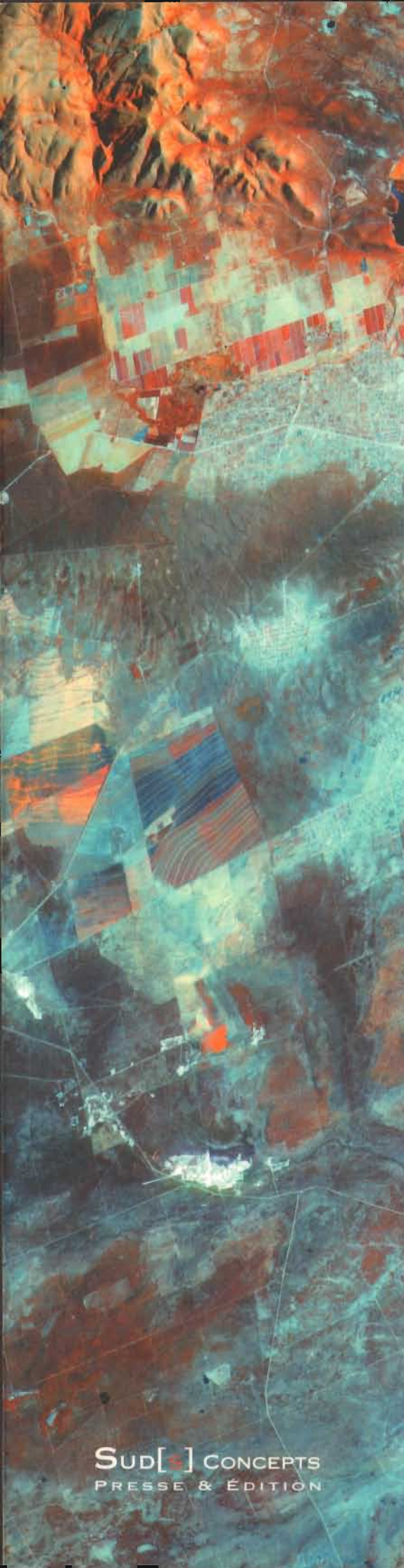
Sustainable Development in Africa & *Satellites*

Technologies and Wisdoms



SUD[S] CONCEPTS
PRESSE & ÉDITION

To the memory of Wangari Muta Maathai

Sustainable Development in Africa & Satellites

Technologies and Wisdoms

How was this book born?

Thales Alenia Space, IRD (Institut de Recherche pour le Développement), BRL ingénierie (BRLi) and ITA (Consorzio Italiano per il Telerilevamento dell'Ambiente e dell'Agricoltura) are partners within the AMESD (African Monitoring of the Environment for Sustainable Development) project. This project aims at developing adequate, space-based applications to address sustainable development issues across Africa.

Projects such as AMESD rely on the synergies between our four companies' objectives:

Thales Alenia Space, a world reference for Systems, Satellites, Instruments, equipment, space infrastructure and ground segments, designed for Telecommunications, Science, Earth Observation, Navigation, Defence and Security applications.
The company's main references in Environment monitoring are: COSMO-SkyMed, Envisat, Jason, SMOS, GMES Sentinels 1 and 3, and the Meteosat satellites for ESA/Eumetsat.

IRD, French public institution, unique in the landscape of European research for development. Its task is to conduct research in the South, for the South, with the South. Its researchers are working on issues of major global importance today as global warming, emerging diseases, biodiversity, access to water, migration, poverty, world hunger...

BRLi, an engineering company delivering consultant services and support to decision makers for sound water resources management, climate change adaptation, protection of the biodiversity and integrated coastal areas management

ITA: 33 years of experience in agricultural and environmental satellite remote sensing services.

Together, we agreed to take this opportunity to ask some of the best African experts to share their concerns and their hopes.
We teamed up with Suds-Concepts, a French communication company and selected the same book-magazine formula as for *Climate Change and Satellites*.
This book-magazine is about Africa by Africans for Africans, for worldwide deciders, and for all the people who care about sustainable development and the contribution space technology may bring.

Enjoy your reading!

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"Today, the duty of humanity involves first of all a duty of Africa. There is no viable future without Africa.

Foreword

Africa, continent of the future

Today, Africa is faced with many challenges—economic, environmental, human and political—that are not a fatality. For Africa, the first continent, is also the continent of the future.

In 2050, more than a billion Africans will be younger than 15 years old and one person in five will be African.

In addition to its very rich human and cultural heritage, a source of determination and creativeness, Africa has immense mining and natural resources and a prodigious ecological potential, especially with the Congo basin, the second largest green lung in the world, and its water resources.

In four decades, Africa will be both the largest market in the world and also the largest construction site in the world because everything remains to be done.

However, its development should be focused on an endogenous procedure and be part of an approach that is both sustainable and global and integrate local and traditional cultures. It goes without saying that science and the new technologies are fundamental ingredients of sustainable development. Satellites are and will be increasingly essential tools for resources management and the protection of the environment.

The book 'Sustainable Development in Africa & Satellites – Technologies and Wisdoms' shows this necessary union between tradition and modernity, between science and knowledge. Illustrating the current growth of awareness of African populations with regard to the challenges of our century, it is a platform for African women and men, for scientists, farmers, artists, for young and old, for all those who are building the future of Africa. Because Africa will be the work of the Africans themselves, first of all through work, good governance, justice and solidarity but not through charity.

I am certain that this book will shed new light on the competences, energy and deep-seated solidarity mobilised by Africans at all levels. Their actions form the leaven that will enable united Africa to construct its future.

Today, the duty of humanity involves first of all a duty of Africa. There is no viable future without Africa.

Alpha Oumar KONARÉ

Former President of the Republic of Mali
and former Chairperson of the African Union Commission

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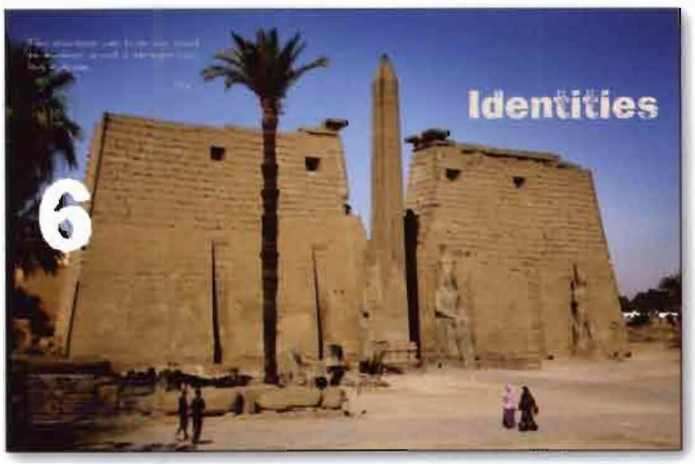

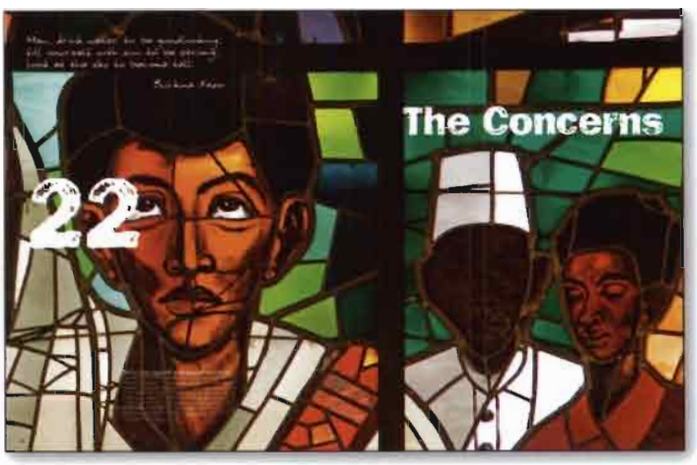

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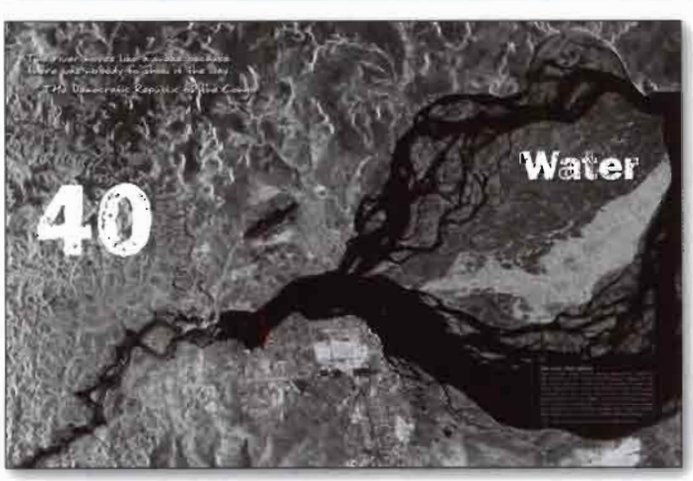

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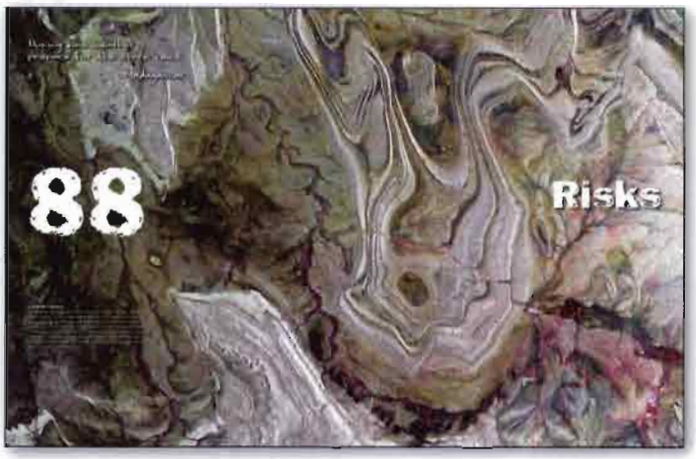

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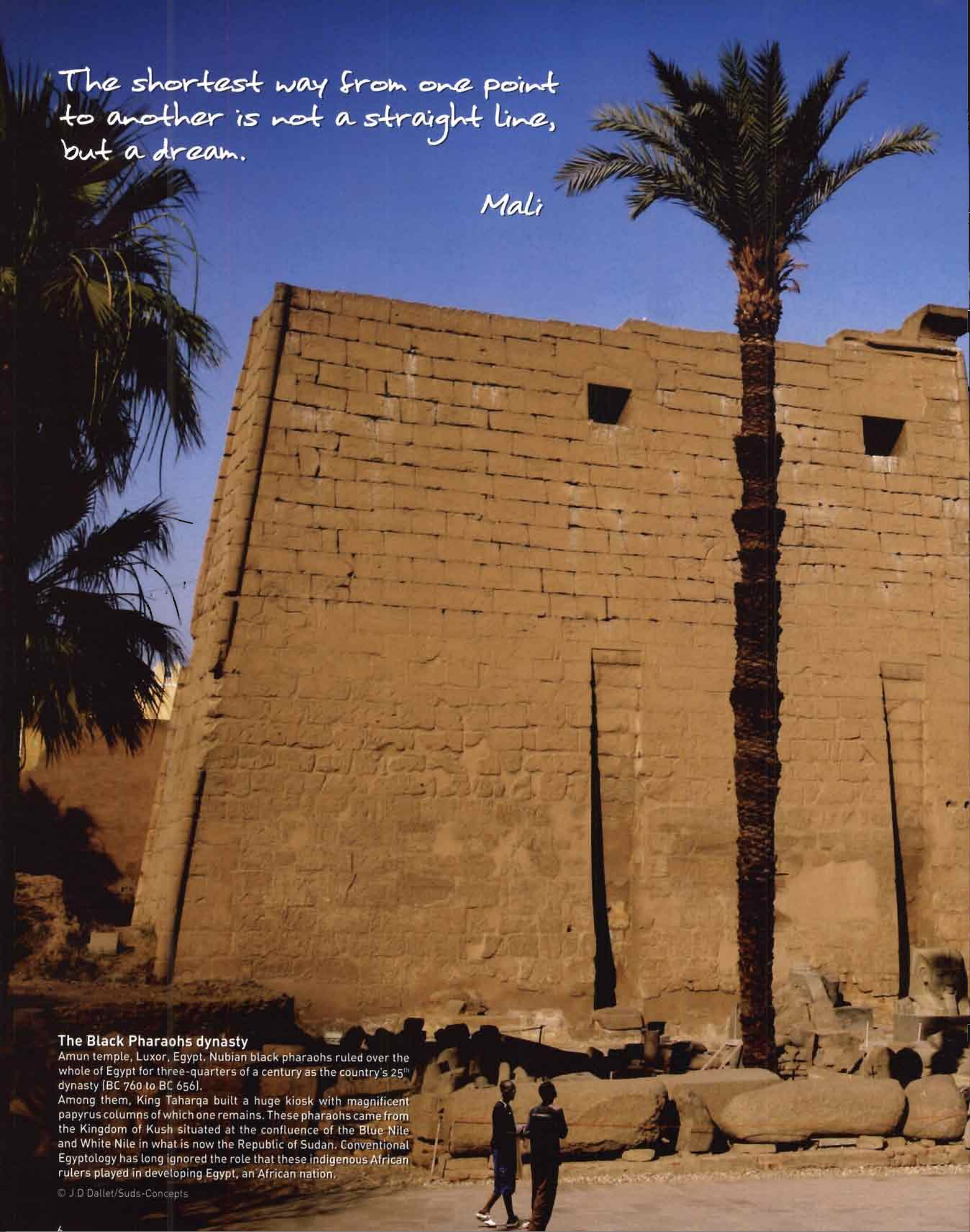
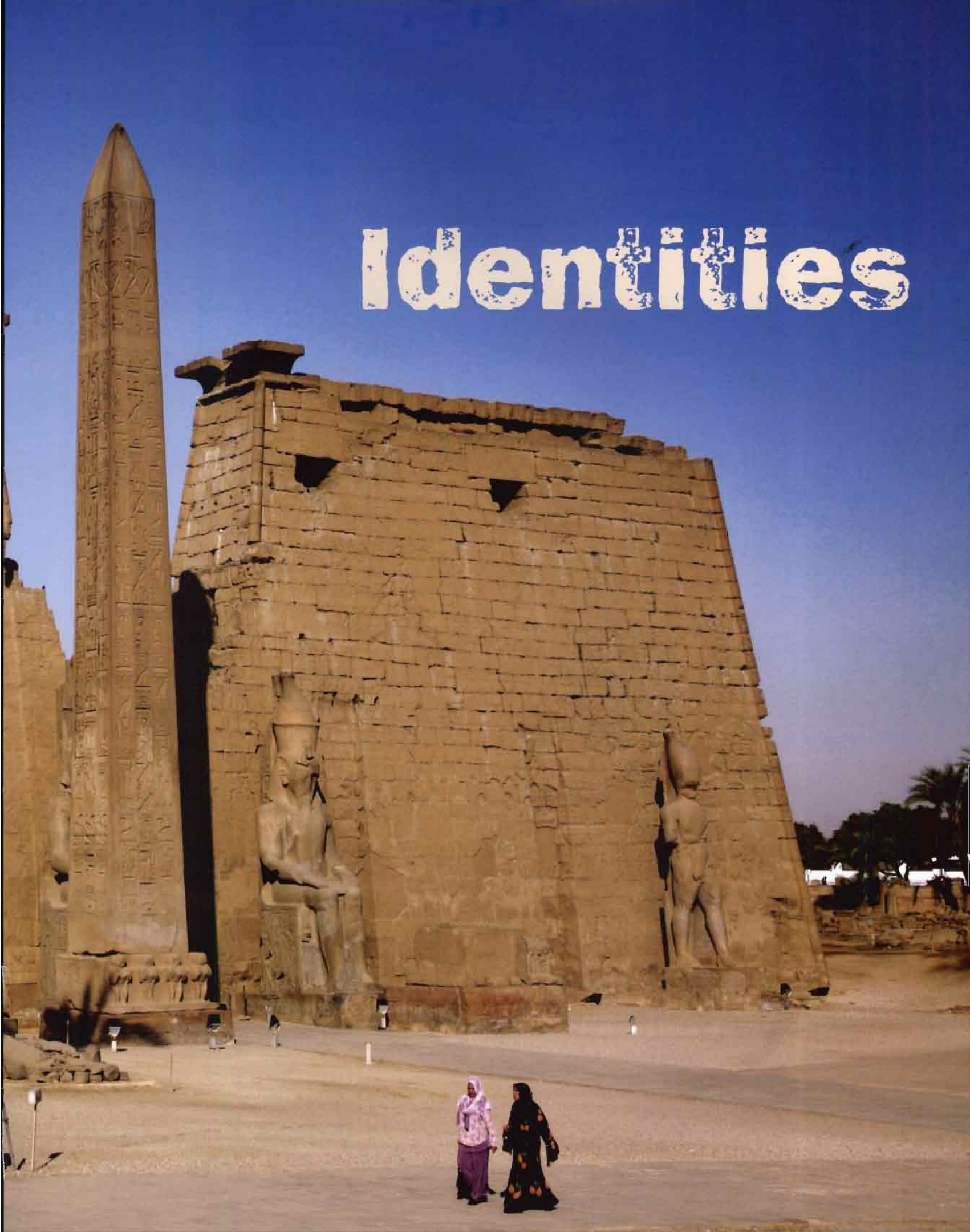


The Black Pharaohs dynasty
Amun temple, Luxor, Egypt. Nubian black pharaohs ruled over the whole of Egypt for three-quarters of a century as the country's 25th dynasty (BC 760 to BC 656).
Among them, King Taharqa built a huge kiosk with magnificent papyrus columns of which one remains. These pharaohs came from the Kingdom of Kush situated at the confluence of the Blue Nile and White Nile in what is now the Republic of Sudan. Conventional Egyptology has long ignored the role that these indigenous African rulers played in developing Egypt, an African nation.

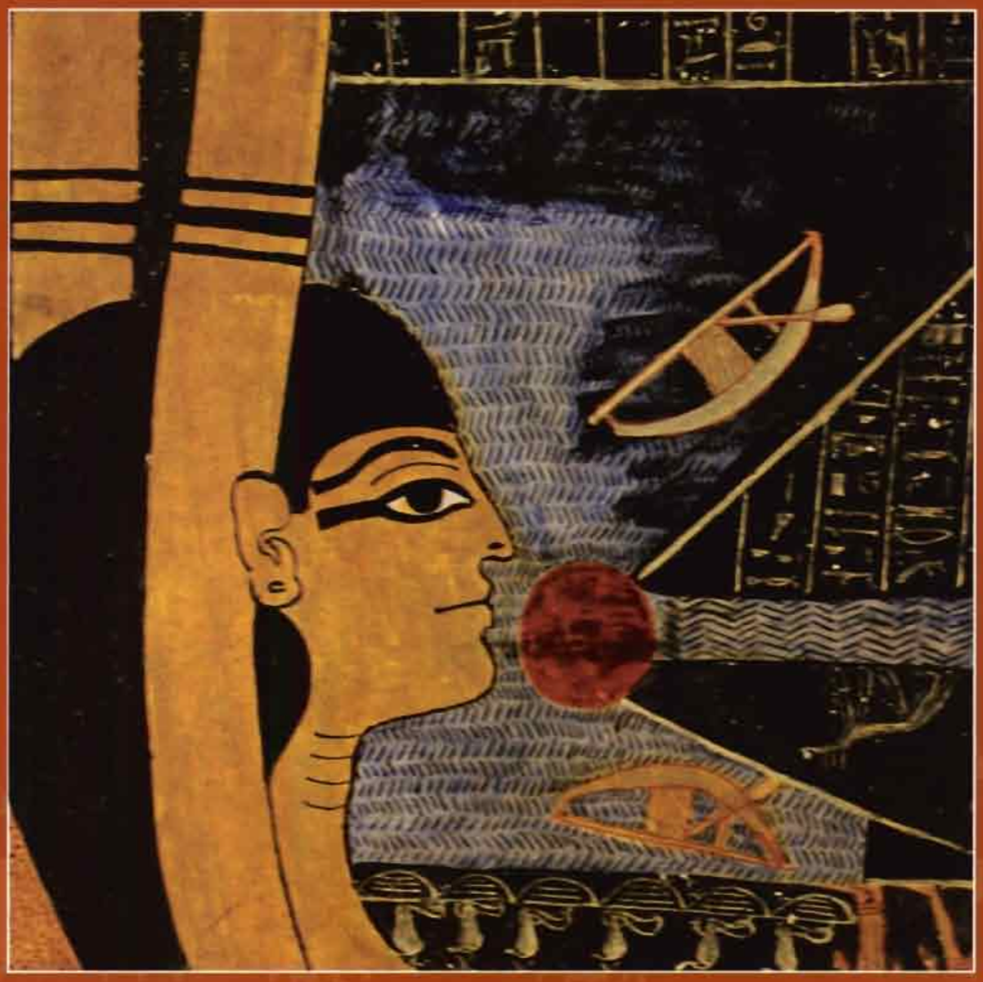
Identities



AFRICA'S PATHWAYS

▲ Rock painting in Twyfelfontein, Namibia. This UNESCO World Heritage Site contains around 2 000 rock carvings. The site is one of the largest and most important concentrations of rock art in Africa and was proclaimed a National Monument in 1952.

◄ Lucy was found by Donald Johanson and Tom Gray on November 24, 1974, in what is now called the Awash Valley in Hadar (Ethiopia). She has been classified in the species *Australopithecus afarensis* and dated to just under 3,18 million years old, making her at the time one of the oldest hominids ever discovered. The Ethiopian National Museum in Addis Ababa displays a fascinating reconstructed full skeleton of Lucy that shows her height and stance and this lively presentation.



▲ The site of Leptis Magna (Libya) is one of the most spectacular and unspoiled Roman ruins in the Mediterranean.
© Y. Rouillon/Suds-Concepts

◀ Ceiling of the tomb of Ramses VI (279 BC to 1213 BC), Luxor West Bank (Egypt), showing the goddess Nut swallowing the sun god in the evening.
© J.D. Dallet/Suds-Concepts

The hypothesis that Africa is the 'Cradle of humankind' continues to be fortified by finds that allude to the perception that the common ancestor of humans and other apes lived in Africa and that the divergence of the two lineages took place here. Molecular studies so far have put the divergence of humans and chimpanzees (closest relatives) at 7-5 Ma and that of gorillas at 9-8 Ma (Kunimatsu et al., 2008).

A continent that once daunted explorers, historians and colonialists alike is arguably one referred today, as the Cradle of Humankind, the home of our own. Thousands of hominin fossils and cultural artifacts have been recovered especially within its rift systems. South Africa boasts evidence of earliest human genes but other countries including Ethiopia, Sudan and Kenya have high genealogical diversity especially among its people. For example the Turkana people of Northern Kenya show that there have been long-term trade and movements within its territory. In his book 'The journey of Man: A Genetic Odyssey', Spencer Wells describes how humans left Africa to populate other parts of the world beginning about 60000 years ago. This confirms that the human species has lived in Africa longest and also strengthens the "Recent African Origin" (RAO) hypothesis which proposes that modern humans are the product of a speciation event in the late Pleistocene in Africa.

This puts Africa in a diversity spectrum with such fossils finds as *Sahelanthropus tchadensis* nicknamed Toumaï ('hope of life' in the local Dazaga language of Chad), *Kenyanthropus platyops*, *Australopithecus africanus*, *Australopithecus boisei*, *Homo habilis*, *Homo erectus* ('Lucy' and 'Turkana Boy') as well as *Homo sapiens*.

A common ancestor

These fossils still set forth a continent that may have had human diversity since time and which today continues to display that diversity embedded in unity. There are a number of clear trends (which were neither continuous nor uniform) from early australopithecines to recent humans: increasing brain size, increasing body size, increasing use of and sophistication in tools, decreasing tooth size, decreasing skeletal robustness. Through this diversity however is a common ancestor, one that continues to be elusive but one that definitely unifies humankind.

With modern humans came diversity as exhibited through their culture, economy and social activities. These traits, though diverse, were and continue to be shared through innovations and advancement of technology as well as through material culture. For example, the earliest tools known to man were never made in isolation. People either traded stone choppers and bone needles among them or shared the knowledge and the raw material to make them.This same technology was and continues to be developed today. For example, iron making is a technology which has been advanced through time for economic efficiency. Similarly, the ceramic technology was practiced in the past in pot making and today the Asians have perfected the same technology in making diverse ceramic products.

The development and management of natural resources have often been drawn from modern science as well as from indigenous knowledge. In utilizing modern science we aim to improve the way that we manage our resources, especially using modern technologies such as large-scale irrigation, chemical fertilizers and ▶

▲◄ Two UNESCO World Heritage sites. Above, the Cliff of Bandiagara (Mopti Region, Mali) first occupied by the Tellem people. The Dogon settled there during the 15th and 16th centuries. © A.Barragan.
Left, the ruins of Great Zimbabwe (near Masvingo), testimony to the lost civilization of the Shona between the 11th and 15th centuries.
© M.Matsumoto

► pesticides, hybrid crops etc. In using indigenous knowledge, we share the benefits of the long history of managing and surviving in environments which have never been favourable. Archaeologists have a role to play into bringing to bear these past perspectives into contemporary issues – settlement patterns, land use patterns, changing environments – in order to provide a framework for today's development.

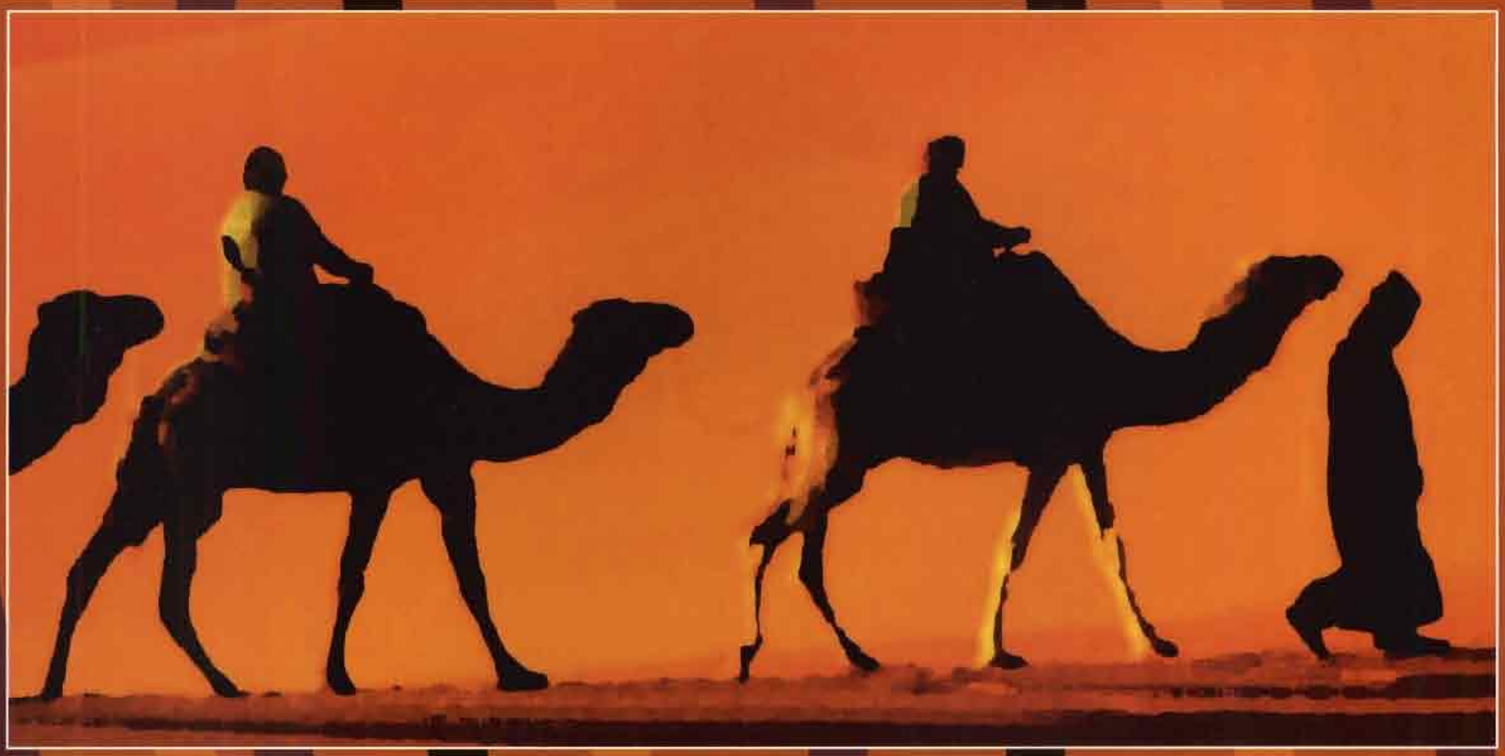
It is obvious that some communities in the past (such as the Pokot of Kenya and Sandawe of Tanzania) have for a long time embraced perennial streams within their region to enhance their crop productivity through irrigation. Rivers and streams within their reach have provided these people with ways and methods of survival. Irrigation schemes going as far back as 200 BC have been identified within areas in Africa and these can be revived to enhance productivity in such areas. In addition, indigenous knowledge as regards to medicinal plants is being practiced in several regions in Africa.

