.org/cee/esd-cop11/index.html; http://tinyurl.com/cjsxer9; download: www.ceeindia.org/cee/esd-cop11/downloads/final-outcomes.pdf

Risk Management at Heritage Sites
A Case Study of the Petra World Heritage Site
Produced by UNESCO Amman Office and Raymond Lemaire International Centre for Conservation at Katholieke Universiteit Leuven in Belgium. ISBN 978-92-3-001073-7, English with a section in Arabic, 168 pp.
The monuments of Petra are threatened by weathering, flash floods and biological damage to the rocks from which they are carved. Petra is also vulnerable to vandalism, theft and the rapid development of tourism owing to a lack of reglementation: tourist numbers rose by 59% between 2004 and the first half of 2010.
Download: http://unesdoc.unesco.org/images/0021/002171/217107m.pdf

Five Stylized Scenarios
By Gilberto C. Galopin. First report in World Water Assessment Programme's Global Water Futures 2050 series 1. Published by UNESCO,ISBN: 978-92-3-001038-6, English only, 16 pp.
An exploration of long-range global water scenarios. This original work is based on research and surveys conducted among dozens of experts in water-related fields in 2010-2011. Provided input for the Scenario Focus Group involved in the fourth World Water Development Report (2012).
Download: http://unesdoc.unesco.org/images/0021/002153/215380e.pdf

Driving Forces 2011–2050
By Catherine and William Cosgrove. World Water Assessment Programme's Global Water Futures 2050 series 2. Published by UNESCO, ISBN: 978-92-3-001035-5, English only, 94 pp.
A summary of the findings of the first phase of the World Water Scenarios process: an analysis of the evolution of 10 major external forces (drivers) that have direct and indirect consequences on water resources.
Download: http://unesdoc.unesco.org/images/0021/002153/215377e.pdf

Now in Chinese

UNESCO Science Report 2010
The Current Status of Science around the World
China Science and Technology Press. ISBN: 978-7-5046-6047-3. Chinese edition of report first published in English by UNESCO in 2010, 540 pp.
For details and to order: http://tinyurl.com/d7owcne; r.jayakumar@unesco.org;
Download: http://unesdoc.unesco.org/images/0018/001899/189958C.pdf

Now in Arabic

Manual on Sea Level Measurement and Interpretation
Fourth in series on this topic. UNESCO-IOC Manual and Guides, 14, JCOMM technical report, 31. Arabic edition of a manual published in English in 2006, 84 pp.
Provides basic information on installing and operating tide gauges.
Download: http://unesdoc.unesco.org/images/0014/001477/147773a.pdf

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Water, Cultural Diversity and Global Environmental Change
Emerging Trends, Sustainable Futures?
Produced by UNESCO Jakarta Office within UNESCO-IHP project on Water and Cultural Diversity. Springer Publishing. ISBN: 978-94-007-1773-2. English only, 560 pp. Announced originally in A World of Science, April 2012.
For details (Jakarta): l.hiwasaki@unesco.org;
download: http://unesdoc.unesco.org/images/0021/002151/215119E.pdf
To order: http://www.springer.com/environment/aquatic+sciences/book