Pastoralists' ways of life have in the past been characterized by a high degree of flexibility. For example they varied their mode of subsistence with contacts with other non-pastoral groups and this enabled them to interact and sometimes live in exclusivity while, at the same time, maintain specific modes of economy.

Commitment to sustainability

Other methods of herd management included culling of herds. This culling varied depending on the expected results. For example, male calves could be culled to reduce food competition with reproductive females. On the other hand, calves close to maximum body weight were culled in order to supply food gains such as blood and meat. These herding practices can be studied in the archaeological record by the bone/tooth remains and subjected to periodic episodes of stress within the environment. Today, pastoral communities continue to utilize some of these practices while others have been forgotten.

The pressure is currently on developers to design projects which demonstrate a commitment to sustainability, for example using cultural heritage to help build communities showing a true sense of cohesion and belonging. Ancient structures such as those seen in communities within Mapungubwe and Great Zimbabwe and Thimlich in Kenya are evidence of a social structure that was in place as early as the 14th century. These structures not only show the social cohesion but also reveal a society that utilized whatever local resources are available and within reach. In addition, these settlements achieved and maintained economic, political, and ideological hegemony through a combination of both peaceful and coercive means. Therefore structured settlements geared towards political and economic development were evident in Africa in the past. Such knowledge can be tapped and integrated to local resources of the historic



▲ The Merzouga dunes in the Tafilalet (Moroccan Sahara) are situated on the direct caravan route from the Niger to Tangier. Artist view.

landscape in current new developments. All these aspects of past and modern life can be related to food and settlement patterns as well as technological changes which are evidently affected by the environment and climatic conditions through time. Favorable climatic conditions and increased interaction amongst communities pursuing different but complementary subsistence strategies made possible the sharing and exchange of ideas and systems of knowledge that once held sway within specific ethnic and subsistence groups.

Access to resources

For example, the hunter-gatherer way of life changed due to migration and settlement in their domain of pastoralists and later of agrarian communities, along with the incorporation of knowledge from all the groups. This created a vibrant community that would elevate individuals and personalities from the groups to leadership positions.Certain material indicators combine to support this proposition: material signatures that relate to shifting settlement patterns, fortification, mortuary practices, territoriality, and migration, all of which combine to support warfare and violence hypotheses. The ability to control access to resources or trade routes is an important element of emergent complexity and political centralization. Physical and military power, embedded in this proposition, can restrict access to wealth creating resources and production. For instance, control over iron production was quite important for rulers, and the physical force needed to monopolize access to iron resources that were beyond the political control of the state capital was probably a necessity. Once asymmetries in power had been established, what strategies do leaders use to stay in power and accumulate more wealth, status, and power? The pathways and mechanisms through which power is centralized will differ from case to case. In this case, elites initially accumulated wealth in cattle and later invested in gold and ivory trade with the coast. To do so, they also invested in local and regional infrastructures considered as viable for communities living and exploiting different but complementary resources. Therefore, these communities were willing to comply and be incorporated into the regional political economy.

There are lessons to be learnt from these past commitments and which can be utilized in enhancing Africa's economy today. For example, systems which allow for sharing and facilitating the movement of goods and knowledge across borders are important in realizing Africa's economic growth.

Dr. Purity W. Kiura
Senior Scientist Archeology
National Museums of Kenya, Nairobi

▲ Construction of South Africa's tracking telemetry and command facilities (today SANSA Space Operation Center), at Hartebeesthoek (Gauteng) in 1963.

A DROP OF AFRICA

Africa's plurality reflects that of its landscapes. It lies astride the equator, bounded beyond the tropics at 23° 27' N and 23° 27' S and has a diversity of special areas ranging from deserts to evergreen forests. Beyond the tropics, at the edge of the Sahara desert in the north and the Namib and Kalahari deserts in the south, lie landscapes and a Mediterranean climatic atmosphere, placing Southern Africa and the Maghreb or the 'western peninsula', that is to say the west seen from Arabia, 'Jaziratel-Maghreb', outside the tropical zone. Between the Mediterranean and the Sahara with the Hoggar and Tibesti ranges and marked by vast stony plains and immense sand dunes, the Atlas Mountains rise to more than 4 000 metres, a kind of natural protection against the advance of the desert but which is nonetheless open to the Atlantic.

This part of Africa situated outside the tropics is characterised by a recent alpine fold and has the same physical and geological structure as its counterpart in the south, Southern Africa, whose relief is more simple, consisting of an inner plateau (veldt) at 700 to 2000 m and bordering scarps separating it from the coastal areas and in the south-east forming the Drakensberg range, with Thabana-Ntlenyana reaching 3 482 m.

The Sahel with its vast steppe landscapes is a helpless 'embankment' in the face of the relentless advance of Saharan sand, aggravated in the 1970s by terrible drought. It separates the arid, desert ecosystems in the north and the humid, rainy savannah regions to the south.

Endogenous species

As it is between the Tropic of Cancer and the Tropic of Capricorn, the climate is tropical by definition. But other local factors perturb the usual meaning given to a classic tropical environment marked by the movement in opposite directions of heat and rain from the equator to the tropical zones. Rainfall decreases while the temperature rises; thermal amplitude is smaller at the equator and greater towards the tropics.

In addition, the mountain landscapes in the heart of tropical Africa create microclimates that remind one of the weather and landscapes typical of temperate latitudes:

- lower temperature with increasing altitude;
- increased rainfall with the rising of hill and mountain levels where appears alpine grassland, while the vegetation layers below are representative of the different domains.

Elsewhere, in addition to the classic typology of the tropical environment, endogenous species, characteristic of Africa, are present. Likewise, tropical plants are sometimes found in cold landscapes far from their usual environment. This is the case of banana in Iceland and in the Lebanese mountains, for reasons of sunshine on the latter case and thanks to a warm thermal inversion layer in the former.

Water is also strongly present throughout the African continent. Sometimes stretching far inland, a network of watercourses, lakes, rivers and lagoons corresponding to characteristic geological formations runs from the Mediterranean coast to the Cape of Good Hope.

In addition to the great lakes Chad, Malawi, Tanganyika and Victoria, large rivers—the Congo, the Chambeshi, the Zambezi—and others flow slowly in evergreen forest where strong precipitations cause frequent, practically annual floods. Other rivers such as the Niger and the Senegal flow far from their sources and cross regions with less rainfall, sometimes creating landscapes of rare beauty with vast stretches of water covered by aquatic plants that are becoming increasingly invasive with the artificialisation of the environment. They form temporary shelters for migrating birds that have crossed the Sahara and are seeking a warmer climate during the northern hemisphere winter.

'Mother' Nile, the longest river in the world, flows east of the Sahara where a few precious oases govern the daily lives of a scattered population. The cradle of one of the greatest civilisations, the Nile is still the natural transition between the great African rift and the Mediterranean.

Cold marine currents along the Atlantic and Indian Ocean coasts—the Canary Islands and Benguela—enhance the presence of extremely diversified aquatic fauna. Warm currents off Guinea, Mozambique and Somalia are the main ▶

▲ Agriculture is Ethiopia's most important economic sector, employing 80% of the work force. At Lalibela airport (northern Ethiopia), tradition and high tech coexist.
© J.D. Dallet/Suds-Concepts

The Great Lakes of Africa
This ENVISAT/ASAR image highlights portions of three lakes located in the Western Rift of the Great Rift Valley: Lake Edward (top), Lake Kivu (middle) and Lake Tanganyika (bottom). Referred to as the Great Lakes of Africa, they are located between the Democratic Republic of the Congo, Uganda, Rwanda, Burundi and Tanzania.

▶ source of water vapour sucked into monsoons and create environments that are dry and cold or hot and rainy, depending on the position.

The climate of Africa reflects geographical factors and is difficult to define, the best way of characterising it being total precipitations and their distribution in time. It has an impact on practically all aspects of socioeconomic life, whether these be agricultural yields, the availability of natural resources, or human and animal health.

Africa is an eco-geographical region with immense riches. However, paradoxically, apart from a few emerging countries, it consists mainly of developing countries. African economies make the region a socially vulnerable one in which populations with low incomes form the majority.

In addition to gathering, hunting, fishing and animal husbandry, including the prestigious Peul, Boro-Boro and Masai traditions, agriculture covers the basic food needs of the population. But it is vulnerable in the face of natural calamities such as drought, floods and locusts. When certain human practices such as uncontrolled forest fires are added to these, food crops display the extent of their vulnerability. Agro-sylvo-pastoral production is then seriously affected, socioeconomic and environmental disturbances are observed, causing recurrent food shortages, poverty, rural exodus, the overpopulation of capital cities, chronic unemployment among young people, emigration, inflation and social revolt.

Is hope to be sought in integration, as is recommended by certain people? This is a fundamental feature of the African situation insofar as effective independence remains to be confirmed and consolidated as a clear break with neo-colonial practices. Innovative development policies should be put into practice at last, with integration by large sub-regional ensembles in all fields and with the 'inclusive participation' of populations (the term used on the United Nations website) and economic and social democracy (M.F. Niang). Indeed, a long-term solution must be sought in the creation or strengthening of supranational mechanisms centred on regional cooperation and multilateral action and with reference to the progress made in a totally different category by the creation of the ECOWAS and WAEMU.

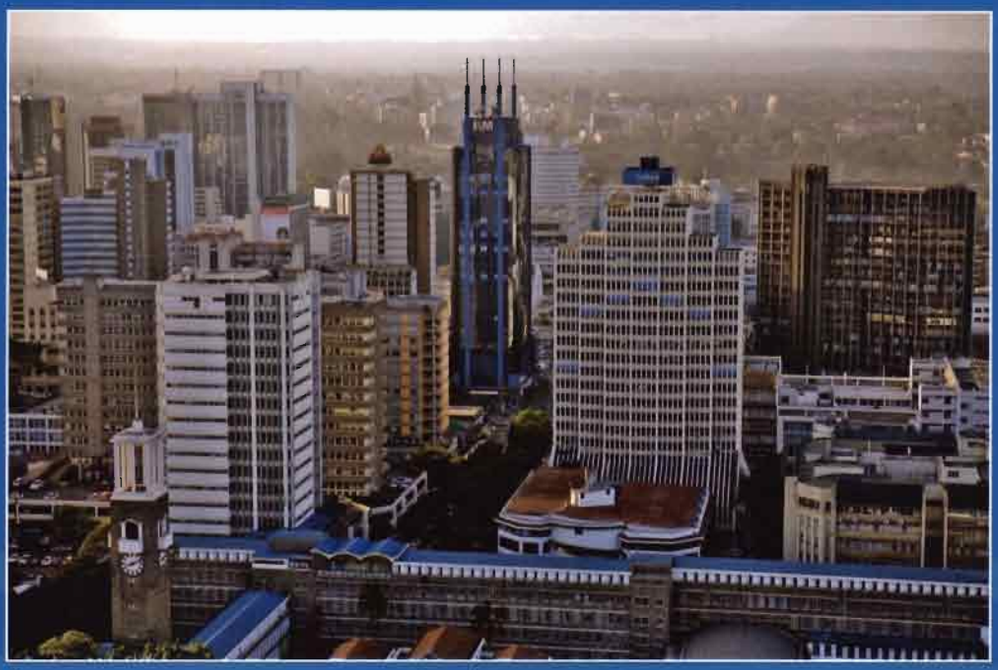
'The image of Africa is strongly conditioned by the ethnocentric viewpoint of westerners, since Herodotus' (A. Berre). Four centuries of slavery and deportation to the Americas and a recent colonial past have strengthened this simplistic perception that was already taking form in antiquity and has long since crystallised, giving birth to a superiority complex among westerners with regard to the African continent.

Africa is marked by this past and has seen its culture—the shop window of all civilisations—first negated and then accepted as primitive culture with no logical thinking and governed by emotion alone: did not Gobineau see African art as just an interior manifestation of the nature of Blacks? However, through the expression of its rich and varied landscapes, for thousands of years Africa has inspired and generated a true cultural mosaic.

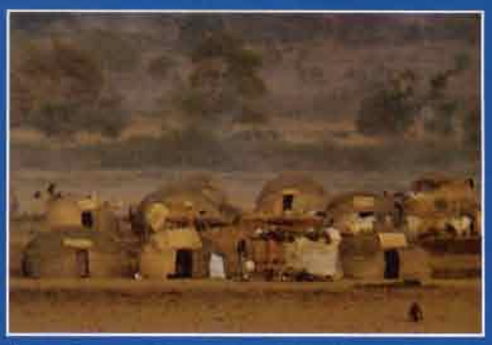
Far from being monolithic, Africa is not mono-ethnic or mono-cultural either. However, there are as many differences, if not more, between a Boro-Boro, a Bamileke and a Senoufo, to mention only these three groups, than between an Albanian, a German and a Portuguese.

Africa, with its many marvellous landscapes, many of which have World Heritage classification, is a fertile ground for cultural fulfilment through its singular beauty and has inspired different forms of artistic expression. Behind African landscapes that are often ascribed with humanity, beliefs have

▲ Montane forest, Mount Kenya (5 199 m). The second highest peak in Africa has been recognised by the UNESCO World Heritage Commission as 'one of the most impressive landscapes of Eastern Africa'. It is regarded as a holy mountain by all the Kenyan communities (Kikuyu and Meru) living adjacent to it.
© Chris 73



▲ Aerial view of Nairobi city centre in Kenya (2011). The name of this city with a population of more than 3 million comes from the Masai 'Enkare Nyirobi', which means 'the place of cool waters'.
© Siegfried Modola/IRIN



▲ The Bororo claim their traditional nomadic culture and identity. Cattle are a source to wealth, power and prestige. Here, traditional houses near the Logone river (Chad).
© Association Handicap Santé

survived the passing of time and subsist in a continuum through a host of artistic and cultural expressions.

Africans have revealed themselves over the years through writing, languages, dance, music, singing, painting, sculpture, etc. and continue to affirm themselves, 'recreating the world, expressing themselves with their bodies and marking in matter the forms formed in their minds, forms irrigated by beliefs, myths, heritages..., forms incorporating the ruins of history and in history' (A. L. Sall). These forms allow for the gentleness of the earth and the hope inscribed in life.

Man and his environment

However, the strong share of the imprint of landscapes in this cultural blooming should not hide the implacable role of geography in explaining them. Space undoubtedly forms the expression of a reflection, that of a synchronous hinging of biophysical factors and human players in a given environment. And the environment in question only achieves optimum balance through the nature of the treatment inflicted on it through socioeconomic activities by the players involved, or even the human societies concerned.

From this viewpoint, could it be said that one of the reasons for the 'malaise' in the African geographical area results precisely from this absence of balances? Or rather from the breaking of balances between man and his environment, from disparities in the treatment of space, of environments, of sectors of activity and of the main players with regard to an exogenous evolution of contemporary history that is partially experienced by proxy?

Finally, in the ancestral savannah formerly used by the Arab-Berber 'azalai' caravans, missionaries from other horizons relayed in their civilising functions by priests of another period, the only survivor, 'splendidly solitary', seems to be the baobab with its sweet and sour fruits, an imperturbable relic but, alas, vulnerable and vegetative, like an octopus whose tentacles have been amputated.

With Senegal mahogany trees uprooted and scattered in a multiform, disparate diaspora, with green oaks proudly deployed in the four corners of the world, the tree that is a fetish, a multi-secular memory, a witness of immemorial times, sometimes seems – beneath the haggard gaze of the witch-doctors of Timbuktu and the voice of the muezzin of the mosque in Djingareyber – to sing a plaintive and painful refrain, that of a funerary plant deadened by the lassitude of keeping vigil over the memory of ancestors, but that the gentle clamour of the trade winds makes 'grow and regrow obstinately and whose fruits gain little by little the bitter flavour of freedom' (D. Diop).

Aminata Ndiaye
Cheikh Anta Diop University
Dakar, Senegal

'Sahel
...Unrecognisable Sahel,
Are you losing your mind
Letting the desert
A vast predator
Reach your borders
The land of the Damel
Is it the play of fate
Or just by mistake
That this breath dares
Invade you from
the north
Stripping leaves
from your roses
Dragging your petals
Towards other
horizons...'

A.Ndiaye

HERITAGE AND CREATION

▲ The Ethiopian Christian orthodox monolithic church of Beta Ghioghis at Lalibela, one of Ethiopia's holiest cities, together with Axum.
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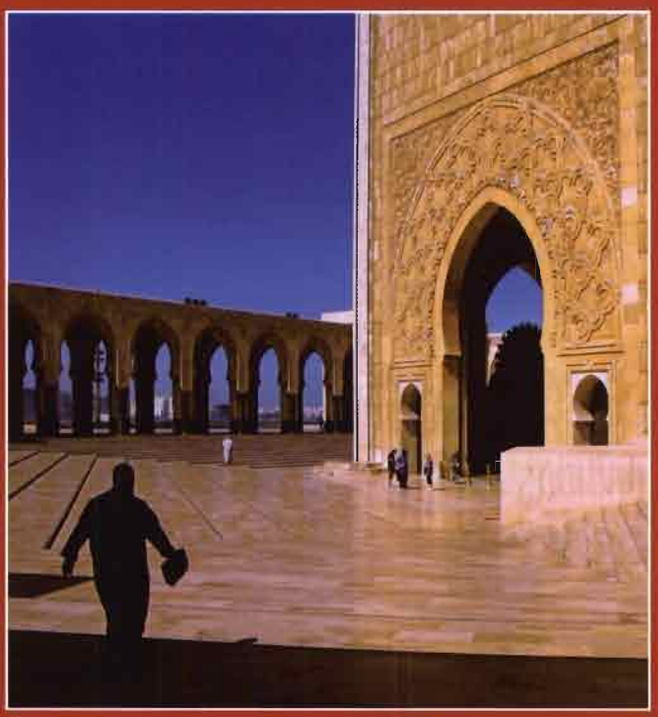

▲ The great Hassan II Mosque in Casablanca (Morocco). About 25 000 worshippers can gather inside and 80 000 outside.
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'Peoples are like men, with nothing left of them after their death but things that come from the spirit, that is to say literature and art, written poems and poems in stone, marble and colours', said Professor Lye M. Yoka. Even if these moving words limit culture to literature and art, they apply perfectly to Africa. More than gold from South Africa, diamonds from the Democratic Republic of the Congo and from Angola and cacao from Ivory Coast and Ghana, culture is the most original thing that Africa can offer to the world.

The question would previously have seemed banal if not insane in the context of the slave trade and colonisation. The verdict was clear: the so-called 'primitive' peoples of the South were considered as lacking in culture or civilisation. It is fortunate that the United Nations, which decreed that 2010 should be the International Year for the Rapprochement of Cultures, has recognised that the slave trade was one of the great tragedies of the history of humanity and invited reflection of the possibilities for soothing and overcoming these painful memories.

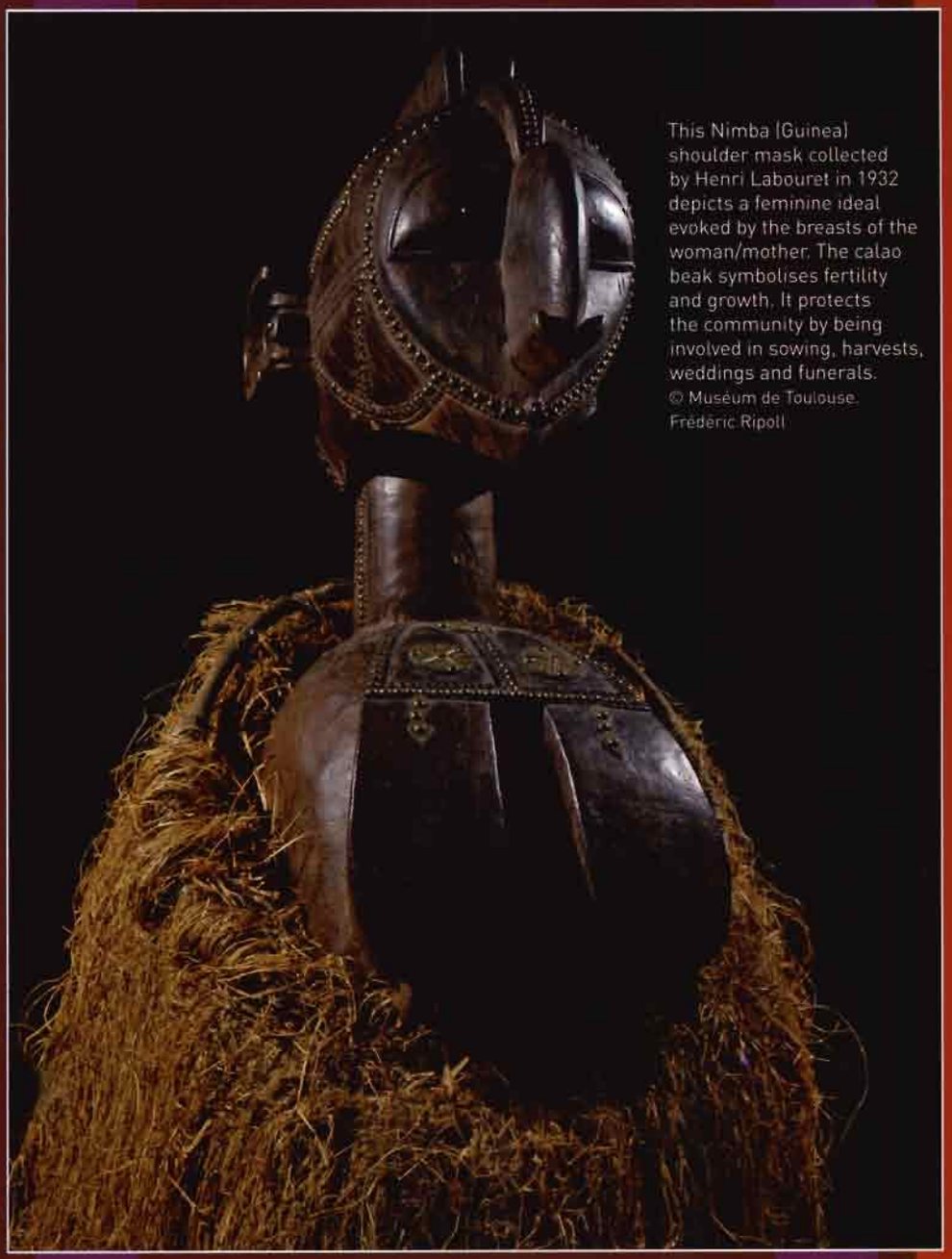
A great cultural diversity

Africa is not the 'geological scandal' mentioned by a nineteenth century geologist. With 56 states and more than a thousand languages spoken including over fifty by more than 500 000 people, a rich and varied cultural heritage—in short, great cultural diversity—Africa is also a cultural scandal and has much to share with the other continents.

Its art goes back the Neolithic age with rock paintings and carvings. These are found in practically all the Saharan mountain ranges from Mauritania to the Fezzan and from the Tassili to the Ennedi (from 6 000 BC to the 1st century AD). Further south were the ceramic sculptures made by the artists of the Nok civilisation in central Nigeria (500 BC – AD 200) and which, according to information from recent digs, are combined with remains of work in iron. They prefigure, in the same country, the Igbo Ukwu decorative bronzes (9th and 10th centuries AD), the extraordinary Ife bronze and ceramic sculptures (12th-15th centuries AD) and those of Benin (12th-19th centuries). They display such technical mastery and are rendered in such a naturalistic manner that initially they were wrongly attributed with classical inspiration.

This tradition in art concerns sculpture (statues and masks), architecture (dwellings and granaries), furniture, pottery, weaving and jewellery. Personal finery, a sign of distinction and protection against bad influences (body painting, headwear and hair, scarification and tattoos), polychrome decoration of dwellings and granaries and woven cloth also form an important part of the symbolic and artistic heritages.

▲ 'Benin bronze' featuring an Edogun (representant of military power) now in Horniman Museum, London, (UK). More than 3 000 brass plaques were sized from the royal palace of the Kingdom of Benin by a British force in the Punitive Expedition of 1897. Nigeria has repeatedly called for their return.
© Mike Peel



This Nimba (Guinea) shoulder mask collected by Henri Labouret in 1932 depicts a feminine ideal evoked by the breasts of the woman/mother. The calao beak symbolises fertility and growth. It protects the community by being involved in sowing, harvests, weddings and funerals.
© Muséum de Toulouse. Frédéric Ripoll

▲ Nok terracotta. This culture in central Nigeria initiated sub-Saharan Africa's earliest known sculptural tradition by around 600 BC. Artists modelled coarse-grained clay by hand to produce human and animal effigies of unknown function.
© The Cleveland Museum of Art

The spiritual life of the peoples of Black Africa is presided over by a complex and varied set of myths and beliefs that are passed on orally or via initiation procedures. African art thus reflects the richness of the history, philosophy, religion and societies of this vast continent. A very large proportion of cultural activity is centred on the family and the community group. The palaver, a technique for solving problems and settling disputes, and solidarity, a strategy for caring for the sick and for vulnerable people, are found throughout Africa. Art, music, folklore and oral literature strengthen existing religious and social models.

Finally, we cannot deny the position and the substantial contribution of ancient African objects—works of great value made with dexterity by farmers who had never been to art school—that are now displayed in museums in the West and the North. Each people and each community has always had its culture, aesthetic language, emotions and civilisation.

African art and the contemporary world

Many so-called traditional African arts are still commissioned, sculpted and used as in former times. As during any artistic period, innovations and conservative currents are side by side. The first *Festival mondial des Arts nègres* held in Dakar in 1966 showed the world and Africa too that African art is not limited to a few 'primitive' masks but reflects the results of an evolution of forms that started 6 000 years ago with the motifs of ceramics and rock paintings. ▶

▲ Musician Louis Armstrong (1901-1971) was the first African American to host a nationally broadcast radio show in the 1930s.
© John Loengard//Time Life Pictures/ Getty Images

▲ Candomblé adept in Salvador da Bahia (Brazil). Candomblé is an African-Brazilian religion practised chiefly in Brazil by the 'povo de santo' (people of saint). It originated from the knowledge of African priests that were transplanted to America during the slave trade.
© J.Coles

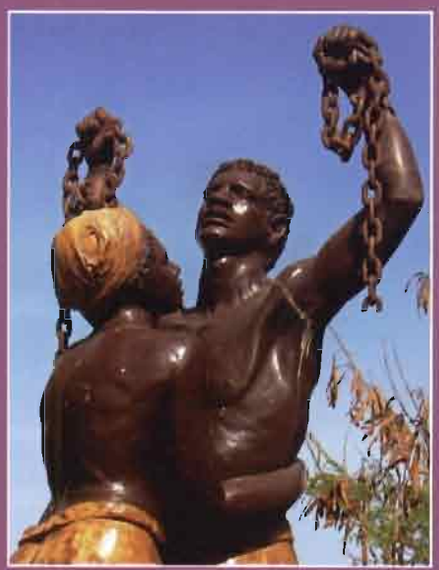
From Africa to America

The intercontinental spread of African cultures took place painfully via the development of the slave trade with the Americas as the destination. From the 16th century onwards, the Spanish and Portuguese colonisation of the New World stimulated the plantation economy and mining. This resulted in the systematic use of slavery and a massive inflow of sub-Saharan labour from the Gulf of Guinea. When the Amerindians disappeared or were lacking, the authorities, allied with the slave companies, replaced them by black slaves who lived in even worse conditions than the natives insofar as they had even less of a legal framework that was supposed to 'protect' them.

Although slavery was not officially abolished until 1886 in Cuba (a Spanish colony until 1898) and 1888 in Brazil, which alone imported 3 million slaves, an involuntary result of this intolerable reality was a considerable human and cultural enrichment.

Considerable interbreeding took place over the centuries in both the Caribbean and Brazil, making these areas a rich melting pot with multiple expressions. We now find syncretic religions of African origin, sometimes flourishing strongly: Santeria, also called Regla de Ocha in Cuba, with Yoruba roots; Palo Monte; Candomblé in Brazil, voodoo in Haiti and so on. Official languages are dotted with hundreds of African words. Oral traditions (stories, narratives and legends) are passed on from one generation to the next and on the way feed literature, the arts and a whole body of imagination and creation that has not been reserved for the descendants of Africans alone: along with the milk of the slave wet nurses, the white children of rich colonial families fed on stories, ways of thinking and different sensibilities. Deep-seated acculturation took place, often unbeknown to all those involved.

African culture has had an undeniable effect in the liberation of the peoples deported during colonisation. This is particularly the case of music, used as an effective weapon in combating racial segregation. The history of jazz tallies with that of slavery in the United States and also chants the struggles for the emancipation of Americans of African descent. Played and liked all over the world, it popularised the cause of oppressed people.



▲ House of Slaves Memorial, Island of Gorée, Senegal.
© Laurent Givernaud

In a different political context, the various musical styles of Brazil have been marked by the music of several parts of Africa. The samba and capoeira originated in Angolan music. The styles in the Nordeste are a fusion of music from Portugal and Africa, especially Yoruba: maracatu, that originated in Recife, and choro, a form of blues.

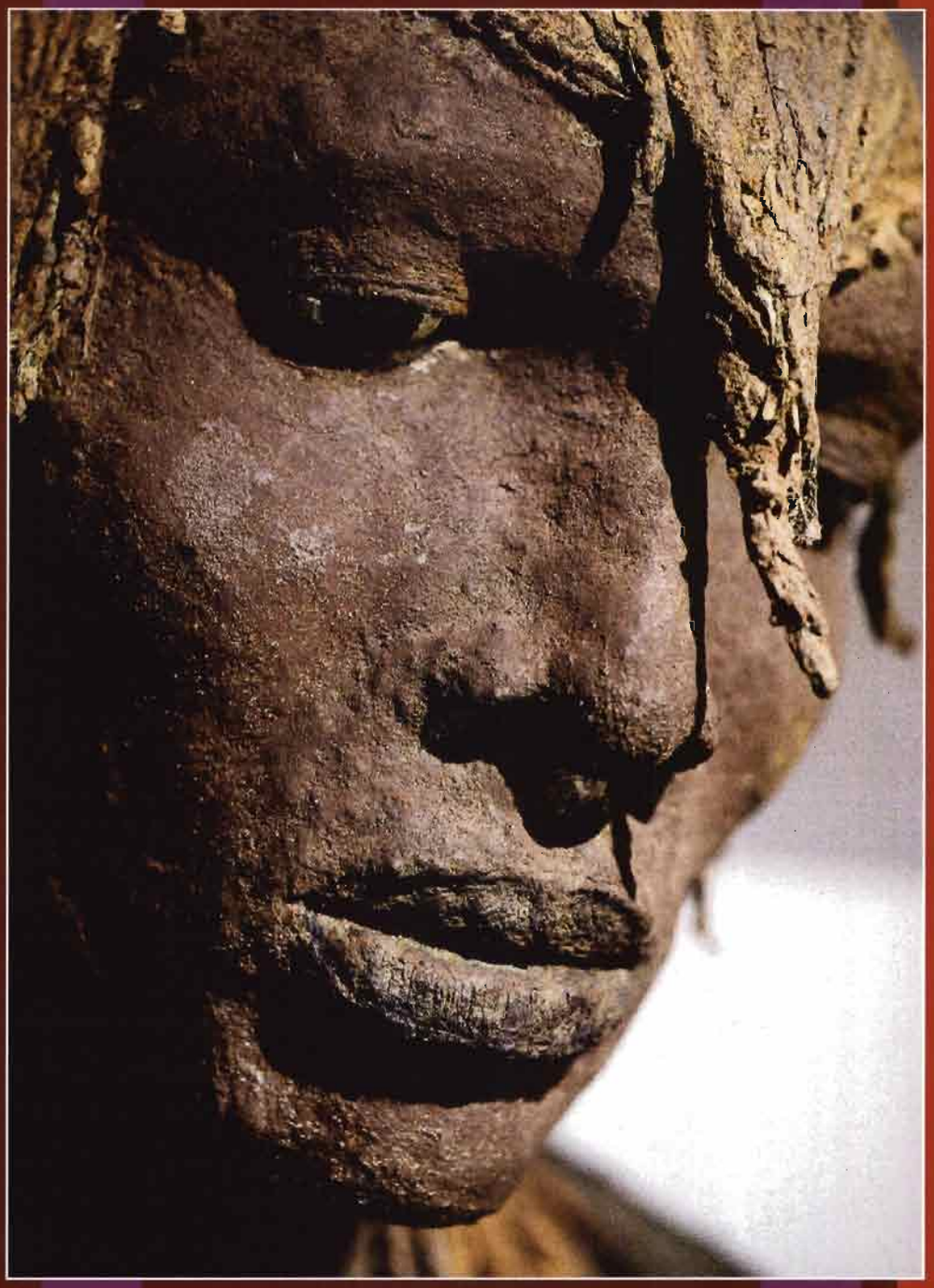
Because of its history fashioned by slavery and forced labour in plantations and mines, Peru has become over the centuries a universe of dance and music to which all the cultural entities in the country have contributed. Creole dances and music are found in all regions and blacks created musical instruments that participate in the national heritage. The Caribbean area has the strongest mark of African heritage, especially in music. With rhythms and instrumental features from Nigeria, Benin and the Congo, the rumba, the son, the cha-cha and the guaracha draw on heritages and traditions, just like the song lyrics and references to Africans cults.

P.L.N

The creation of schools of art and architecture in sub-Saharan cities (like the famous Poto-Poto school in Brazzaville) has encouraged artists to use new materials such as cement, oil paint, ink, stone and aluminium. Their images and drawings attempt often an astonishing synthesis of the traditions of Africa and those of the contemporary world. This is a renewal, in a rightful return of audaciousness in artists inspired by African art. Artists like Ousmane Sow and Assane N'Noye in Senegal, Paul Ahyi in Togo, Twins Seven Seven and Ashira Olatunde in Nigeria and Nicholas Mukomberanwa in Zimbabwe are among the most remarkable with regard to these new forms of creation.

In the Democratic Republic of the Congo and around the Gulf of Guinea, so-called 'naive' paintings depict—like masks in villages—the characters in a contemporary urban society in a period of crisis: the civil servant, the policeman, the prostitute, the fickle woman, the soldier and the drinker. They show—in cafés or on walls—burials, a portrait session at the photographer's, a dance evening, a reconciliation scene, etc.

The Democratic Republic of the Congo thus welcomes some of the most popular artists in Africa like Chéri Samba, the darling of Kinshasa, Joseph Kinkonda and Tsibumba, while Frédéric Bruly-Bouabre is the most famous painter in Côte-d'Ivoire. The democratisation enhanced by the weekly press provides a medium for political caricature that stems directly from this popular imagery.



▲ Ousmane Sow, *Warrior standing*, detail (1987). This artist born in Dakar (Senegal) in 1935, obtained a diploma in physiotherapy. He made sculpture his full-time profession when he was fifty.
© Béatrice Soulé / Roger-Viollet

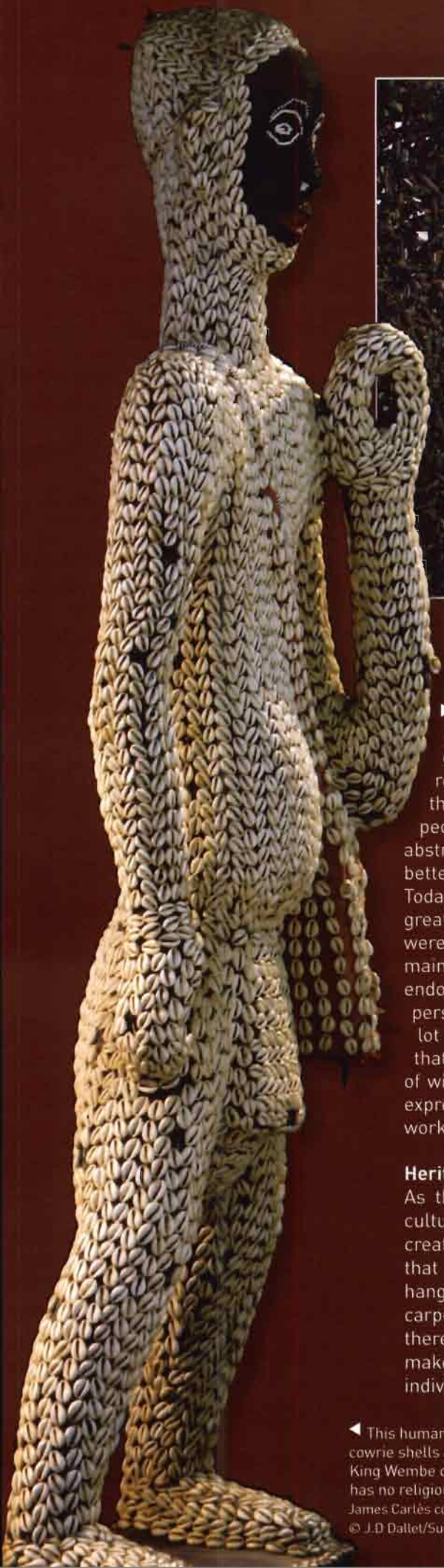
New inspiration for artists

Cities receive a flood of western packaging and machines that have broken down for want of spare parts. This forms possible materials for a renewal of artistic expression, this time at the initiative of the creator himself who becomes a fully-fledged artist and no longer a craftsman, albeit a skilled one, who must obey unchanging aesthetic canons. Steel sheet from tin cans can be used in many ways and, from Dakar to Brazzaville by way of Lomé and Bamako, in the hands of children who have no other toys, recycled wire is turned into lorries, motorbikes, formula 1 cars, aeroplanes and space shuttles. Better still, the wars of 'liberation' and 'aggression' have inspired artists. Cartridge cases from rounds fired during confrontations between armed factions, are collected and welded, sometimes combined with recycled objects to give birth to a new form of sculpture, as can be seen in the works of Freddy Tsimba.

African artists receive awards at pan-African and international fairs and festivals. Likewise, the Marché des Arts du Spectacle Africain (MASA) in Abidjan, the Festival Panafricain du Cinéma de Ouagadougou (FESPACO), Dak'Art (the Biennial of Contemporary Art), the Brazzaville–Kinshasa Festival Panafricain de Musique (FESPAM), the Kora in South Africa, etc. are all markets that benefit both artists and African and western managers.

African literature counts talented writers of excellent books overseas or in Africa and that dominate in kiosks and bookshops. The Nobel Prize for Literature has been awarded to four African writers: Wole Soyinka, Nigeria (1956), Naguib Mahfuz, Egypt (1988), Nadine Gordimer and John Maxwell Coetzee, South Africa (1993 and 2003)! The fact that several African cultural assets are on the World Heritage list is further proof of Africa's contribution to the world.

Traditional African art, and in particular its symbolism, has fed the inspiration of leading western artists. It inspired some of the most important movements in modern art in the western world as for ▶



▲ Freddy Tsimba was born in 1967 in Kinshasa where he graduated in visual arts, specializing in monumental sculpture. For this one, *The apostle of disarmament*, he used bullet cartridges he has collected over more than ten years of war in his native Congo.

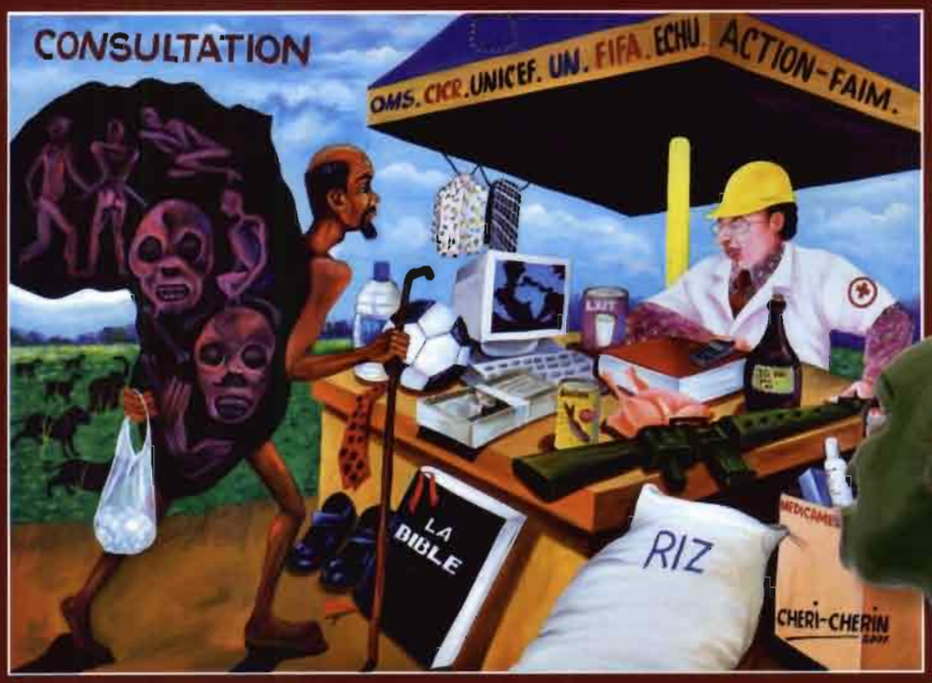
example with the discovery of African art by the early twentieth century cubist painters. They were the first to recognise in disconcerting aesthetics the humanist values of the sub-Saharan peoples and to admire the power of the abstraction of this art, finding stimulation to better go beyond the naturalistic approach.
Today, this contribution would perhaps be greater if Africa, the cradle of humanity, were not experiencing problems in maintaining its culture. What a lot of endogenous knowledge is unknown, kept by persons having sworn to secrecy! What a lot of experiences of human organisation that have been little catalogued! What a lot of witnesses' accounts and original artistic expression, the fruit of 'uneducated' creative work, that is being sorely neglected!

Heritage theft and pillaging

As they are soaked in an environment of cultural ebullition and an abundance of creativeness, our contemporaries consider that everything goes without saying: why hang on to copper Katanga crosses, raffia carpets and wooden statuettes? Aren't there still artists and craftsmen who can make them? This is the negligence of individuals and governments, together with the recent abstractions, theft and pillaging of heritage items during war. The compiling of an exhaustive inventory of all the cultural heritage items of the countries of Africa that should be safeguarded, displayed and disseminated is overdue.
At the beginning of the second millennium, which some consider generates fears and doubts about the future of humans and the harmonious coexistence of cultures —O. Spengler's 1918 notion of the decline of the West has resurfaced— the use of ancient African arts by western artists shows that the crossing of cultures and the comparison of various expressions in the arts are one of the best paths to renewal and richness.
We can thus conclude like Louis Michel that 'each people has a message that it can deliver to the world. Each people and each human being possesses via his or her culture and his or her positive identity the means to give humanity the genius of his or her imagination and creativeness'. The cultural personality of Africans has been destructured by the slave trade and colonisation for six centuries but they cannot lose their self-confidence as players in their history. Cheikh Anta Diop invited Africans to reappropriate their ten thousand years of history to 'fertilise our imaginations and place us in a confident society from which development emerges'.

◀ This human-sized Bamiléké sculpture (in wood, cloth, cowrie shells and small beads) was a personal possession of King Wembe of the Bana Kingdom in western Cameroon. It has no religious or ritual function but is just symbolic (power).
James Carlès collection.

Pascal Luzala Ngasiala
Institut National des Arts, Kinshasa
The Democratic Republic of the Congo



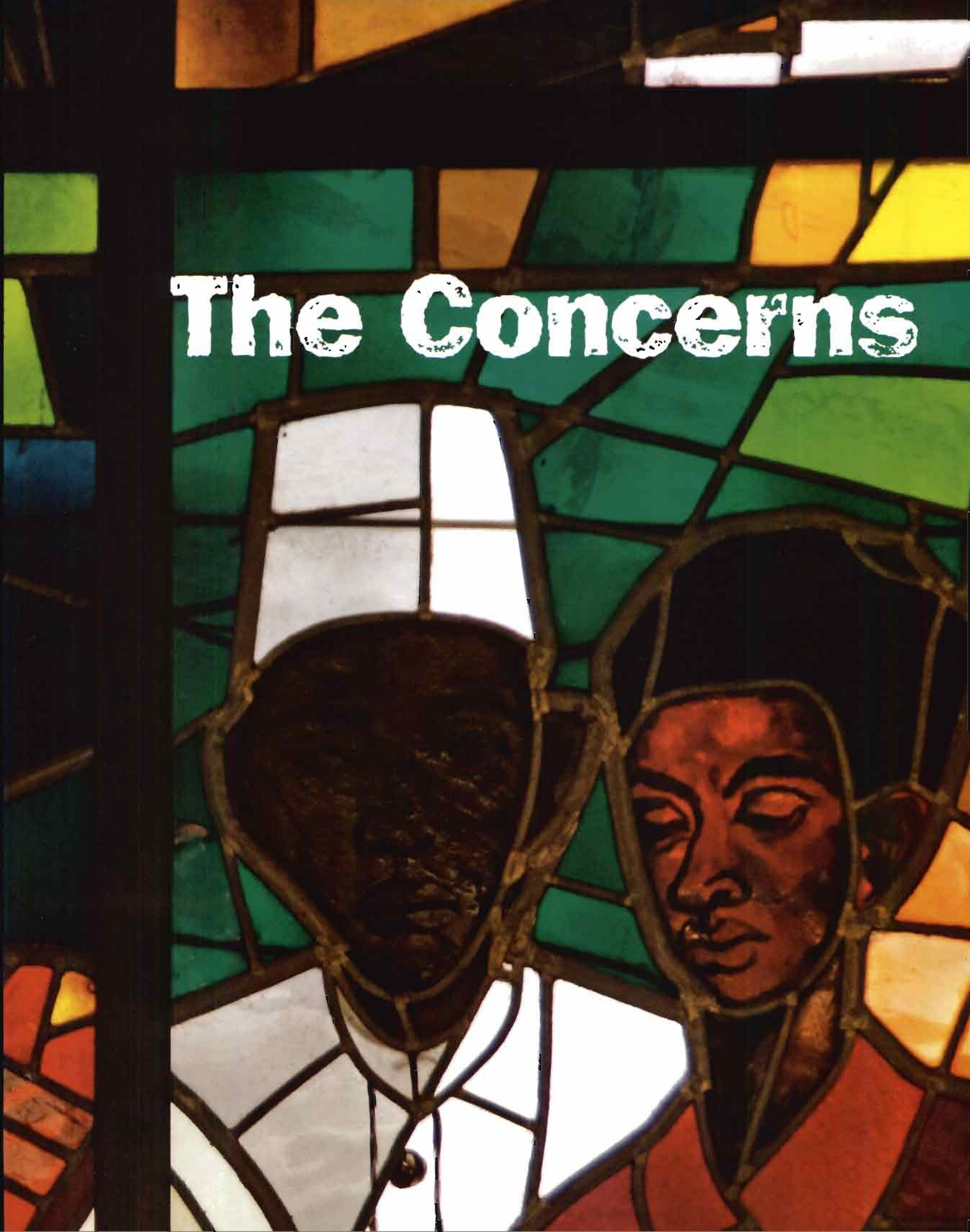
▲ Joseph Kinkonda, called Cheri Cherin, was born in 1955 in Kinshasa (DRC) where he studied at the Académie des Beaux Arts. He is one of the best-known painters in the capital and a teacher of many young talented artists. *Consultation*, acrylic on canvas.

▲ This large mural painting on a wall of the National Library in Rabat (Morocco) associates the Arabic and the Tifinag alphabets (Amazigh languages) symbolizing unity between the two cultures. Qalam means 'the pen'.

▲ Quaye Kane (1927-1992) was born in Ghana where he worked with his uncle, a carpenter. His coffins are made in the replica of the deceased profession or reflect the social status of the deceased. This plane was exhibited in a London art gallery.

▼ George Lilanga (1934-2005) was born in Tanzania. He gained world renown with his sculptures and paintings representing the shetani spirits of the Makonde people of Kenya, Tanzania and Mozambique. His cartoon-like personages have influenced contemporary creators, particularly the pop artist Keith Haring.

Africa: Past, Present and Future (1960-1961)
The entrance of Africa Hall, the headquarters of the United Nations Economic Commission for Africa, is one of the greatest achievements of Afewerk Tekle one of Ethiopia's most celebrated artists (born 22 October 1932). It shows his mastery on a gigantic scale (150 m²) of a medium which has inspired artists ever since the Middle Ages, and it embodies in its three panels Africa's sorrowful past, present struggle, and its high aspirations for the future. Here part of 'Present'.



The Concerns

Committed to sustainable development

◀ Campaign against HIV in Batho, Bloemfontein, South Africa.
© Elisabeth Deliry Antheaume/Indigo/IRD

▲ Fifteen years ago, only about 25% of Ethiopian boys and 20% of girls went to school. Today, in most of the country, it is close to 90% for both (here in Addis Ababa). Schoolchildren were 3,5 million in 1990 and about 16 million in 2010.
© J.D Dallet/Suds-Concepts

Different assessments, including the AUC-UNECA Economic Report for 2011, on Millennium Development Goals (MDGs), have concluded that a number of countries in Africa are making progress on some fronts while recognizing that much more progress is needed in other fields. Progress registered includes, for example, more girl children going to school, lowering of the HIV/AIDS infection, among others. However, we need to do more in combating poverty. At this rate, it may not be possible for a number of African countries to attain MDGs by 2015.

Efforts are under way to address challenges to our pursuit of MDGs. For instance, through the Comprehensive African Agriculture Development Programme (CAADP), we are trying to increase agricultural production, productivity, food and nutrition security against odds occasioned by climate change, volatile food prices and others. The African Union has also put in place Africa Day for Food and Nutrition Security to be commemorated annually to raise awareness. We are also taking forward the implementation of the July 2008 Sharm el Sheikh AU Summit Declaration on Water and Sanitation. All these efforts will propel Africa forward in the pursuit of MDGs relating to hunger and malnutrition, water and sanitation as well as poverty eradication, among others.

One other important Millennium Development Goal relates to Sustainable Development. It is important to note that the July 2011 Malabo AU Summit focused on the Theme Sustainable Development and Empowerment of Youth. The outcome of the Summit has enhanced Africa's preparedness for Rio+20. And more importantly, to renew our commitment towards sustainable development in all its dimensions, from biodiversity to water and land management, among others.

Satellite information

Sustainable Development is, indeed, a key component of the African Monitoring of the Environment for Sustainable Development (AMESD), which is a programme that African Union is implementing in Member States in partnership with the European Union and Regional Economic Communities, among others. Satellite information is important for decision making, Measuring, Reporting and Verification (MRV) on Reducing Emissions from Deforestation and Forest Degradation (REDD) and also it has helped United Nations Environment Programme, African Union Commission, and African Minister's Council on Water (AMCOW) ▶

Millennium Development Goals
A young girl replenishes her family's water supply from a nearby well refurbished by UNICEF, near Korhogo, Ivory Coast. African leaders have declared their commitment to achieving universal access to clean water, through NEPAD and Millennium Development Goals (MDGs).

Spanish fan over the Sahara
This Meteosat image shows a movement of cold air from Europe to Western Africa causing a major dust storm over large parts of West Africa (early March 2004). As it moved south, the cold air fanned out across the Sahara, strongly diverging over subtropical regions giving the dust front the form of a Spanish fan. In red, cold high level ice clouds. Pale violet: the dust-storm. In the following days, the dust was blown out across the Atlantic Ocean and reached the coast of South America.

▲ Installation of the AMESD station at BDMS (Botswana Department of Meteorological Services), Gaborone, Botswana, 2010. © Telespazio

▶ Integrated development of an area with villagers. This *Méthode Active de Recherche et de Planification Participative* (MARPP, Active Participative Research and Planning Method) was developed in 1985 in East Africa. © E.Kaisin

▶ to jointly produce the African Water Atlas.

We are trying to acquire and apply advanced technologies for earth observation and satellite imaging to obtain data and information to support our policy making in various sectors including environment management and agriculture.

It is noteworthy, though, that Africa's gains towards Sustainable Development are being undermined by among others climate change and climate variability as well as the frequent and intense natural and manmade disasters. This is, indeed, a global challenge entailing floods, droughts, erratic weather patterns, coastal erosion and so on that call for collective actions and partnerships.

Cognisant of this fact, Africa is duly engaged in global climate change negotiations with one unified structure and one common position advancing Africa's interests. The African Union is also implementing policies, programmes and projects that promote sustainable development through advancing climate smart agriculture, the green economy and adaptation as well as mitigation measures. Among the AU key programs in this regard are AMESD as well as the ClimDevAfrica, the Great Green Wall for the Sahara and Sahel and those related to Disaster Risk Reduction.

The wellbeing of humanity

Africa, with now one billion people, is facing pressure on its limited resources including its ecosystems, land, forest, water and cities, among others. Our policies and programmes mentioned above have taken this into account and recently we launched African Cities Resilience Programme under Disaster Risk Reduction to deal with challenges posed by increased urbanization coupled with rural urban-migration.

For the African Union, in pursuit of our mandate based on four pillars, namely peace and security, regional integration, institutional capacity building and shared values, we continue to harmonise continent-wide policies, build partnerships, mobilize resources, and advocate for African causes. Our preoccupation No.1 is the wellbeing of humanity and in particular African citizens. In all this, sustainable development for the benefit of the present and future generations is of paramount importance.

H.E. Mrs Tumusiime Rhoda Peace
Uganda
Commissioner for Rural Economy and Agriculture at the African Union Commission

Looking from the North

▲ Spring in the corn area, near Khemisset (Morocco), between Rabat and Meknès.
© J.D Dallet/Suds-Concepts

SAÏD MOULINE
General Director of the National Agency of Development for Renewable Energies and Energy Efficiency
Rabat, Morocco.

What could be the basis for a joint policy concerning sustainable development between Morocco, Algeria and Tunisia?

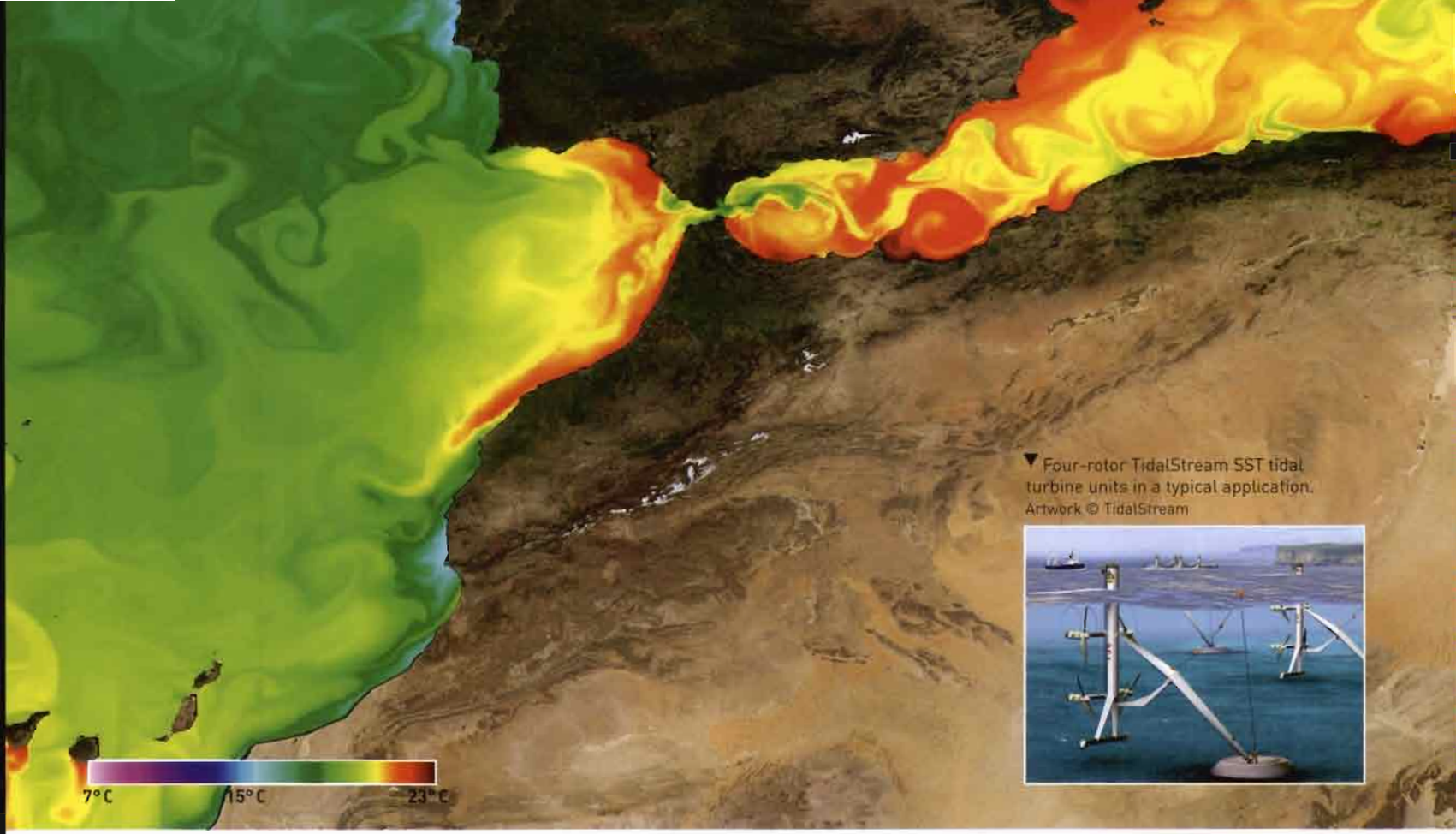
The Maghreb countries share the same Arab-Berber, Andalusian and Jewish cultures and have the same geographical context, with a Mediterranean climate in the north and a very arid Saharan zone. As regards the economies, each country chose its own pathway in the 1960s: with its energy resources, Algeria opted for strong industrial development, Tunisia for the tertiary sector and Morocco used agriculture and fisheries as a base. Rebalancing then took place in the three countries.
As regards demography, the region has long displayed strong growth: the population of Morocco, Algeria and Tunisia increased from 60 million in 1994 to 70 million in 2000. Growth rates have decreased to more acceptable levels, much more so than south of the Sahara. In a context of increased scarcity of fossil fuels, climate change, accelerated desertification and exhaustion of marine resources, the Maghreb countries face the same challenges.

Is sustainable development one of the priorities for the Maghreb?
Absolutely. We want to move towards sustainable development. Even if you often hear that 'it's a problem for the rich countries and we should devote ourselves to other priorities first'. But you always win when the economic, social and environmental aspects are integrated. An example is that of non-responsible forest exploitation. In Morocco, where today 98% of the population is supplied with electricity, 20% of the energy used still comes from firewood. This has environmental consequences – deforestation aggravates the silting up of reservoirs – and also social effects: for a long time young girls could not go to school because they had to carry firewood, not to speak of carrying water. A structuring Maghreb project would be a joint green belt for the three countries that would stop the spread of desertification.

What are the main challenges to be met?
The first is water. A true water civilisation was born here and spread to Europe via Al Andalus. Today, the decrease in rainfall (resulting from climate change) worries us, as does the salinisation of coastal ground water (over-exploited by agriculture), soil erosion and desertification. The desert is advancing in the south. Water availability is less than 1000 m^3 per person per year in Morocco and 500 m^3 in Algeria and Tunisia. Thanks to the dams built in the 1960s, capacities in Morocco are sufficient to cover consumption in towns and the country, industry and agriculture. But the pollution problems remain. Untreated sewage is released into the sea by numerous large cities in the Maghreb. Whence our proposal within the framework of the Euro-Mediterranean project that all the cities in the South should be equipped with sewage treatment facilities like those in the North. The same goes for the management of solid waste facilities. In these sectors we could make progress in concrete projects that would enhance Mediterranean integration.

▲ The fishing port of Salé (Rabat, Morocco).
© J.D Dallet/Suds-Concepts

What about agriculture and fisheries?
Morocco wishes to play a role in agricultural development in Africa. It is not acceptable



▼ Four-rotor TidalStream SST tidal turbine units in a typical application.
Artwork © TidalStream

▲ Temperature of the Atlantic at the end of June 2010. From the Mercator Ocean model at 1/36°. Knowledge of the physical state of the ocean at the surface and at a depth (state of currents, temperature, etc.) is important for setting up marine current power installations. © Mercator Océan/MyOcean/CNES Production: Mira Productions.

that the continent is still unable to ensure food self-sufficiency, given its riches in terms of land, water ... and phosphates, of which Morocco holds more than 75% of world reserves. Yields can be increased considerably by using fertiliser manufactured from phosphates, without repeating the mistakes made in Europe. Numerous African countries are interested. In order to promote agriculture with greater respect for ecosystems, the Office Chérifien des Phosphates is working on a concept of rational fertilisation that will serve as a true green revolution in Africa. Associating Algerian gas and Moroccan phosphate could make our region the world leader in fertilisers. Morocco has launched the Halieutis programme aimed at implementing the sustainable exploitation of fisheries resources. Our fishing remained small-scale in comparison with the European and especially Asian over-equipped armadas that scour the Mediterranean off Mauretania ... This over-fishing resulted in the almost total disappearance of certain species and the near-bankruptcy of certain inshore fishery sectors. It was catastrophic. Tuna is a major issue for example.

There is determination today to triple the GDP of the sector by 2020 by creating villages of small-scale fishermen, by developing aquaculture and processing in order to gain new markets in North America and the Middle East for example. Hence the need to protect resources, as was done for octopus when this risked disappearance.

▲ Solar power plant in the Sahara.

Is the renewable energies sector part of these projects?

Morocco is showing the way in this domain. We rely on imports for 95% of our energy. This is why we hope to attain 42% renewable energy in 2020 and reduce this dependence. Large structuring operations and voluntaristic master plans have been set up to reach 2000 MW installed load in each of three fields—solar, wind and hydraulic power—in 2020. We are also developing research on the use of marine energy as in addition to sun and wind, the country has more than 3500 kilometres of coastline. We are also working on making Morocco a green energy exporter in a few years.

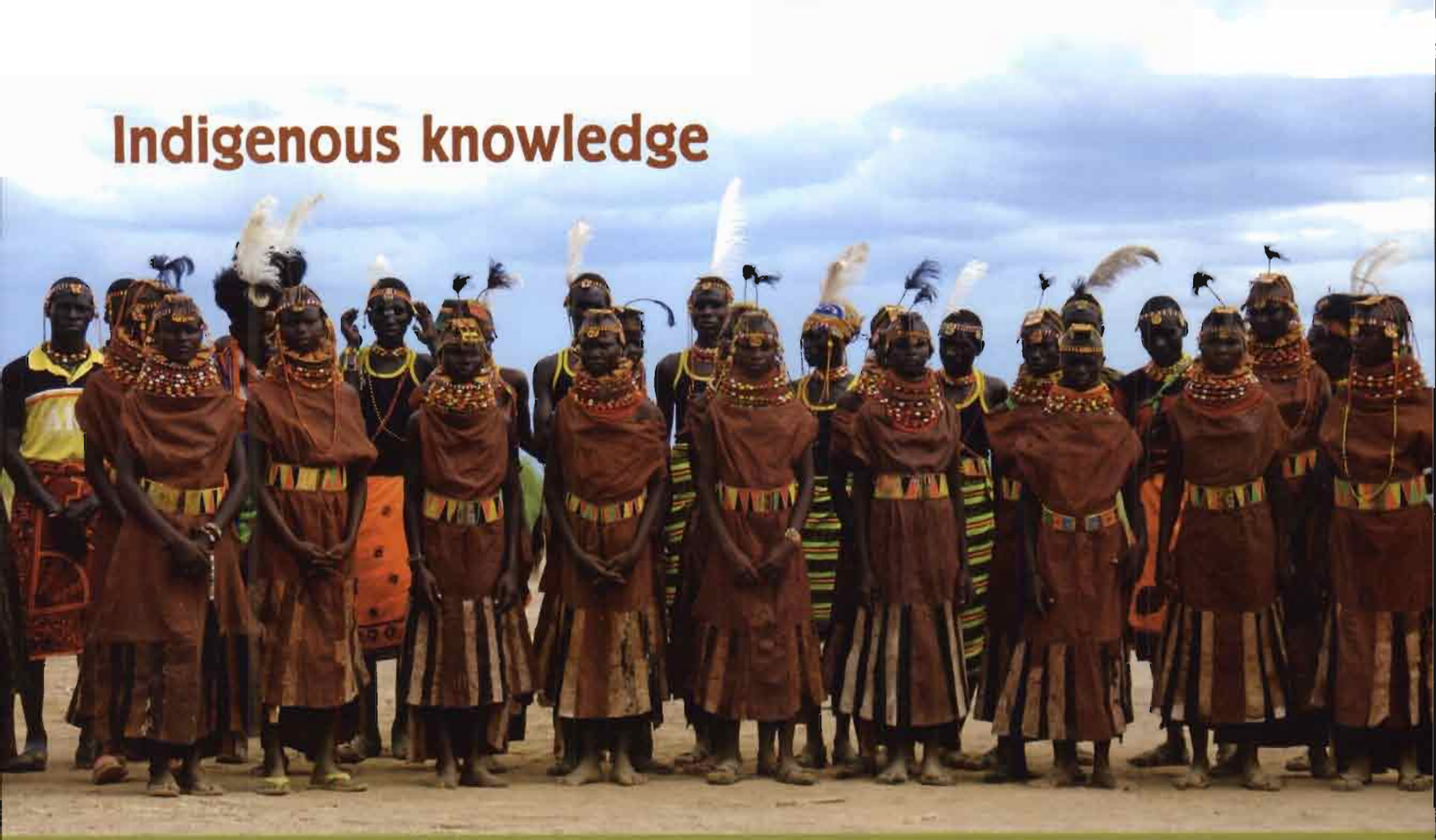
We talk about sustainable energy not because of the low CO_2 emissions but also because we think about industrial integration and regional development with an accompanying feature for the most isolated regions where there are few activities. Energy efficiency must not be forgotten: care must be taken not to waste it. The message is easier to get over in Morocco than in countries like Algeria with rich gas and oil resources, but the more we progress in the integration of the Maghreb, the more strength we shall have to respond to the issues of sustainable development and create more resources for everybody.

This requires expertise in high technologies and, again, we wish to establish ourselves as a regional platform. In the space sector for example. We have been using satellite data in the water and mining sector for about a decade. We need to measure marine currents with altimetric data provided by European satellites such as ENVISAT and Jason in order to set out marine current power installations. Satellite applications are also very useful for monitoring fishing.

We would like to develop regional cooperation in these fields.

A new North-South partnership is needed. The world is changing, and especially the Arab countries. Expertise exists in the South and should be taken into account, but much training is still needed.

Indigenous knowledge



▲ Turkana dancers perform to celebrate the onset of rains at Lokori, South Turkana (Kenya), October 2010. If rain is often greatly expected, El Niño and La Niña cycles can cause massive flooding in low lying and poorly drained areas like South Turkana. © Mark Kamau

There are more than five communities of people residing in the northern region of Kenya. These include the Turkana, Rendille, Dassanech, Gabra, Borana, El-molo and Samburu. They are mainly pastoralists and practise different cultures and traditions. Divination is used for prediction of different events be it weather, disease, fortune, death or any other event of importance within the community. Widely practised is *haruspication* or reading of entrails of animals to predict such events as drought caused by lack of rains or floods. Entrails from goats are the most commonly used as it is possible to read the veins of the entrails in totality. Entrails reading mainly involves the layering of veins. Veins that are heavy with blood and layered point to onset of rain in the very near future. Dry veins indicate drought.

Powers of the elders

The other divination is *augury* which is a very ancient method of watching and listening to birds and interpreting their movements and sounds. Certain birds, if seen, can be used to predict storms or floods. Such birds include the Grey go-away-bird, Grey Loerie called *Chiba* by the Rendille and Lel (*Corythaixoides concolor*) among the Turkana. The whistle of this rare bird during the night along dry riverbeds predicts onset of heavy rains and flooding within a week. The constant cry of jackal through the nights also indicates onset of rains.

Specific elders are believed to possess these powers or revelations that come from a higher influence. They are considered to control these acts during their lifetime and can only pass on the same authority through divination from a higher power.

Scientists and diviners

There are proverbs that relate to weather within these communities including these two as used by the Gabra people.

Do'ofti Waaqa Duubassa, Taa Naama Affaan. (The signs of God's provision of rain are clouds, while that of a man is the tongue/mouth- what you speak!)

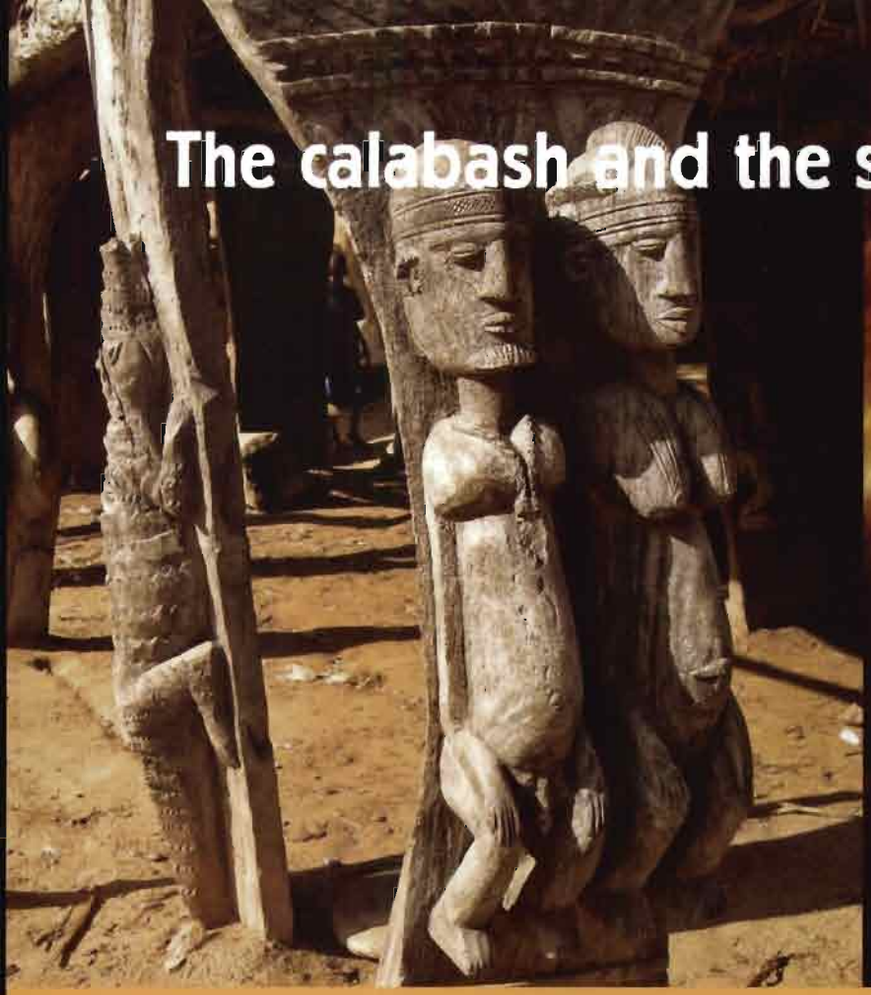
Laff Rob It Goothanaan, Thurratt Abburrattaan. (The area that you need to utilize during the rainy season. Its planning starts in earnest in the dry season)

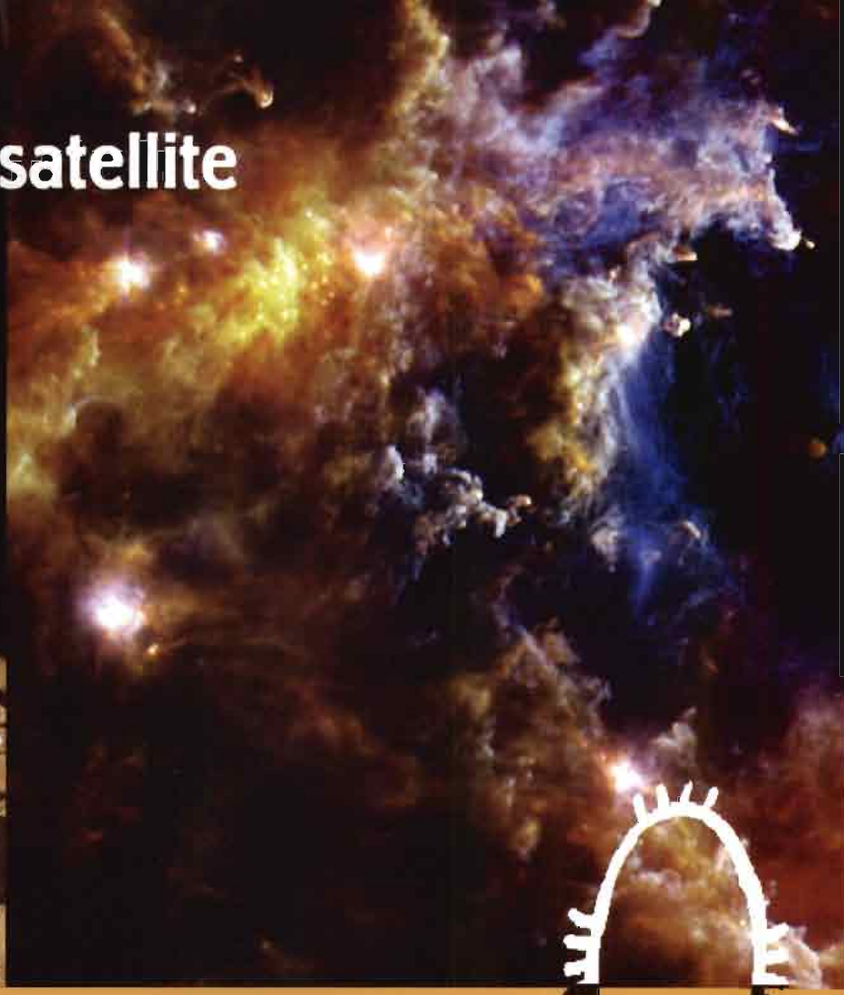
Today, most of these groups of people embrace modern technologies to predict weather. Instruments such as rain gauge, wind barometers can be seen dotting the landscape. Information is relayed to the people by scientists on the ground, using satellite imagery as well as other means of weather prediction. However, the divination method is still alive within these communities and scientists are working hand in hand with the diviners in realising a common goal for the sustainable development of these areas which are currently facing serious issues related to climate and anthropogenic effects on resource availability and management. Such is the IGAD Climate Prediction and Applications Centre, which is working with a project known as Integrating Indigenous Knowledge in Climate Risk Management in support of Community-Based Adaptation in Kenya.

Dr Purity W. Kiura,
Archaeology-National Museums
Kenya

▲ The Grey Go-away-bird, has a distinctive loud alarm call 'quare', sounding like 'Go-away'. It can be used to predict storms or floods.
© Axel Bührmann

The calabash and the satellite





▲ In the Dogon creation myth, the original created beings were the Nommo twins. © All rights reserved. In their cosmogony, Sirius B star is mentioned as Pô tolo (fonio star, bottom) and Sirius C as Emma ya tolo (female sorghum star, right). © Doc. M. Griaule

▶ The Rosette cloud (image by ESA Herschel satellite), close to the constellation of Orion, the Hunter. Sirius is located at the heel of this constellation. What the naked eye perceives as a single star is actually a binary star system, Sirius A and Sirius B. The scientific community has not confirmed the existence of Sirius C, described by the Dogon. Maybe a space telescope will succeed.
© 2000 – 2011 ESA. ESA/PACS & SPIRE Consortium, F. Motte, Laboratoire AIM Paris-Saclay, CEA/IRFU-CNRS/INSU- Uni. Paris Diderot, HOBYS Key Programme Consortia

In Africa, the perception of space, at least among certain peoples, is not limited to indicating the sensorial processes—especially sight and hearing—that make it possible to situate an object in space. Among the Dogon and the Ewe, for example, space is often evoked metaphorically or emblematically to explain the creation of the world.

According to the Dogon, 'Amma, god the creator, omnipotent and immaterial, launched the planetary system, balls of earth transformed into stars that women then gathered in the sky to give to their children. These put spindles through them and made them spin endlessly like sparkling spinning tops. Amma made the sun-female, the moon-male and the earth, a lump of clay that he squeezed in his hand and spread in space, going northwards, lengthening towards the south, and extending to the east and the west, stretching its flesh, separating its limbs like a foetus in the womb. The world became a woman, lying on her back, north-south. Amma, god the creator, the «father» of creatures, wished to unite with mother-earth, represented by the world as an egg consisting of a double placenta, to engender beings that would further his creation. The first beings were created, fertilised by Amma's words. A pair of androgynous twins, one of whom revolted against paternal authority and the other a «saviour». Put to death and then resurrected, the saviour, Nommo, used his own sacrifice to reorganise the world that had been disturbed by the actions of his rival brother, Yorougou, the fox'.

The Ewe peoples explain the beginning of the world as follows: 'At the beginning of all existence there was a Calabash. It filled time and space. It was the All. Divided horizontally in the centre, its lid formed the Sky and the base formed the Earth. The Sky was male and contained Water. The Earth was female and Fire burned in its entrails. The Calabash as a whole was thus Earth, Air, Fire and Water. Life was born at the initiative of the Sky which, one day, sent water to the surface of the Earth. The Earth received the first rain and coolness made plants germinate. These underwent metamorphosis, some turning into animals and others into human beings. The Sky and the Earth, put into contact by Rain, made Lightning which triggered the primordial impetus, launching the perpetual movement of the Sky and the Earth themselves, together with the Water and Fire that each contained'.

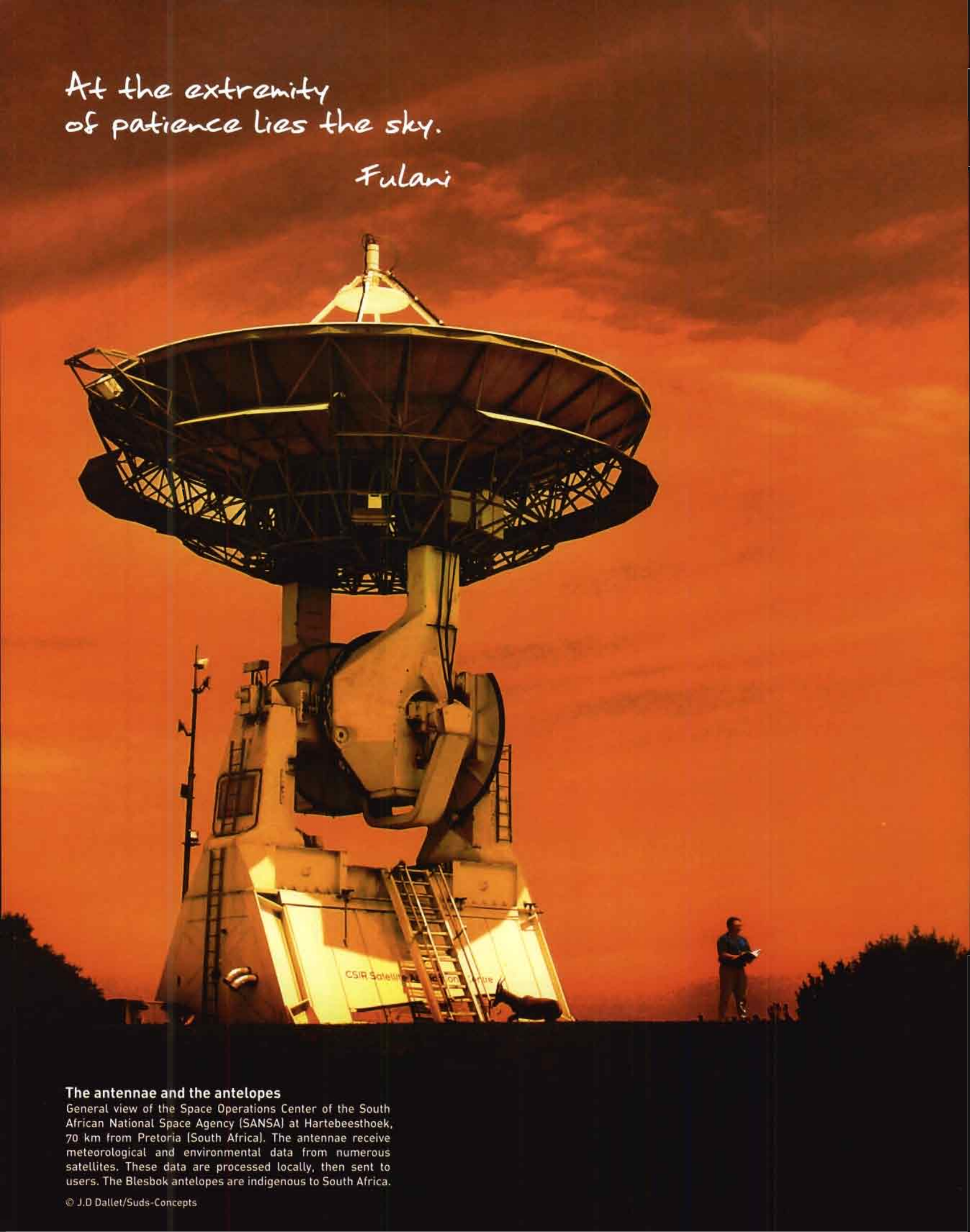
Is there a risk that this knowledge passed on from generation to generation without fault, except sometimes to soften the images, might be called into question as satellites are becoming more familiar to us and bring us almost perfect images of the earth and the sky?

The cosmology and cosmogony of the Dogon and the Ewe, and of many other peoples here and there, used celestial bodies to explain the creation of the world. With the rapid development of electronic, information and communication technology, might there not be doubts and weakening of their beliefs? Because, beyond its limits, science gives us the means to push back the barriers of ignorance.

Dr Aly Tandian
Teacher researcher, dpt of sociology
GERM coordinator
Université Gaston Berger de Saint- Louis
Sénégal

At the extremity
of patience lies the sky.

Fulani



The antennae and the antelopes
General view of the Space Operations Center of the South African National Space Agency (SANSA) at Hartebeesthoek, 70 km from Pretoria (South Africa). The antennae receive meteorological and environmental data from numerous satellites. These data are processed locally, then sent to users. The Blesbok antelopes are indigenous to South Africa.


Space Tools
CSIR

Deserts and crop fields

Top image: part of Erg Iguidi desert, Algeria. These sand dunes in the Sahara between Algeria and Mauritania are formed by the prevailing winds. Average elevation is of 496 meter above sea level. AlSat-1 satellite image.

Bottom image: Ismailia Governorate, Egypt. In red, the irrigated crop fields. The most important crops are clover, maize, sesame and wheat. Bottom right, the Great Bitter Lake. Fish catch in this region amounts to 82% of the total figure for the country. From left to right, the cities of Qussasin, Mahsama, Abu Suwerr and Ismailia (on the west bank of the Suez Canal). Nigeriasat-1 satellite image.

ARMC: space cooperation for development

Dr PETER MARTINEZ
Chairman, South African Council for Space Affairs

What is the genesis of African Resources Management (ARM)?

Four African countries, Algeria, Nigeria, Kenya and South Africa have been working together since 2003 to establish a combined space asset that collectively serves a unique need for regular up-to-date monitoring of the African environment. The initiative (initially only commercial) came from the successful SunSat satellite programme of Stellenbosch University that led to the creation of the SunSpace company. Then came the idea of having a constellation of satellites to address Africa's development needs: the African Resources Management Constellation (ARMC).

What is the goal of ARM?

ARM helps to provide easy access to satellite data for end users in disaster management, food security, public health, infrastructure, land use, and water resource management. It thus supports urban development, mapping for the surveillance of climate change effects and sustainable development. Today Algeria is operating the Alsat-2A satellite, Nigeria has recently put on orbit the NigeriaSat-X and NigeriaSat-2 satellites and South Africa is preparing the follow-on of Sumbandilasat satellite.

How is it managed?

The project gained political traction when the governments of other countries started to become interested. The concept is that participating countries will each contribute one satellite to the constellation and will have access to the other satellites from South Africa, Algeria and Nigeria. At this stage, Kenya does not have an indigenous satellite industry, thus is participating through its ground station.

In December 2009, the governments of the four participating countries signed a memorandum of understanding (MOU). It is stated that ARMC is open to other African countries, even if they cannot participate to the space segment. It thus became a project driven by intra-African cooperation considerations.

A steering committee was formed and workshops were held. For example, in South Africa, a users group having a need for earth observation data was constituted. All their requirements were consolidated in a final set for the ARMC. This document was shared with the other African countries and they would go through the same process to define their priorities.

What are the main advantages of such a structure?

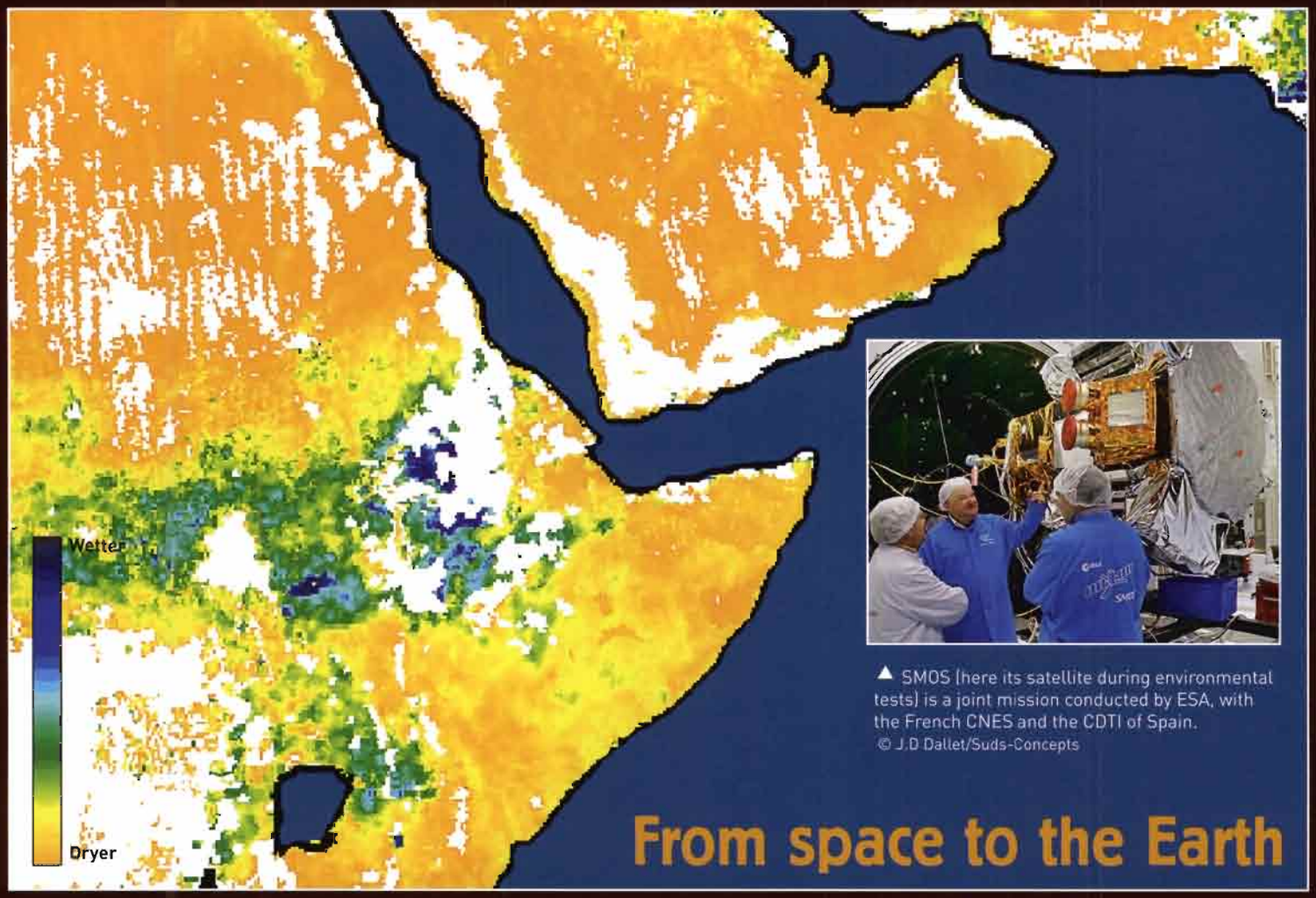
Instead of having a dedicated satellite for each country, the phase zero is that each country contributes capacity on one satellite. And to start with, a certain fraction of time dedicated to an existing or planned satellite would be a country contribution to ARMC. As the constellation becomes operational and a satellite needs to be replaced, a country would build a fully dedicated satellite. This would be the idea to realize the project in a faster way than starting each with a dedicated satellite.

▲ An observation satellite transmits images to the earth using an 'image telemetry' subsystem that includes a modulator. Here, a modulator under manufacturing; it is like that equipping the Alsat-2A satellite launched in 2010.

What is the future?

I see the benefits of ARMC considerably more than just cooperating on a technical level. It is also to start growing capacity in Africa, from a policy and regulatory level, in the joint pursuit of space activity. The ARMC and the SKA (Square Kilometre Array Telescope) are key projects for defining intra-African cooperation.

There are discussions about establishing an African space agency. My personal view is that, in the long run, it is something to discuss, but in the medium term it is a completely premature kind of activity. The reason being that we do not have experience in the African space community of having our industries working together, addressing inter-operability. Not to forget also the regulatory issues, data sharing practices.



▲ SMOS (here its satellite during environmental tests) is a joint mission conducted by ESA, with the French CNES and the CDTI of Spain.
© J.D Dallet/Suds-Concepts

From space to the Earth

▲ Drought in Somalia, Kenya, Ethiopia and Djibouti is pushing tens of thousands of people from their homes. This image, derived from SMOS satellite data, shows soil moisture in the Horn of Africa in July 2011.
© 2011 ESA/CESBIO

Better knowledge of the effect of climate on the composition and quality of cultivated soils is essential for determining crop management sequences that match the land. The promotion of scientific research is therefore essential, especially in the field of the environment (agro-pedo-climatology).

Africa and Europe have a long history of cooperation in spatial remote sensing at the service of sustainable development in Africa. Numerous institutions such as the African Union and the European Union and certain bi-national cooperation work have implemented programmes aimed at using satellite data.

The agricultural scientific research sector in Ivory Coast is one of the best in the field of cacao but the budgets have shrunk considerably since the 1990s. Funds are devoted mainly to 'conventional' research: improvement of germplasm, disease management, etc. There is insufficient consideration of environmental factors, adaptation to climate change and the study of cacao agro-ecosystems.

Budget constraints and research priorities are not the only reasons. Ten years of political crisis means that the network of environmental observation instruments has not been maintained and developed. This slows understanding of the evolution of climatic factors and the impacts of climate change.

Agricultural and environmental field research can be consolidated by data gathered in space by observation satellites. Long times series of such key environmental data such as rainfall, temperatures and evapotranspiration are available.

The role of space applications

Programmes have been implemented by the European Union and its organisations to use spatial data in Africa. The first step was to make available to African specialists data such as those from SPOT satellites, providing mapping of natural or agricultural plant resources (VGT4Africa programme), or from ENVISAT and ERS in the field of water resource management (TIGER programme). New satellites like SMOS measure soil moisture among other things and the future Sentinel 4 and 5 will be devoted to meteorology and climatology. These data are of crucial importance for understanding the limits of land systems. Especially by incorporating agro-climatic dynamics at the scale of West Africa or by collecting new local data for which land-based instruments are far from having high priority in national budgets.

Strengthening user networks

Reception networks such as PUMA and EumetCast for EUMETSAT meteorological data had to be developed to give better access to data. Seeing that data often remain within African meteorological or civil aviation services, programmes such as AMESD have been developed to extend the dissemination of spatial application to African research centres.

▲ Installation of the AMESD station on the premises of INDP (Instituto Nacional de Desenvolvimento das Pescas) in Cape Verde in October 2010. The main theme is fisheries monitoring.
© Telespazio

In spite of these efforts, the reality of the field shows how far there is to go. Although regional research centres are improving the integration of spatial data, we are still far from achieving generalised access to national specialised research centres and university laboratories. However, applied research comes up against limits for want of this information that can fill gaps resulting from lack of infrastructure. This is the case of many crops in Africa and especially for cacao in Ivory Coast

Researchers will not have all the local agro-pedo-climatic data defining each production area. They will therefore be unable to master the entire evolution of local biodiversity, a key element for understanding the agro-ecosystems on which new agricultural techniques are based.

Research and food security

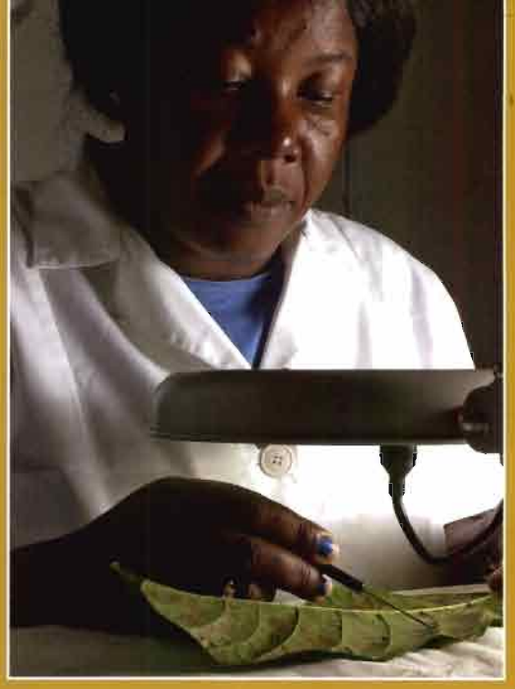
Another challenge is that of passing on knowledge to farmers and supervising them. It is essential to incorporate these needs in the strategies developed. For Ivory Coast this means the maintaining of its position as the world's leading cacao producer, involving a resource that provides income for a third of the population of the country.

These considerations also apply for staples (yam, millet, etc.) to achieve better mastery of the evolution of factors of production and crop forecasting capability.

Many African countries possess excellent human resources in remote sensing and scientific research. However, an increasing population and environmental stress factors make it urgent to strengthen the use of spatial applications and give access to them to those involved in applied research. The development of research programmes focused on the needs of farmers requires the enrichment of the environmental data bases held by the programmes.

Promoting environmental scientific research is essential for perfecting agro-pedo-climatic knowledge about production regions and for determining appropriate crop management sequences. This cannot be done without the gaining of awareness by political decision makers so that their researchers possess tools that will turn food insecurity into a development opportunity.

Cédric Lombardo
Associate Director
Bedevelopment Consulting
Abidjan, Ivory Coast



▲ Sao Tomean scientist examining a cocoa leaf infested with a minute insect.
© IFAD/G. Planchenault

Improving cacao production

Cacao is a symbol of the Ivorian miracle that took the country to the position of leading world producer, with the highest per capita GDP in West Africa. Together with coffee, it forms 40% of exports and 20% of GDP. Achieved thanks to small planters, this performance has been accompanied by their sacrifice to the benefit of economic liberalism and the sacrifice of the environment on the altar of development.

Growers are nearly half a million. They practice subsistence farming and more than half are illiterate. They cannot obtain loans and buy inputs or new cacao varieties that would improve productivity. As they can't hire agricultural workers, their children escape schooling to work in the plantations.

A quarter of 12 million hectares of primary forest in Ivory Coast has been sacrificed for the development of cacao. Deforestation has been instrumental in the sharp decrease in precipitation in the region. Together with Liberia, Ivory Coast is an essential point of entry of the rainy season in West Africa.

To maintain and then increase productivity, a sustainable development strategy must be based on secure selling and production systems. The government of Ivory Coast and its development partners have well understood the need for the reform of the sector in order to improve conditions for growers.

C.L.

Yields forecasting

▲ Maize is the most widely grown crop in Zimbabwe. Its growth is increasingly coming under stress due to high temperature and low rainfall conditions. Climate change could cause maize yields to decrease dramatically under dryland conditions in some regions, even under full irrigation conditions.
© Rutendo Nhongonhema

Agriculture is the mainstay of the economy in Zimbabwe and is important for food security and the economy. Over 70% of the households in Zimbabwe depend on rain-fed agriculture for their livelihoods. Its contribution to the GDP is expected to increase to 23% in the 2010/2011 season. Agriculture employs about 37% of the labour force and supplies almost 25% of exports. About half of raw materials in the manufacturing sector comes from agriculture. This makes agriculture monitoring of paramount importance for both the policy makers and other stakeholders in the country. The main crops in Zimbabwe are maize, sorghum, millet, tobacco, soya beans, cotton, groundnuts and beans. The majority of the population are subsistence farmers who farm for household consumption with very little going for sale. These households that make up about 70% of the population also have agriculture as the main source of livelihood.

Rain-fed agriculture in the past has been affected by climatic variability such as drought which has improved vulnerability of the majority in the country. Zimbabwe basically has got two major seasons, winter, cold and dry, and summer, hot and wet, the season when most farmers plant their crop. Rainfall ranges from 450-1 000 mm per annum and is usually received between October and March.

AMESD helps policy makers

Agricultural monitoring is done by the Ministry of Agriculture through the Department of Extension Services (AGRITEX). This involves the employment of 4 800 frontline extension workers, which makes it very expensive. The department carries out three crop and livestock assessments per season and each costs almost half a million American dollars. This is very expensive for a developing economy like Zimbabwe whose GDP based on purchasing power parity of $ 200 is 8 542. Agricultural monitoring through earth observations has a potential to reduce the cost of monitoring as well as to improve the accuracy of data collected.

The AMESD receiving station used in the prediction of drought and rainfall will greatly help policy makers, who are the main users of agricultural data, to plan ahead. For example, at the sign of a bad season, they want to know the situation in the whole country. The station will also be handy in the yield estimation which has been a challenge because of the lack of experienced staff in human estimation. Whilst earth observations will not be expected to replace the usual methodology, they will complement it and hence improve the accuracy and timeliness of data collection.

Whatever data the extension worker provides it will be triangulated with the data from remote sensing. It is our hope that, after ground truthing and establishing the level

◀ Africa produces about one-third of the world's sorghum.

▶ Millet (*Pennisetum glaucum*) branched cluster of flowers, south of Niamey.
© P.Hiernaux

▲ Millet is extremely important in the semi-arid and sub-humid zones as a staple and an ethno-botanical crop. It is grown on 18,5 million ha by 28 African countries covering 30% of the continent.
© Jaspreet Kindra/IRIN

▲ Selecting data from the AMESD station at the Botswana College of Agriculture.
© Telespazio

of accuracy of remote sensing, we will be able, in some areas, to use the data from the receiving station.

Space technology came to Zimbabwe years back, but – like many developing countries – it has not been able to fully utilize it. This mainly because of the lack of knowledge about its importance and capacity to use it, lack of equipment as well as possibility to use it within the government, the main monitor of agricultural production in Zimbabwe.

Attempts to introduce use of this technology into government have been done by some partners such as the United Nations Development Program but, because of lack of equipment and skill, very few departments are using the technology. As a result, the country is lagging behind and mostly finds itself affected by disaster which it would have avoided by using new tools.

Space technology not only makes it easier to monitor activities like agriculture, climate change and drought, it can also be used for timely planning which is needed in most disaster-prone areas.

The need for competent staff

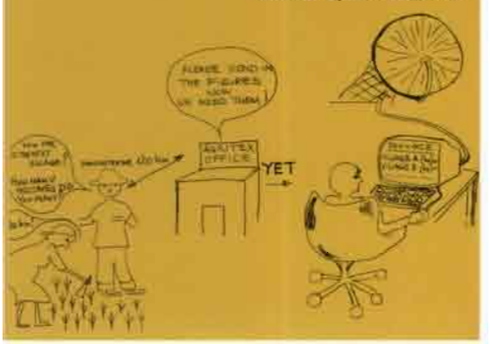
Zimbabwe largely depends on agriculture, which is very sensitive to environmental variations. Satellite technology can not only improve its management but also help to face climate change consequences. Sustainability of agriculture in Zimbabwe means sustainable livelihoods for the people. One of the reasons why poverty has been a thorn in the flesh for the country is because sustainable development has been lagging behind. Zimbabwe is striving for sustainable development but needs competent staff for capacity building in new technology as well as initiatives for acquiring equipment. Response to many shocks and hazards depends, to some extent, on sustainable development. Hence commitment of the country to support it is a key issue.

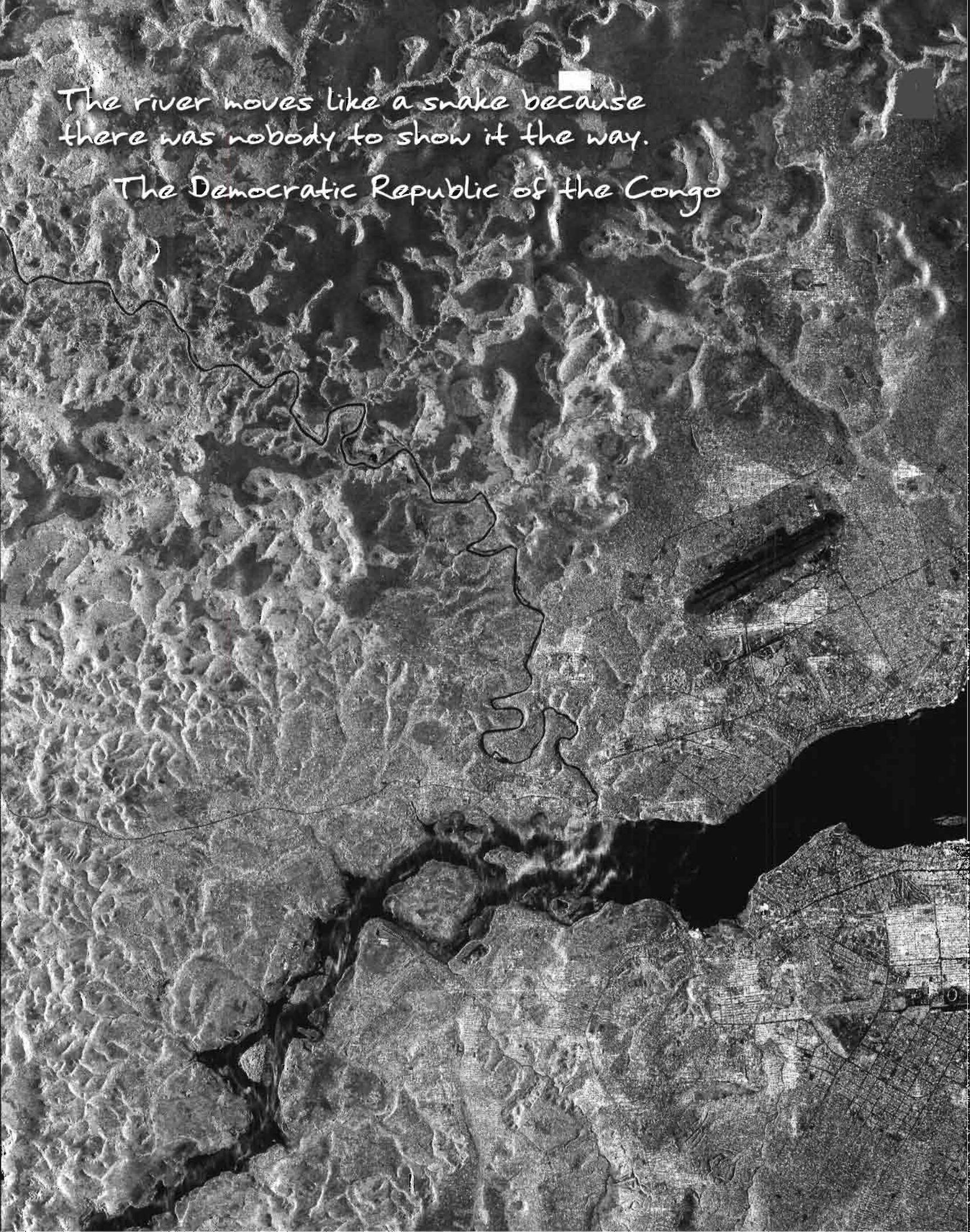
Rutendo Nhongonhema
Ministry of Agriculture
Harare, Zimbabwe

Data collection

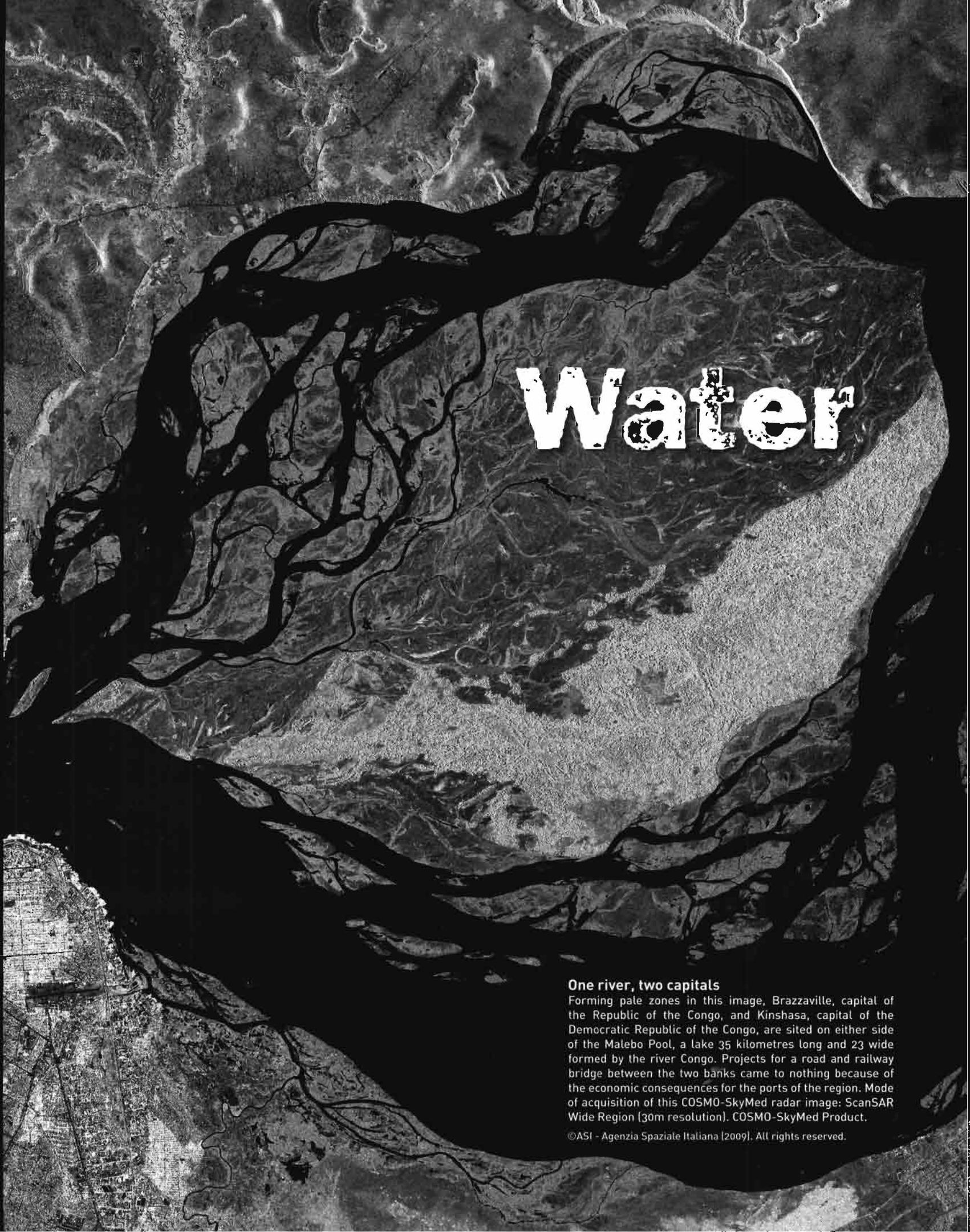
At the sign of a bad season, policy makers would want to know the situation in the whole country. The extension worker is asked to provide the data for example areas affected by mid season drought in a very short time. They have to walk across their whole area, sometimes 70km wide, in seven days asking farmers which area they planted is affected by drought. Now the AMESD station will help the Head Office in mapping indicative areas affected. Then the extension worker might walk the distance at her own time, collecting other data like cropped areas and yield estimation.

Sheilla Bauren
Extension specialist, AGRITEX
Harare, Zimbabwe




The river moves like a snake because
there was nobody to show it the way.
The Democratic Republic of the Congo

Water

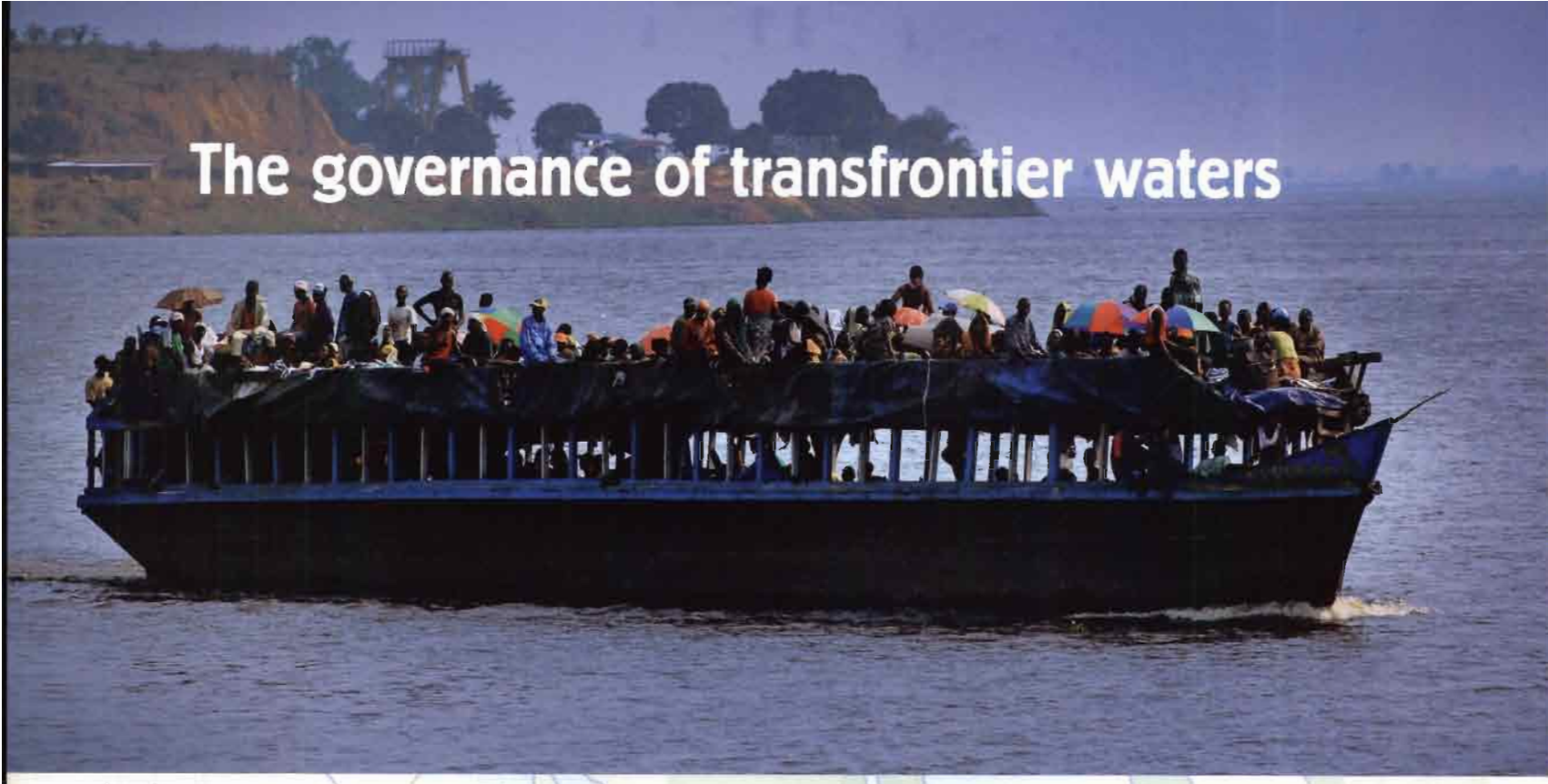


One river, two capitals

Forming pale zones in this image, Brazzaville, capital of the Republic of the Congo, and Kinshasa, capital of the Democratic Republic of the Congo, are sited on either side of the Malebo Pool, a lake 35 kilometres long and 23 wide formed by the river Congo. Projects for a road and railway bridge between the two banks came to nothing because of the economic consequences for the ports of the region. Mode of acquisition of this COSMO-SkyMed radar image: ScanSAR Wide Region (30m resolution). COSMO-SkyMed Product.

The power of water
A meandering stream in the Congo Basin. The Congo River is Africa's most powerful river in the world and the ninth longest (4700 km). During the rainy season over 50000 m^3/s of water flow into the Atlantic Ocean. Its sources are in the Highlands and mountains of the East African Rift, as well as Lake Tanganyika and Lake Mweru. Its flow is relatively stable because part of its watershed is always in the zone of rain. The Upper Congo abruptly ends with Stanley Falls, a 100 km stretch of rapids. The Congo River Basin has a very high species richness, and among the highest known concentrations of endemics.

The governance of transfrontier waters



▲ DRC is a vast country with little more than 480 km of paved road. So many people prefer to take boats, although they are often overloaded, resulting in accidents. Here at Maluku, about 80 miles from Kinshasa. Plans are being made for the rehabilitation and better navigability of the Congo River Basin. © J. Ladel

Reducing by half the number of people exposed to poverty, malnutrition and lack of access to clean drinking water forms part of the Millennium Objectives. In 2002, the Johannesburg summit added access to sanitation and the Evian G8 undertook to support NEPAD (New Partnership for Africa's Development), in which water is a major preoccupation. Finally, Africa has been recognised by the IPCC as being a continent that is particularly vulnerable in this respect. It is therefore essential that every African government should manage the impacts of climate change on water resources. In addition, the pollution of these resources is still a major problem that deserves particular attention. Our future depends on this, especially as the abundance of natural resources forms a very strong potential for development and regional economic growth.

The Congo River Basin features a vast trans-frontier catchment with an area of some 3 822 000 km². This is the second in the world as regards size and flow after the Amazon, making the region one of the major water resources in the world even though precipitation has decreased in the last three decades. The region houses 60% of the biodiversity of the whole of Africa. The protection of natural resources in central Africa, and especially water, is a major economic issue, especially for navigation, fisheries, agriculture, potable water supply, irrigation, hydroelectricity, etc. and contributes to mitigating climate change via the conservation and restoration of the second largest forest in the world after Amazonia. The ecosystems of central Africa form the basis for socioeconomic activities that are closely linked to the quality of these environments (natives of the forest of the 'Central Basin').

The main problem as regards the improvement of water resources is ensuring that development plans are in line with national strategies: for the reduction of poverty while improving capacity to manage the everyday challenges of climate variability; and to provide a long-term response to the impacts of climate change.

Promoting inland waterways

Establishing confidence and sharing our knowledge and approach to the catchment beyond frontiers is the foundation for the implementation of integrated water resource management in zones that are highly vulnerable and those with a risk of conflict. In 1999, the Heads of State of Cameroon, the Republic of the Congo, the Central African Republic and the Democratic Republic of the Congo set up the International Commission of the Congo - Oubangui - Sangha Basin (CICOS) with a mandate for the 'promotion of inland waterways'. In 2007, the CICOS mission was broadened to cover integrated water management and a strategic action plan was drawn up. The four CICOS member-states account for 83% of the drainage basin of the river Congo and Angola, an observer at CICOS since 2007, has 8%. The other countries with territory in the drainage basin are Zambia and Tanzania and, to a smaller extent, Burundi and Rwanda. Gabon has also joined CICOS as an effective member.

The hydroelectric potential of the Congo basin with regard to the power supply for central Africa and for the continent as a whole needs no further demonstration. Although it is an eminently profitable source of energy, the potential is very little exploited. Installed load is currently only 4 667 MW. The potential is estimated to be more than 150 000 MW with 100 000 MW in the Democratic Republic of the Congo alone. The Inga site has capacity of 44 000 MW but only 3% is installed. The proportion of the population supplied with electricity is small, especially in rural areas as far as the four CICOS member-states are concerned. At the regional scale of central Africa, electrification reaches 13% and consumption per person is still very low at 109 kWh per person.

Exploiting the potential depends directly on the hydraulic infrastructure that can be established in the Congo basin in the light of hydrological data. Knowledge of resources is the base of all water management: you can only manage what you know. Hydrological ▶

▶ data also form the basis for all planning, sizing and management of hydraulic infrastructure. The monitoring of water levels is particularly essential for water traffic, especially during low-water periods.

Only about 20 gauging stations are operational out of the hundreds that have been installed in the basin. This results in particular from the years of political instability and conflicts in the sub-region and the lack of maintenance by the national managers of the stations. The countries of the region are also experiencing difficulties in the gathering and dissemination of hydrological information as entry, processing and archiving systems are unsuitable or nonexistent. The other major difficulties concern technological inadequacies, especially in the telecommunications network, and weaknesses in regional cooperation with regard to the exchange of data.

The technical and scientific issues are considerable. In 2002, ESA launched the TIGER initiative to make a contribution to a recommendation of the World Summit on Sustainable Development. The aim was to help African countries to gather, analyse and disseminate geo-information on water using earth-observing technology. This compensates for the weakness of *in situ* data collection infrastructure, making close management of resources possible. TIGER could also provide a homogeneous overview of large regions, making it easier to integrate local information at the national level and at the transfrontier scale, including remote, inaccessible and somewhat unsafe zones.

Spatial altimetry data

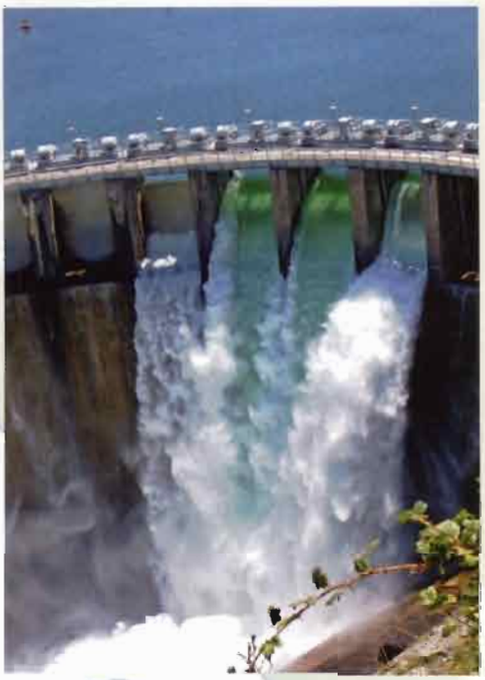
In addition to the TIGER initiative, the countries of central Africa participate in the AMESD programme via the water resources management theme. Two operational services can thus be developed by the CICOS, entrusted with the development of a low water warning system for river traffic on the Oubangui and the monitoring of the hydrological cycle of the Oubangui sub-basin and the water body in the forest in the 'Central Basin'. Implementation involves the use of spatial altimetry data from ENVISAT and JASON-2 missions through a collaboration with IRD and Brazil (ANA). Development of their use will first be focused on the Oubangui, one of the main tributaries of the river Congo whose vulnerability to climatic variability is the most marked of the basin. These operational services could be used by numerous players in inland waterways, the environment, development, planning and hydroelectricity.

Here, it is essential to establish large-scale hydraulic infrastructure while taking the downstream effects into account. Any development operation has interactive effects at different points in the basin, most of which is currently undeveloped. The various countries thus have the following duties:

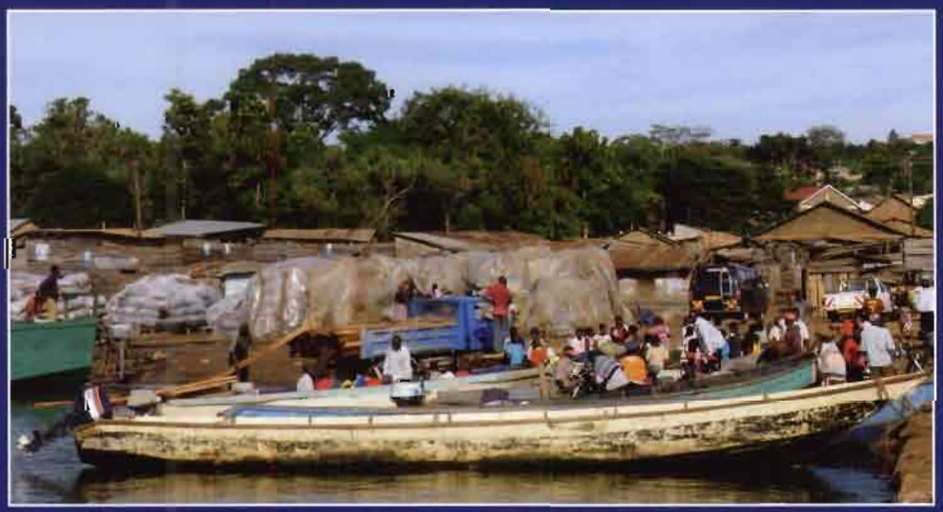
- optimising the choice of hydraulic equipments at the scale of the basin as a whole,
- assessing the cumulated impacts of these equipments, especially as regards transfrontier projects,
- taking into account the conceivable impacts of climate change.

Allowing for these constraints into account is essential in the use of our water resources.

Dr Georges Gulemvuga
Director of Water Resources
International Commission for Congo-Ubangui-Sangha Basin, Kinshasa/ Gombe
The Democratic Republic of the Congo



▲ The Inga Dams (DRC). Inga I and II operate at low output and there are plans for Inga III and Grand Inga. With only 3% of capacity installed, Inga dams are considered as "white elephants".



Water route prospects

The Congo basin has 25000 kilometres of navigable waterways. Within the framework of its spatial development, river navigation is a very dynamic component of the industrial transport of heavy loads and bulk goods in general. With the implementation of the sustainable growth and development approach to the Congo Basin-Atlantic Ocean corridor, the waterway route has great prospects, with the development of special economic zones, the enhancement of inter-bank and interregional trade and the free movement of goods and persons, forming true catalysts of sustainable development. Photo © Jean-Michel Cliteau/BRLi

Colonel Benjamin Ndala
The Republic of the Congo
Former General Secretary of CICOS

Devoted to water

▲ Public fountains were installed in rural Tunisia to bring water closer to families and lighten the workload of the women and girls. © FAO

CHAFIA TBINI, 25, volunteer in charge of a public fountain at Oued Sbaihya, Zaghouan (Tunisia)

I have devoted part of my life to water since I was a child. As a little girl, I went with my mother to fetch water from springs and from wells in the wadis. It was difficult and hard, especially in summer and winter. Today, I still go to fetch water with neighbours and cousins. Like me and my two sisters who are 10 and 14 years old, most of the girls in the douars (hamlets) leave school very early and look after flocks and fetch water. I was a teenager in 1994, and a fountain supplied by piping was installed not very far from our douar and I was very happy to see a fountain for the first time. The project was to serve 450 families distributed along several douars in Oued Sbaihya. In all, 34 public fountains were installed to bring water closer to families and lighten the workload of the women and girls.

Our potable water network has run into difficulties since it was installed:

- Because of technical problems, water has never reached 4 fountains and 60 families continue to fetch water from distant fountains, wells, etc. under very difficult conditions;
- The price of water per cubic metre at the public fountain reached 2 dinars (DT, about Euro 1,1) in 2009 in comparison with DT 0,174 in SONEDE network (see opposite) for the welfare category;
- Technical and especially management problems caused repeated and often long supply cuts throughout the network; the worst one lasted from 2004 to 2009. We had to buy water from bowsers (DT 5 to 7 per cubic metre) or get supplies as we had done in the past;
- In August 2010, the Groupement de Développement Agricole (GDA) of Oued Sbaihya was attributed the management of the network and rehabilitated part of it with the help of the technical department. The price per cubic metre was lowered by 25%. However, the 60 families in the upstream part still have no water.
- The GDA has made families responsible for managing the fountains. The volunteers total 22 men and 8 women. I manage the one for our douar. I have the key and, at a time agreed to with my neighbours, I sell them the water at the price set by the GDA per can, or more rarely per tank. The GDA manager does a round of the fountains to collect the money on the basis of the meter reading. However, for lack of means of transport, he does not come very often and the electricity bill (for pumping) is not paid in time. The Société Tunisienne d'Electricité et de Gaz then cuts the electricity supply and this results in cuts in water supply. In spite of our involvement as unpaid volunteers, we always come up against the same problems.

With Noureddine Nasr
Programme Officer, FAO
Tunisia

▲ Islamic engineers transmitted the piston pump technique to Renaissance engineers in Europe. Islamic Museum, Sharjah (UAE).
© J-D Dallet/Suds-Concepts

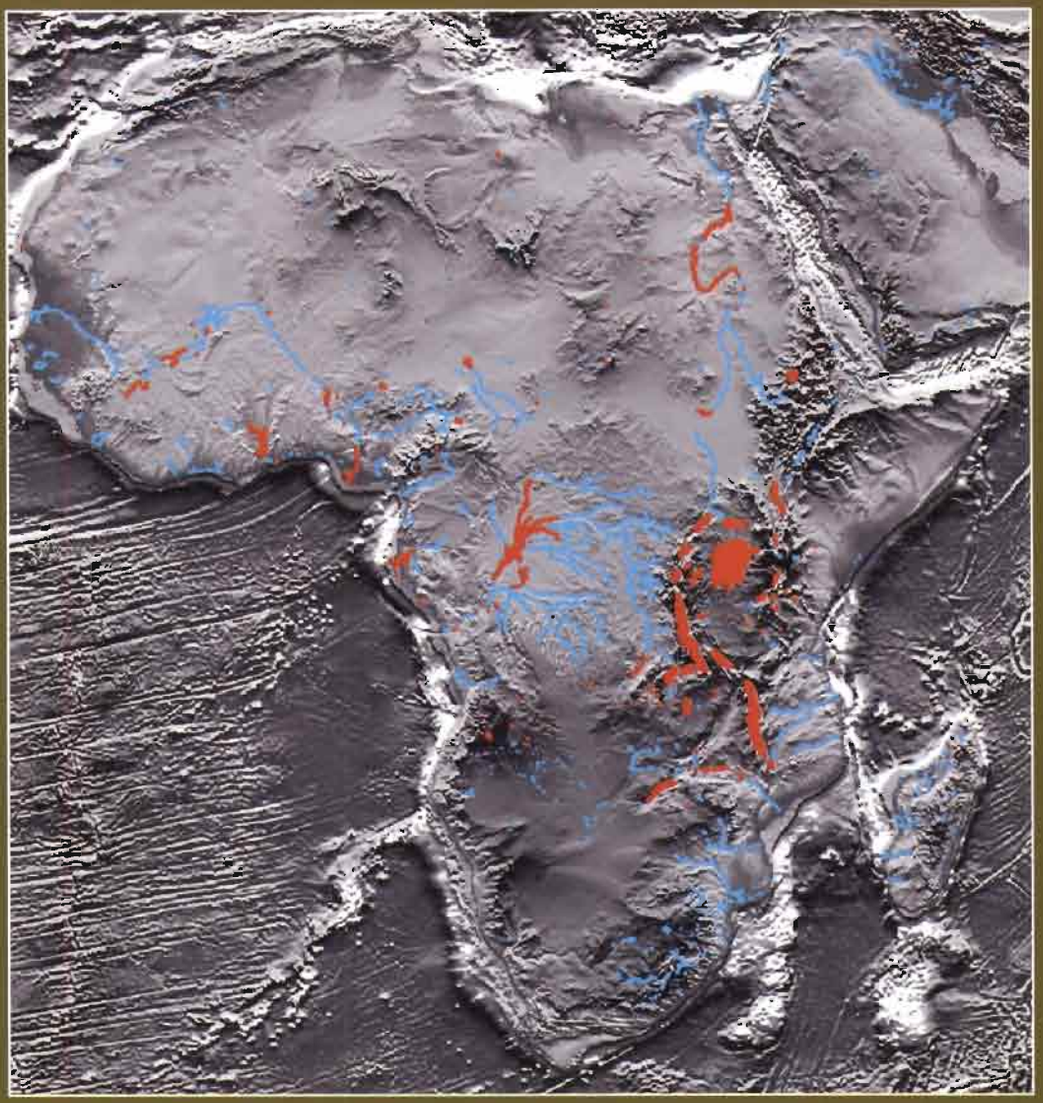
Water a right for all

Potable water has played a central role in Tunisian towns since antiquity, for reasons of hygiene during the Punic and Roman period and then for spiritual reasons with the Muslim civilisation. Today although Tunisia has attained the Millennium Development Goals as regards potable water—supply is complete in urban areas and exceeds 90% in rural areas—there are still disparities between town and country. Voices are being raised in a revolutionary Tunisia to put an end to them.

The potable water policy was supported by a strong social undertaking by the government after Independence: 'national solidarity'. The SONEDE (Société Nationale d'Exploitation et de Distribution des Eaux) was set up in 1968 and was to apply an equalisation system that should make it possible to supply water to all citizens at the same price. But people who live in dispersed rural areas – generally very poor – are not connected to SONEDE networks. They are penalised by prices higher than those in towns (see opposite) and sanitary risks remain high.

At a time when a new Constitution is taking shape, a citizens' initiative is calling for this right to be guaranteed for a dignified life. Water must be part of the national heritage and every citizen must protect it and pass it on to future generations. Its management must be subject to democratic control, obliging the government to guarantee this right of access, both physical and economic, for all Tunisians.

Sarra Touzi
Programme Officer, GWP-Med
Tunisia



Africa's rivers and lakes

The River and Lake system implemented by De Montfort University (UK) has been put live over Africa (top image). It delivers accurate height data over major lakes and rivers on the African continent within a few days of data collection by the ESA Envisat RA-2 Radar Altimeter. Red indicates area where such products are currently generated, and blue where products may be generated in the future. Managed by LEGOS France (CNES/CNRS/IRD/UPS), the Hydroweb database provides similar temporal series of water heights on large rivers and lakes.

Bottom left: Envisat/MERIS image acquired in 2010 featuring Lake Malawi. Situated in the Eastern Rift of the Great Rift Valley it is the third largest lake in Africa and one of the world's few ancient lakes. On the eastern shore are Tanzania (north) and Mozambique (south); South West, Mozambique and, North West, Zambia.

Bottom right: the Niger delta. Envisat/MERIS image taken in 2007 showing the lower Niger River system in the West African country of Nigeria. The Niger River (left) and the Benue River (centre image) merge.

Mosi-oa-Tunya

Situated in between Zambia and Zimbabwe, the Victoria Falls are one of the most spectacular natural wonders of the world. Local people call it *Mosi-oa-Tunya*, 'the smoke that thunders'. They are 1708 m wide, making it the largest curtain of water in the world. It drops between 90m and 107m into the Zambezi Gorge and an average of 550 000 m^3 of water plummet over the edge every minute. People can swim in the Devil's Pool, right on to the edge of the falls (top right). The falls and the surrounding area have been declared National Parks and a World Heritage Site.

Ngondo, the festival of water peoples

▲ The 2006 Ngondo ceremony. The diver and his assistants prepare to set out in a pirogue to seek the sacred vase. In the background, pirogues of oarsmen go to Wouri bridge for the start of the traditional race. © Steven Le Vourc'h

At the end of November each year, Douala vibrates to the rhythm of the Ngondo, the great cultural festival of the Sawa. For two weeks, these Cameroonian coastal peoples celebrate the cult of water on the banks of the Wouri. The place has links with Cameroon's colonial history as this was where the Portuguese navigator Fernando Póo landed in 1472. Amazed by the abundance of prawns, he gave the name of Rio dos Camarões ('Prawn River' in Portuguese) to the river that later gave its name to the country.

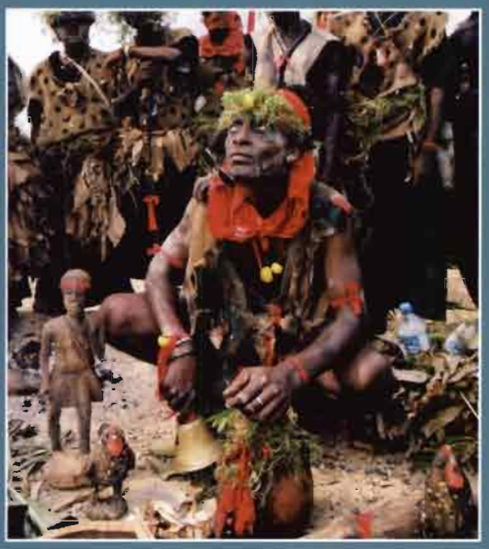
Some thirty coastal and south-western ethnic groups participate in this festival grouping the Sawa, Tondé, Jébalé, Ewodi, Bakoko and Bassa peoples and others. It has three main parts: the immersion of the sacred vase, the election of Miss Ngondo and a pirogue race.

Deep symbols

The immersion of the sacred vase starts with an assembly very early in the morning on the last day of the festival. Dignitaries in ceremonial dress come to the river accompanied by their staffs and followed by a dense crowd of people. Initiates on a pirogue look for a secret passage for the immersion of the sacred vase. An emissary goes into the Wouri with the vase to seek messages sent by the water divinities, the 'Myengu' (sirens). Once they have been brought to the surface, they are interpreted by the ancients who meet in the sacred hut. Tradition has it that the 'Myengu' protect their people and help them to carry out their instructions that are sources of blessings: strength, wisdom, prosperity, fertility, good fishing, good harvests, fraternity and love of one another, peace in households and throughout the country. This immersion of the sacred vase is the mystic aspect of the ceremony and the occasion for this people to communicate with their ancestors.

The spectacular and very popular final event of the Ngondo is the race between giant pirogues that can be crewed by up to 70 paddlers. It is watched by thousands of supporters gathered on the banks of the Wouri. It also has a mystic connotation

▲ The pirogue race, a high point of the Ngondo ceremony. In addition to being spectacular, it also has a mystical aspect. © Sébastien Cailleux



▲ The Ngondo (the initiates above) shows the determination of the Sawa peoples to use their cultural heritage and the aquatic environment of the coast of Cameroon, both of which deserve to be protected. © Sébastien Cailleux

related to the water divinities. After these events that honour Sawa culture, the spectators watch the finals of the traditional wrestling competition and the crowning of Miss Ngondo or Ntolè. Elected the previous day, her main task is that of helping to educate young Sawa girls.

The interests of coastal people

Although today the Ngondo is considered to be the Sawa cultural festival, little is known about its origins. It probably started around 1830, that is to say before the first missionaries arrived in Douala in 1843. Initially, the ceremony was held at the confluence of the river that gave it its name and the river Bessekè, the former seat of the Ngondo. It was aimed at defending the economic interests of the coastal peoples who could not stand up to their invaders on an individual basis. The Ngondo also functioned as a court to settle internal conflicts.

The holding of the Ngondo has experienced various disturbances. The German colonial administration was concerned about its prerogatives and suspended it in the 1920s. It only started again in 1949, with several changes, under the French colonial administration and in 1954 its representatives defended the autonomy of Cameroon at the United Nations. TheNgondo was forbidden again in the 1970s and then re-established in 1982 on the arrival of President Paul Biya. The content evolves and the themes change each year: 'Nguinya Mulema' (The power of courage) in 2009, 'Titimbe' (Perseverance) in 2010 and 'Musango' (Peace) in 2011. The Ngondo is thus not outside national realities.

The Sawa people wish to reconcile tradition and modernity by adapting the Ngondo to the changes of our times. The 2010 event thus included trade fairs, cultural events, lectures and debates and sports events (traditional wrestling). There was even a carnival. Organised in the streets of the economic capital of Cameroon as a fringe event, the procession was appreciated by Cameroonians and foreigners.

Hervé Villard Njiélé
Cameroon

Water quality survey

▲ The coastal lake of Manzalah. The largest delta lake in Egypt has been undergoing continuous and pronounced changes since long times. Image taken by EgyptSat-1 in 2009. © National Authority for Remote Sensing and Space Sciences (NARSS), Egypt.

Governments all over the world pay more and more attention to water resources because these either become increasingly scarce or they are a threat due to flooding. At the same time there is a growing awareness that the quality of water resources should be protected. Water of good quality and without risks for public health is nowadays considered to be a major asset.

In Egypt, being an arid country with hardly any rainfall, water management is of particular importance. Without a proper management, water will become a constraining factor in the socio-economic development of the country.

Egypt's Northern lakes support substantial fisheries and aquaculture activities are deeply concerned. The water quality is affected by agricultural drainage water, containing salts, nutrients, pesticides, herbicides, and industrial and municipal effluents from all towns and villages that drain either directly or indirectly into the lakes. In response to the increase in nutrients loading and fresh water inputs, the fish community in Lake Manzalah has been transferred from a brackish (mixed species) to a fresh water (Tilapia) dominated fishery.

In 2005, the project 'Satellite Monitoring of Lake Water Quality in Egypt' was funded under the international TIGER initiative with the objective to design, develop and implement an Earth Observation (EO)-based capacity for the operational monitoring of water quality in Lake Manzalah.

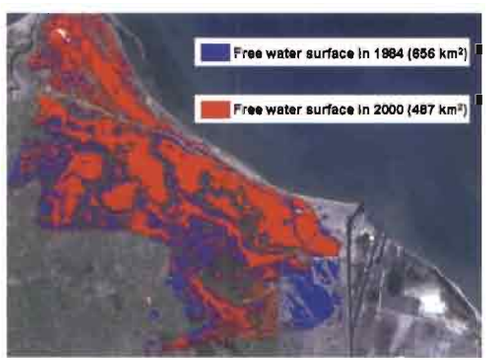
Adequate water management

The procedures currently in place rely on the collection of in-situ measurements at drainage channels leading into the lake once per month. However, this field-based approach does not adequately capture the spatial and temporal variability of water quality parameters in the highly dynamic lake ecosystems.

Key to the formulation of adequate water management scenarios is accurate and reliable information on the occurrence and distribution of water quality indicators, such as turbidity, algal blooms or areas infested with invasive plant species.

In particular, water quality information is required to answer the following questions:

- Where does the pollution come from? Which areas are affected by it?
- What actions can be taken to mitigate the problem (e.g., allocation of buffer zones)?
- What is the status of the problem (increase, decrease, no change)?
- To what degree has an improvement occurred?



▲ Impact of land reclamation on Lake Manzalah. Data map courtesy of Akram M. Elganzori.

Incorporating EO-derived information into the existing water quality monitoring program is expected to have a positive impact on the management and sustainable use of water resources in Egypt in the long term by providing a consistent, accurate record of the spatial and temporal variability of critical water quality parameters.

In-situ observations are provided by real-time water quality (RTWQ)

▲ Fish is a traditional and important component of the Egyptian diet, and is the main source of cheap animal protein for a growing population. Here at Luxor West Bank.
© J-D Dallet/Suds-Concepts

probes for the following parameters: specific conductance, standard pH, turbidity, luminescent dissolved oxygen, chlorophyll, total dissolved solids, temperature and water level and an associated field sampling program, while satellite observations include MERIS (primary data source) and MODIS (secondary data source) imagery. The earth observation data are acquired concurrently with field observations with support of ESA.

The project improved the existing lake water monitoring service by allowing the generation of quantitative water quality products (TUR – Turbidity –, TDS – Total Dissolved Salts, and CHL – Chlorophyll-a). In addition, the frequency of coverage maximized by using each available image acquired over the area of interest (for water constituent products only). In addition to obtaining accurate information about the spatial variation of critical water quality parameters in the lake, the continuous measurements of RTWQ stations in Lake Manzalah provided important information for water resources managers at a very high temporal resolution. RTWQ measurements were much more efficient than conventional in-situ measurements, while EO-derived products added the spatial dimension, which cannot be realized by other means.

Finally, by establishing relationships between EO signatures and the primary water quality parameters already mentioned, the potential exist to extend this capacity to secondary parameters like nutrients and Dissolved Oxygen that cannot be observed directly via EO, but that could be mapped via existing relationships with primary parameters.

People need information

As people who live in the islands around the lake (50000 inhabitants) need information about fishing and cultivation of the land, the project provided the water quality data to them directly to use. 'The MERIS images give us a picture of the whole area. Without this, we only have information on the water outlets', Official said, adding: 'If we stop the project here, then this would only be considered research work'.

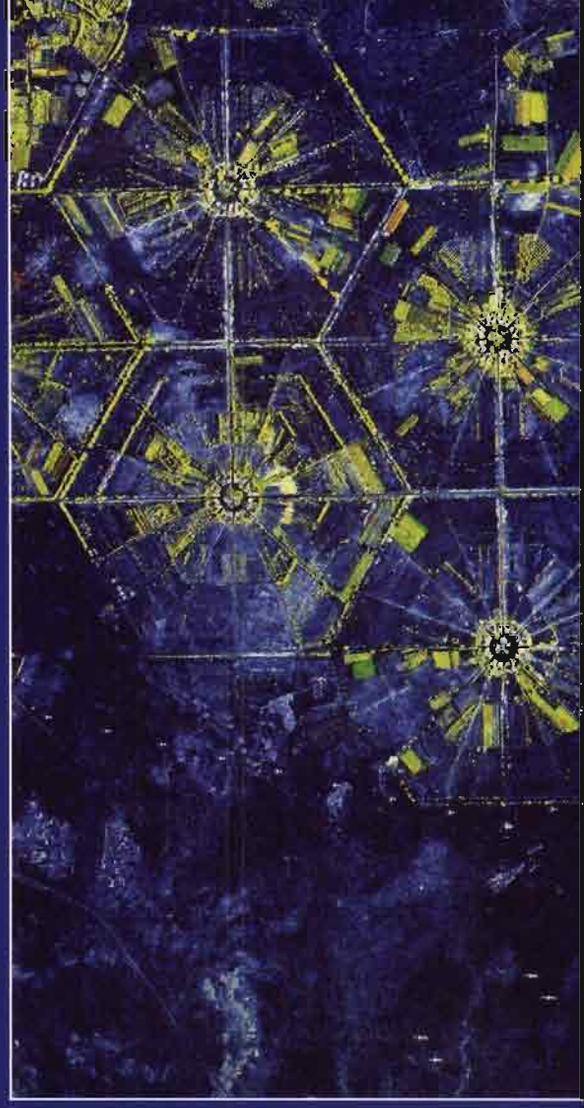
So, to implement operationally, the project worked to keep all who could potentially benefit informed of results and data available. A Memorandum of Understanding was signed to monthly sharing the data between the National Water Research Center, the project host, and the Fishery Development Authority to disseminate the available data and exchange views about the actions needed. 'The system maintenance and continual improvement is representing the future challenge for the project staff', project coordinator stated.

▲ Paddling funeral boat, tomb of pharao Meketre, western Thebes.
© R. Clavaud/Suds-Concepts

Pr Akram Mohamed Elganzori
Director Strategic Research Unit
National Water Research Center
Ministry of Water Resources and Irrigation
Cairo, Egypt

Preserving the oases

▲ Oases are a model relationship through which, under the hardest living conditions, vital life cycles and self- sustained ecosystems are created. Here in the valley of the Drâa, Morocco's longest river (1100 km).
© J.D Dallet/Suds-Concepts



With regard to bioclimatology, the Moroccan oasis zone at the edge of the Sahara is a semi-arid area where precipitation is very irregular from one year to the next (frequently less than 200 mm per year) and that has a markedly continental character. This situation gives it particular physical characteristics: poor soils and arid climate, strong Saharan influences with wind erosion, sandstorms, drought, desertification and inadequate water resources because ground-water is limited and evaporation intense.

The situation of the oases in southern Morocco is worrying today. It prefigures an acceleration of the effects of desertification and climate changes with the degradation and finally the abandoning of entire oases whose social, ecological and economic roles are of great importance for regional balance, in particular as their vegetation and microclimates form a natural barrier against the spread of the desert.

This serious deterioration of the oasis heritage has been in progress for a number of years as a result of the highly irrational exploitation of water resources. At a time when water resources are dwindling naturally as a result of the drought cycle, increasing demands are made on them by strongly growing populations and totally unsuitable cultural practices.

This major oasis problem is conditioned upstream by hydro-agricultural systems whose sustainability is now in danger. The gradual disappearance of favourable conditions for farming in oases has caused a gradual decrease in the incomes of a whole section of the population. It has had an impact on their way of life, causing pauperisation that has now become a real problem for most of the southernmost oasis societies.

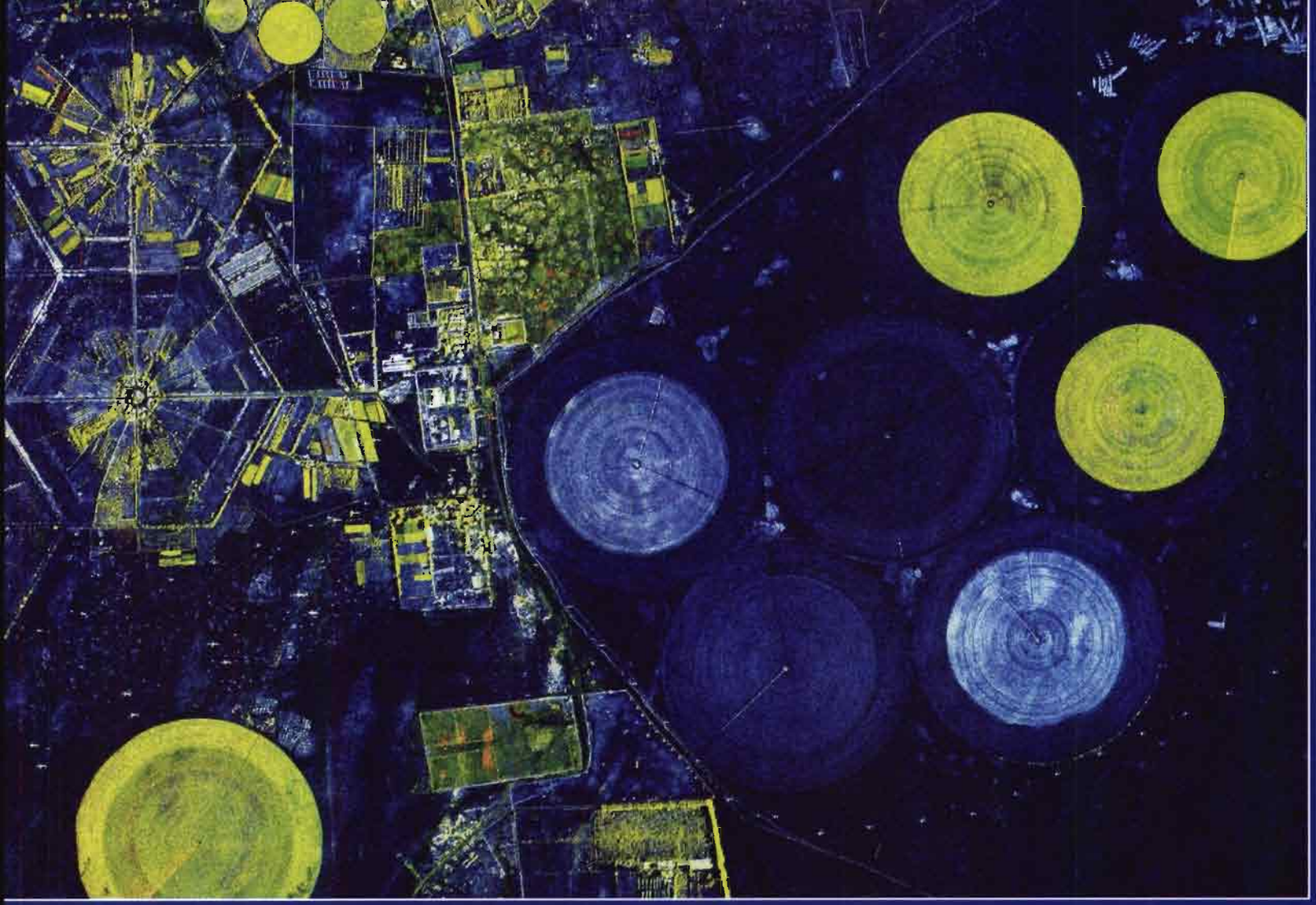
In Morocco for example, hundreds of thousands of families are now concerned and unfortunately the trend is becoming more marked. The situation has been aggravated by a migration movement whose financial remittances are generally the only income of the remaining population.

The Kingdom of Morocco has conducted in-depth studies on oases within the framework of the Planning and Development Strategy of the Oases of Morocco. This was launched by the *Direction de l'Aménagement du Territoire* (Town and Country Planning Authority) that is handling in particular the execution of the Programme Oasis Tafilalet (POT) in partnership with UNDP. In this context, the twin task of producing a book on the oases and establishing an ecomuseum in the Talafet (south-east Morocco) was entrusted to IPOGEA, Research Centre on Traditional and Local Knowledge.

Underground intake galleries (*khettara*) that supplied the oases with water were identified, thanks to satellite mapping. Traditional water and resource management techniques were also classified using a computerised iconographic system (SITTI) developed for UNESCO. These tunnels are difficult to identify in the vast expanse of desert but are clearly visible on satellite maps thanks to the shafts dug to ventilate them. This system can be used to identify former oasis establishments and/or bring them back to life by restoring the galleries.

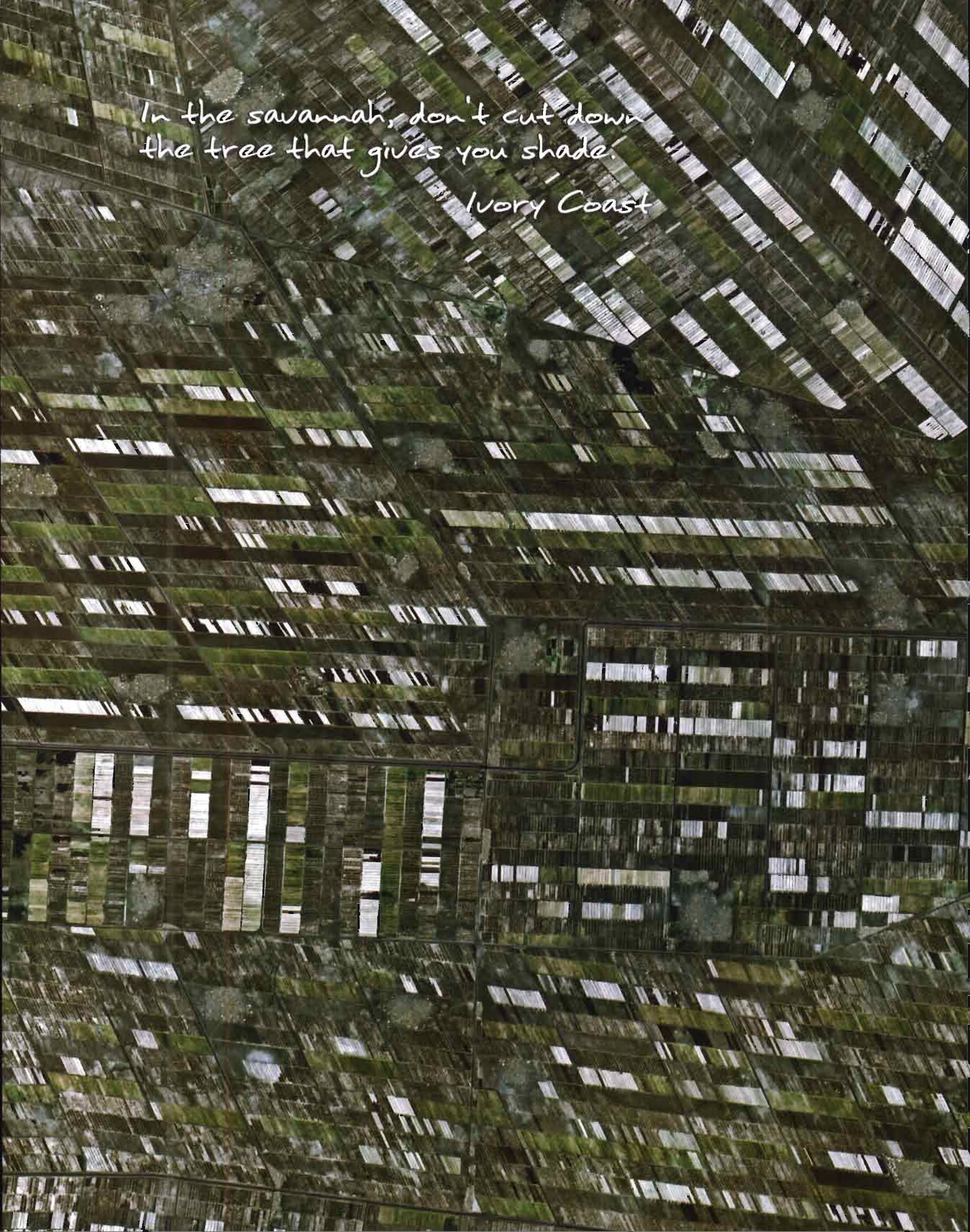
The oases are witnesses of human ingenuity in resource management in arid zones and form an example of sustainable development for the entire planet. This is why we are launching a world-wide appeal and propose an alliance among Arab countries aimed at protecting them.

Amine Ahlafi
Architect and local expert consultant
IPOGEA Morocco



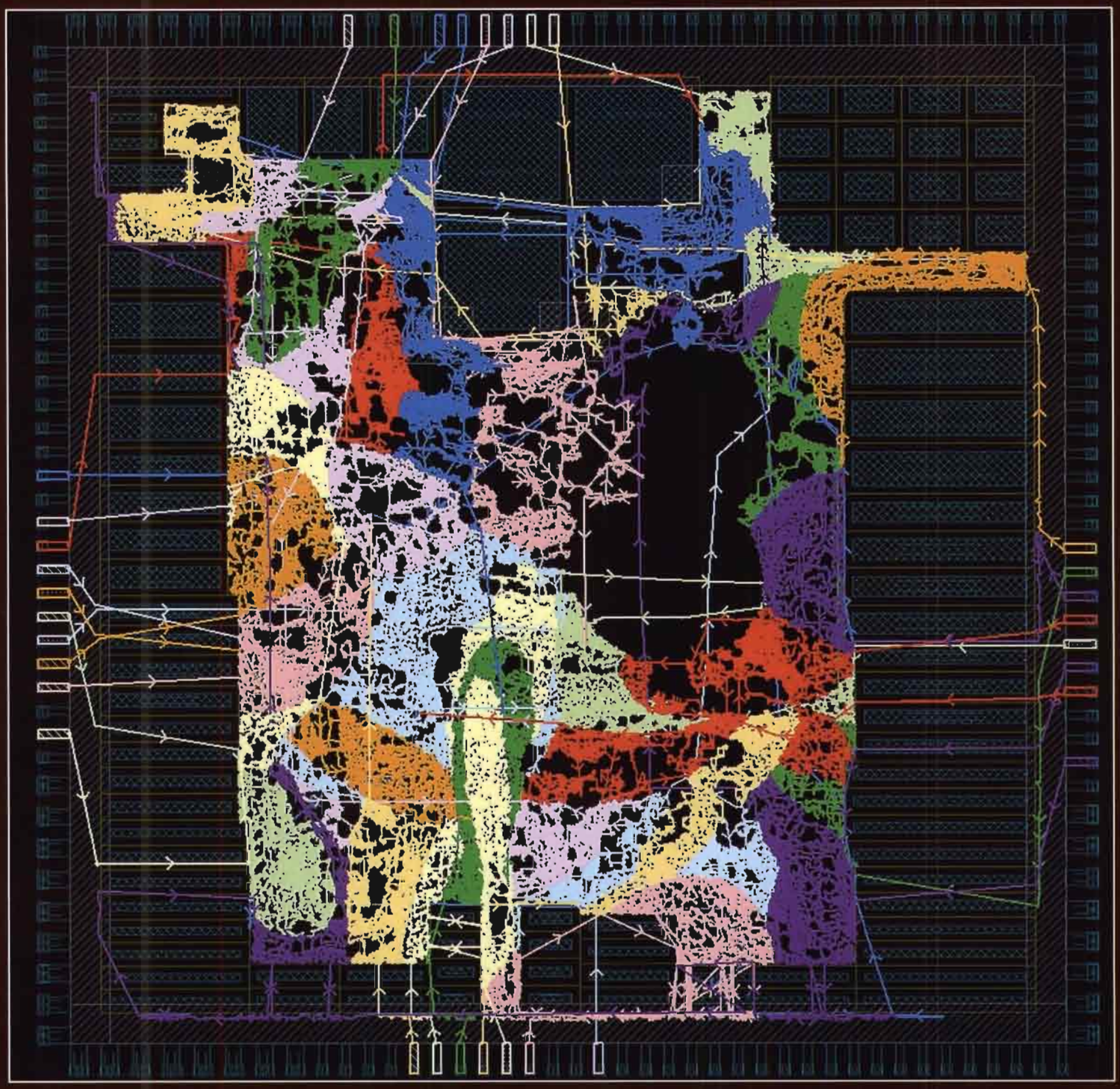
▲ Kufra oasis in south-eastern Libya. The hexagonal cultivation pattern, typical of this area, allows a better spatial distribution and prevents water loss.
COSMO-SkyMed © ASI processed and distributed by e-GEO

▲ The Water master of an Algerian oasis presents its hallafa. From the position of this perforated copper plate in the clay, he determines the flow rate by blocking more or less the passage of water to varying degrees.
© Pietro Laureano. For more information on oasis management, refer to 'Planète Oasis' printed by Pietro Laureano


In the savannah, don't cut down
the tree that gives you shade.
Ivory Coast

Soils

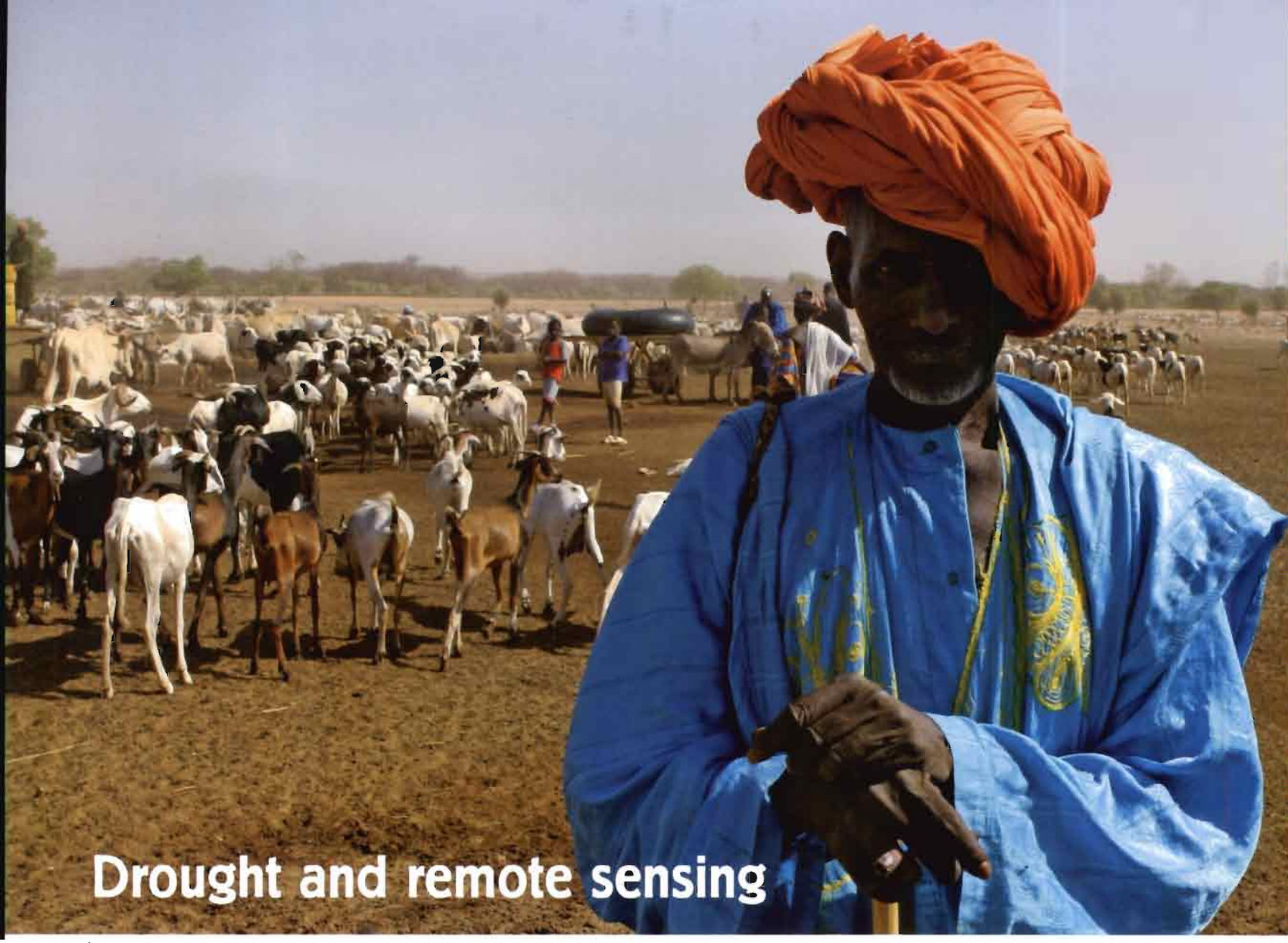
Conserving soils for sustainable agriculture
Wad Madani irrigated fields. The capital of Al Jazirah state in eastern central Sudan lies on the west bank of the Blue Nile. It is the centre of a cotton-growing region and of local trade in wheat, peanuts, barley, and livestock. The headquarters of the Agricultural Research Corporation are located here. This national institution is in charge of research in irrigated agriculture and high-yielding cereal varieties. It also aims at managing and conserving the country's soil and water resources for sustainable and productive agriculture. Image acquired by SPOT satellite in 2006.



Confidential data

Electronic components have ever more functions. Their layout resembles a maze. Here, the layout of an integrated circuit similar to that of the decoder card equipping a SPOT5 receiving station. In particular, the card ensures that the data is confidential. SPOT satellites transmit images to receiving stations scattered in Africa and around the rest of the world. The data are decoded there using this type of card to ensure that access is reserved to those that ordered the images.

Thales Alenia Space © Etienne Liégeon



Drought and remote sensing

▲ Lumbol Samba Abdoul village, Senegal. Cattle graze near a watering spot installed thanks to a development project (co-financed by IFAD, 2002). Private operators are now developing similar programmes for production and seeking to intensify the network of horticultural producers and their capacity in marketing
© IFAD/Susan Beccio

Recurrent drought during the last 30 years has had a disastrous effect on an already very difficult economic and social situation. The determining and early locating of these anomalies make it possible to set up mitigating measures. As regards ecology, Senegal is part of the Sahel zone where most of the population has economic dependence on crop farming and livestock. However, rainfall in this zone displays considerable variability in space and time and this can penalise crops and grazing.

The *Centre de Suivi Écologique* (CSE, Ecological Monitoring Centre) in Dakar has set up a system based on the use of modern technologies such as remote sensing and geographic information systems to identify the location of the zones affected by drought. From the beginning of May to the end of October, a multidisciplinary working group with participation of the CSE meets every 10 days and relays information in the form of illustrated bulletins to decision makers, ministries and farmers' organisations. Previously sent by post, they are now distributed by e-mail.

Analysing and monitoring

The system is hinged on the following components:

- analysis of the crop installation phase (millet, groundnut) using a model based on rainfall estimation images calculated using Meteosat data (May to August). This is one of the periods most susceptible to drought. Farmers often wonder whether their first sowings have any chance of success. They are provided with forecasts by zone. If the forecasts are poor, sowing will have to be repeated and we can then suggest alternatives with suitable seed varieties;
- analysis of the precipitations evolution (data provided by the *Agence Nationale de la Météorologie* of Senegal) to determine rainfall deficits and surpluses and to assess the impact on crops and grazing land (May to October);
- vegetation growth monitoring (May to October), based on the Vegetation Conditions Index (VCI) calculated from SPOT VEGETATION data obtained thanks to a partnership between CSE and VITO (figure next page). This makes it possible to measure and identify the zones in which the vegetation and hence crops display signs of stress;
- analysis of the grazing conditions around the main water points in the pastoral zone of Senegal using satellite images and ground measurement operations to determine pasture production and to guide flock and herd movements (August to December). One of the major outputs at this level is the ▶

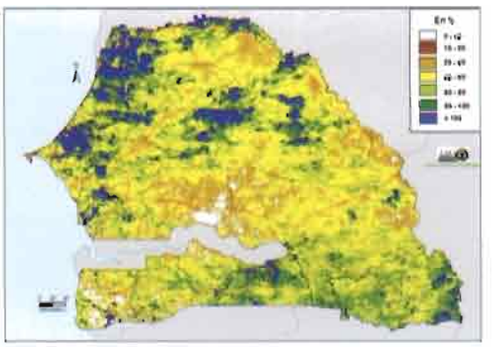
▲ This villager's vegetable crop at Mopti (Mali) depends on the amount of water in the river Bani.
© Céline Villalard 2003

▶ plant production map quantifying available biomass. Its immediate use is the guiding of transhumance to zones where forage is available.

At the halfway point and at the end of the rainy season, environmental watch bulletins on 'Monitoring of agricultural and pastoral zones in Senegal using remote sensing and geographic information systems' are published for partners of the CSE, of the Multidisciplinary Group that monitors the agricultural season, national decision makers and development partners. The work of the CSE is thus completely integrated in the national system for agricultural and pastoral monitoring and serves to support the work of development projects operating in this field. This context ensures the information input in the decision process and feedback from those who receive it.

Combining satellite and field data makes it possible to identify drought four to six weeks earlier than before and describe it more accurately; to this must be added the possibility of assessing the impact on agriculture well before the harvest in order to facilitate decisions concerning food security. The advantages of satellite data for drought assessment lie in certain intrinsic features of remote sensing: a synoptic view of a large zone at various scales, continuous archiving allowing retrospective studies and comparison with the present situation, good data reception frequency and often at a reasonable cost.

One of the issues for the future is the continued supply of this information, that



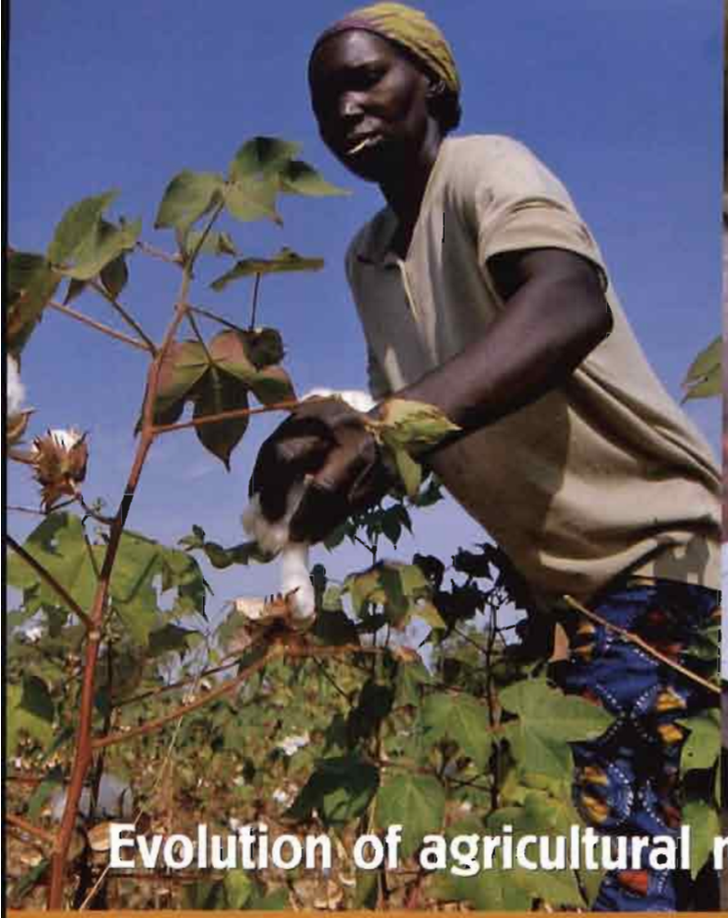
▲ Vegetation Condition Index for the second 10 days of July 2011. Data Map J-A Ndione. Courtesy of the VEGETATION programme, produced by VITO.

is to say continuing observations. Thus institutions like the CSE must continue to ensure the long-term viability of projects. The main challenge is that of being able at the end of the project to incorporate the achievements in the regular environmental monitoring activities performed by institutions. Decision makers must therefore understand this necessity. This is a battle to be won but we remain optimistic.

Appropriation by communities

We should not forget that we are working for the good of the populations and so the human aspect is very important. Attention must therefore be paid in this problematics to the integration of local and endogenous knowledge. First of all the right questions must be asked. What is the value-added of what we propose in comparison with what farmers know? What is its social usefulness? How is it perceived by the population? Finally, we must be aware that we do not use the same reasoning and thus abandon our 'laboratory language' for that of experienced reality to provide better information. Appropriation of our output by these communities is essential. As an example, mention can be made of the NICT project entitled 'Use of NICT in the temporal monitoring of transhumant cattle by basic communities for the sustainable management of Sahel pastoral resources' with the participation of Fulani herders in the development of outputs, and especially maps in their language. This is a fine example of the appropriation of tools. These issues must be integrated in the everyday experience of populations in order to succeed the advent of sustainable development.

Dr Jacques-André Ndione,
Dr Abdoulaye Faye et M. Gora Beye
Centre de Suivi Ecologique
Dakar, Sénégal



▲ Cotton is the main source of foreign currency for Mali and Burkina Faso (here near Ouagadougou).
© Joerg Boethling/agenda

▲ Maps are used by scientists to show the situation of fields around Kebila in the Sikasso Region of southern Mali.
© Mamy Soumaré

Evolution of agricultural methods

Increasing agricultural production in Sudano-Sahelian Africa is achieved mainly by increasing cultivated areas. However, demographic growth is 3% per year, with a doubling of the population every 20 years, and one can wonder if land resources will be sufficient to meet demand for food. Cotton growing developed in Mali, as elsewhere in West Africa, forming a true agricultural revolution. Total cultivated area increased from 60 000 to 600 000 hectares, production from 40 000 to 600 000 tonnes and the number of draught oxen from 100 000 to 600 000 in 30 years. This leap in quality enabled farmers to develop a new farming system for their land.

Cultivated land and fallow

Fallow was gradually abandoned and the age of fields under continuous cultivation increased. This was seen by combining satellite images, maps as reported by stakeholders and the geographical positions of the fields of 15 farmers chosen according to the diversity of their practices. All the fields cultivated in 1985 still are whereas cultivation rarely exceeded 5 years in the old system. Aerial photos and satellite images can be used not only to reconstruct the history of land occupation but also to show the present situation. Farmers identify the main domains—cultivated land and fallow—from a simple coloured composition on the green, blue and red channels. This pilot work is to continue during the next three years within the framework of the *Programme d'Appui aux Systèmes d'Exploitation en Zone Cotonnières du Mali* (PASE2, 'Support Programme for Farming Systems in the Cotton Belt in Mali') under the direction of the Chamber of Agriculture and with support from *Agence Française pour le Développement* (AFD, French Development Agency).

The elimination of fallow reduces the frequency of land clearance and slash-and-burn. The halting of bush fires, which are the main source of CO_2 emission in African agriculture contributes to improving the carbon balance. Transfer of matter results in an increase of the fertility of cultivated soils whereas it falls when crops and fallow are alternated. The viability of such a system depends on the presence of sufficient head of livestock to ensure transfer of fertility and also that of pasture to feed the animals. Farmers must improve the productivity of the pasture to ensure the sustainability of the system, but this is a problem in zones with high population density as in the old Mali cotton belt.

Prospects for action

The involvement of stakeholders in the production of maps makes it possible to compare the viewpoints of technicians and users. There are numerous constraints: the languages used are different and stakeholders tend to censor their expression and align their viewpoint with that of dominant thinking: the slogans uttered by politicians and by certain development bodies. However, the knowledge produced jointly helps the user in his work and enriches the analysis made by the researcher.

Developing new methods

Technicians must use tact and pedagogic skills. In participative diagnosis, stakeholders said that shortage of land was a major difficulty in a context where the ratio of cultivated to non-cultivated land is 1:3 or even 1:5 and that fields can be further enlarged. How is it possible to make them understand that this constraint is not a valid one in their context? This is all the more delicate as people's word is strongly significant, and there is above all a practically religious obligation for young people to respect their elders.

The data will be updated in five places in Mali using SPOT5 images collected in 2007. The changes observed will be used for forecasting and for developing new methods for managing areas. Based on this study, management plans will be developed, incorporating biomass flows between the various components and grouped rotations. All that on the basis of successful discussion between all the stakeholders.

Dr Mamy Soumaré,
University of Bamako
Mali

Mineral resources mapping

The sustainable exploitation and use of Africa's vast mineral resources (copper, cobalt, nickel, gold and diamonds) is a key issue, not only for development of the continent, but also for the world's future. In Zambia, it has been contributing between 60 and 90% of total national foreign exchange earnings for over 70 years. With about 2 billion tonnes of reserves of copper ores, the large-scale mining sites on the Zambian Copperbelt and North-western Province mines provide formal employment for over 35 000 people. The sector generates between 9 and 15% of the Gross Domestic Product (GDP). But due to the declining of ore reserves and of average grades, increasing mine depth, lack of new discoveries and of reinvestment, copper production and earnings declined from the peak of 755 193 tonnes in 1969 to about 250 000 in 2000. Since 1991, the Government has embarked on liberalising the economy so as to move towards a sustainable balance of payments position. The ultimate goal is reducing the incidence of poverty and uplifting the living standard of all Zambians.

The need for good geological data

Driven by world copper demand leading to high prices and increased production estimated to be over 1 megatonne by 2012, reserves are declining. Zambia should therefore attract investments to search for more copper ore, its sustainable exploitation and more importantly in downstream value addition. The country needs improved infrastructure and services to support investment, good geological data and up-to-date geology. The 45% of the country not geologically mapped is not within existing infrastructure and services such as those along the railway line. The potential for discovery of new deposits is higher in the inaccessible areas and therefore use of satellite data is a must.

For this reason the Geology Department in School of Mines at the University of Zambia is participating in the EU-funded African-European Georesources Observation System (AEGOS) project involving 23 African-European partners. It will provide up to-date information for all planners in order to make meaningful mineral exploitation investments. Being a first project of its kind, African representation is of 10 partners but this is expected to rise once the countries see the benefits of the project. In this regard, the Universities of Zambia and Lubumbashi are developing a project on 'Mineral Resources, Environmental Management and Geotouristic potential in the DRC - Zambia Copperbelt'. It will map the environmental impacts of exploitation of copper in the transboundary border of the two countries and recommend developing some abandoned mining sites as geotouristic sites.

Also Zambia Integrated Water Resources Management Centre is involved in the ESA TIGER Project, working with satellite images such as the ENVISAT ASAR to map water resources such as in the Kafue National Park. Limiting factors exist, like vegetation cover and lack of skilled human resources, but coverage, repeatability and prices of images are not necessarily an issue for geological mapping since geological changes require millions of years. Inexpensive archived images can be used.

▼ Botryoidal malachite (copper carbonate), Katanga, DRC. Malachite (from the Greek for mallow, in allusion to its green color) is a common secondary mineral formed in the oxidation zone of copper deposits.
© Geco, courtesy BRGM

Providing employment

Zambia could play a role in the US$38 billion worth world market of copper products through integration in the copper value chain, passing from cathode production to value added products used in plumbing, hydraulic and wear by friction in engineering. Also, copper sulphate has industrial and agricultural uses, and in its high purity form copper is useful in the electronics and jewellery industries. Such downstream manufacturing plants should be created, so that when mining ceases, Zambia could import the cathodes from neighbouring countries such as the DRC and Angola.

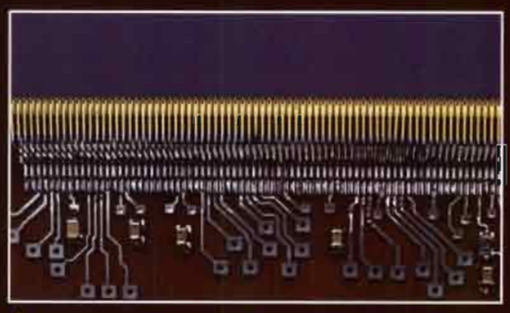
This would continue to provide employment and wealth to sustain the urban development that has resulted from the mining of copper. A good example is the manufacture of a jackhammer in the UK during the mining period and which is still being produced and used in Zambia today.

Pr Imasiku Nyambe
Director
Directorate of Research and Graduate Studies
University of Zambia
Lusaka

▼ Native copper sample, Kamoto mine, west of Musonoi in Katanga Province, DRC.
© Geco, courtesy BRGM

▲ People washing ore at Kolwesi mines,Katanga, the most southern province of DRC. Katanga is rich in copper and cobalt, the latter being used in batteries for mobile phones.
© FairPhone

▼ Native gold nugget (185 g) coming from Makosso Dimonika placer (Republic of the Congo)
F. Farges © MNHN



▲ Copper is widely used in the electronics industry. Here a multipin connector.
© J-D Dallet/Suds-Concepts

▲ This kind of abandoned mining site in Katanga could become a geotourism attraction.
© FairPhone

◀ SPOT5 imagery of part of the Zambian copper belt. AEGOS objectives include identification of innovative products, services, and spin-off projects as well as capacity building in basic remote sensing and geographic systems. With the help of optical satellites such as SPOT and Landsat Thematic Mapper which provide spectral and spatial characteristics of objects, geological mapping and acquisition of good geological data can be accelerated. Courtesy Pr Imasiku Nyambe.

▼ Tenke Fungurume copper-cobalt mine, Katanga, DRC. © Commdev

San knowledge

JIM MORRIS, representative from D'Kar, Ghanzi District, Western Botswana.

D'kar was started as a farm, donated to the San community in 1964 by the Reformed Church of Namibia. We tried to develop activities. In 1998, the Kuru Development Trust was created to initiate agricultural, small business, educational and cultural projects. In 2001 it joined the Kuru Family of Organisations (KFO) working with San communities in Western Botswana and South Africa to secure a positive future for indigenous minorities.

D'kar is known internationally for its annual Kuru Dance festival and art centre. San artists produce colourful oil paintings on canvas, linoleum prints, etchings and lithographs. Their work is presented at international exhibitions and museums. They use traditional designs, but also produce original contemporary art. They paint animals we respect: elephant, rhino, giraffe, elands and ostriches... To increase their self-awareness and pride of the young generation, we encourage them to paint. It is also a way of expressing political and social preoccupations.

Another issue here concerns two unique plants, Harpago or Devil's Claw and Hoodia. Devil's Claw has been used for generations as a remedy for inflammation, pain and fever. It was brought to Europe and used to improve digestion. Concerning Hoodia, our forefathers used to take just a bite of this plant before going hunting in the Kalahari Desert and they could walk for days without eating or drinking.

Today it is considered as having potential as an appetite suppressant. So the South African Council for Scientific and Industrial Research (CSIR) patented Hoodia in 1998 and recognised in 2003 the San as owners of the traditional knowledge about it. We are supposed to get 6% of royalties from the sale of the active ingredient.

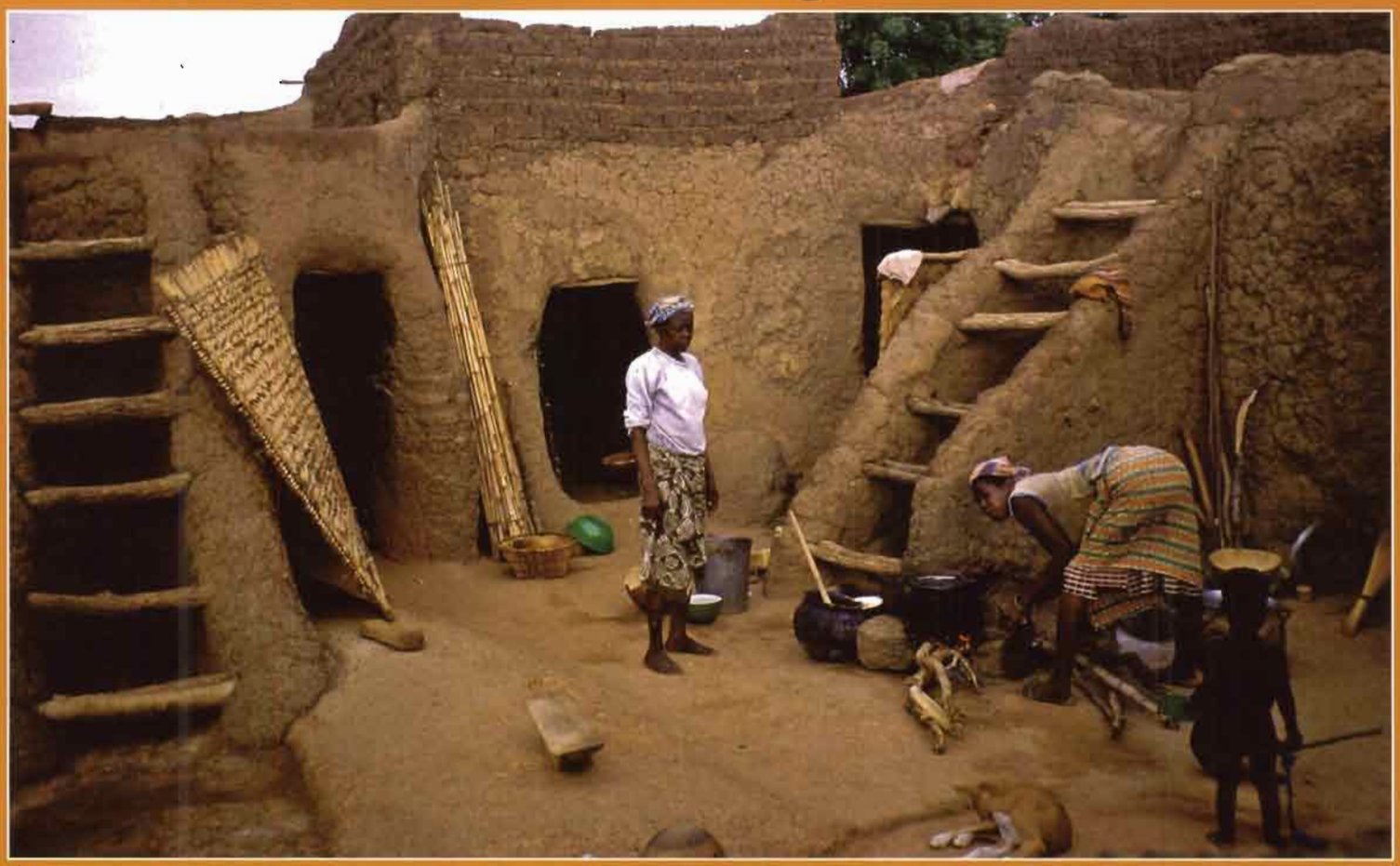
There have been agreements between the CSIR, the UK-based company Phytopharm and the US giant Pfizer to commercialize it. Even Unilever investigated Hoodia for its weight-loss diet products. But, in the end, the San didn't get much from these unique plants.

Now Hoodia is listed in the Convention on International Trade in Endangered Species (CITES). To protect it and get a decent share of the business, we would like to start a farm to build up a sustainable harvesting industry. But it turns out to be very difficult for our community. We recognise that technology is important but it will not actually bring out traditional knowledge from our people. We want not to lose our knowledge but maintain our culture and the biodiversity of our ancestral land.

Detail of a San tribe painting from the Kuru Art Center at D´Kar, Botswana.
© J.D Dallet/Suds-Concepts

Top left, Jim Morris with his brother with cultivated Hoodia plants.
© J.D Dallet/Suds-Concepts

Tradition and modernity



▲ With the increase in intense rainy periods and over-exploitation of land, traditional architecture (here in the Houndé region in Burkina Faso), increasingly expensive to maintain, is being abandoned and replaced by concrete and corrugated iron, much less appropriate for the high temperatures during the dry season.
© Stéphan Dugast/Indigo/IRD

FIDEL YOGO ADIGUIPIOU has devoted his retirement as a former agricultural advisor, to the study of sustainable development, particularly the impacts of climate change in Burkina Faso, his country.

Fidel, what triggered your involvement?

The first thing was in 1985; it rained on 9 November 1985. We had never seen rain in November—our rainy season ends on 15 October at the latest. The second event was in January of the following year: for several days there was reddish dust above the country; it was opaque and almost completely veiled the sun. At the time, we attributed the phenomenon to the passage of the Paris-Dakar rally! It is only now that we are able to understand what was brewing.

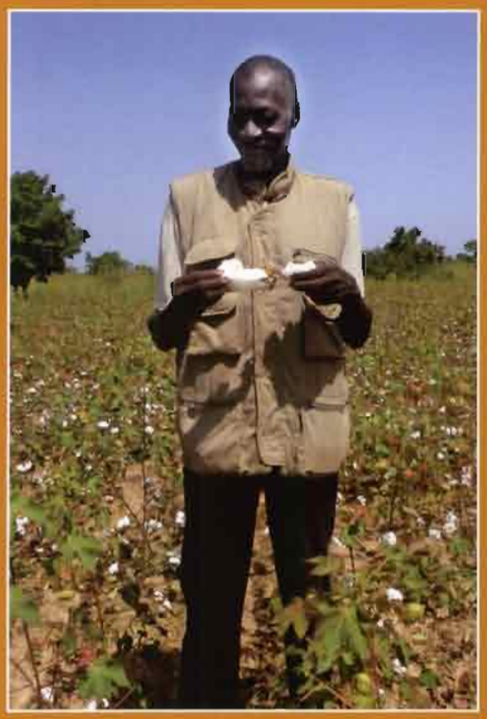
We could have seen these changes coming but we carried on felling our trees as if nothing were happening and the desert continued to advance and now suddenly there has been much more heat and much more rain for three years. Whereas the rainfall we know in this region of Burkina Faso is from 800 to 1200 mm in the rainy season from June to October, it was more than 1600 mm in 2008, 2009 and again in 2010. And the temperature in the dry season is now often over 45°C in the shade! But more precipitation does not mean that the rainy season is longer—the rain is increasingly intense. Precipitation from 15 August to 15 September last year was 400 to 500 mm—this used to be the total from June to August.

What is the most visible impact that is the most tangible for the population?

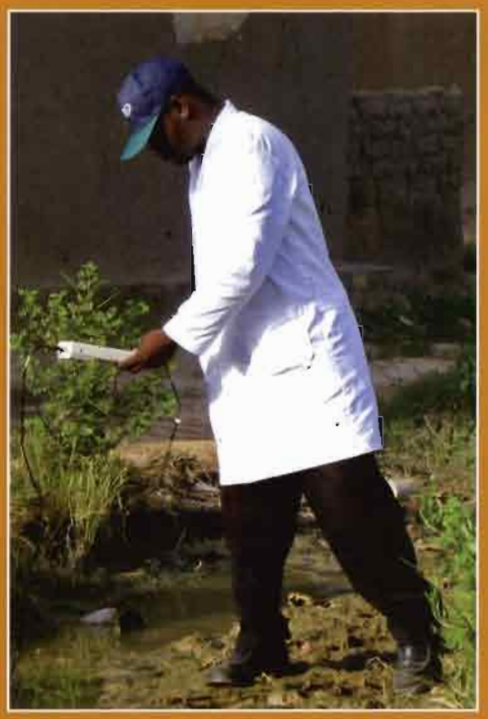
Our traditional habitat is threatened! Kassena dwellings are built entirely in sun dried bricks. Even the roofs are built in earth. They are very heavy and can collapse suddenly when it rains too hard. I have to rebuild my house every year, and last year nearly died, crushed with my family. The people of my village try to combine the techniques of the Kassena and the Mossi, who have thatched roofs, but this is difficult in our culture as thatched dwellings are reserved for bachelors and this isn't very glorious for a family man...

The solution would be to use concrete blocks. But this is much too expensive for a Burkina Faso farmer: earth for building is free while concrete blocks represent months and even years of income for a farmer! And as regards sustainable development, the earth is right there while cement and the transport of concrete blocks use energy.

It has to be understood that our agriculture is living on borrowed time. I was an advisor before I retired. My job was to accompany farmers in the use of modern farming techniques. In 1976, yields in the region for cereals as a whole were something like 800 to 1200 kg per hectare, with an extendable fertiliser formula. This is used much more now and often accompanied by manure, which is favourable for sustainable development. But we still don't manage to exceed 1200 kg per hectare. I don't really know how to explain this but I can tell you that a field under 50 cm of water from August to September will not give you 1200



▲ Fidel Yogo Adiguipiou is concerned about the consequences of climate change for plantations. Here, a cotton crop. © Christophe Nussli



▲ Science and tradition in Burkina Faso. A technician is measuring water quality. The initiation of a new soothsayer of 'the congregation of leaves'. Soothsayers are consulted when the rains are later than usual. © Florence Fournet and Stéphan Dugast/Indigo/IRD

kg per hectare! And rain is decimating our livestock. Our animals tend to be suited to Sahel conditions and when they have their hooves in water they catch a form of pneumonia.

How does the population react to this calling into question of ancestral practices?

Our dwellings and our farming are affected because we do not master the local weather any more. When you are a farmer, you instinctively want to plant in low-lying land because there is more moisture; now you have to go higher to hope to see Noah go past with his Ark! And then what will happen if the rainy season is a bad one? We don't know where to turn our heads ...

Before, when we had a few drops of rain in March everyone went wild with joy and sang 'Here's the mango rain, here's the mango rain'. This year, it is now on 7 March and it has already rained three times. Three rainfalls—if it were June, that would be enough to prepare the land and sow ... But a farmer who prepares his land in March would be crazy!

Before, we also made much use of animals and plants to forecast what was going to happen in the days to come. Migratory birds showed us when the rainy season was arriving. For example, when the toucans and black herons leave for the south this marks the beginning of the winter season and the harvest. But I haven't seen any black herons for several years. This is a great loss as they also get rid of locusts

▲ A Fulani caravan on its way to the weekly market in Dursi in northern Burkina Faso. © Daina Rechner /Indigo/IRD

for us: our best insecticide. This was also the sustainable management of our environment!

And it's not just the migration of animals that has changed. In 1969, when I started to work, there wasn't a single Fulani nomad, or a Mossi. The cattle farmers arrived with the great Sahel droughts in the 1970s and then they got into the habit of returning; today they form a fair proportion of the population, I would say half came from the north because of climate change and the shortage of grazing in the Sahel. Think that some farmers have as many as 10000 head of cattle, so they send 500 to the left, 500 to the right and 500 to the south, ... And as their cattle are used to eating the foliage of trees and eat the regrowth, the farmers don't hesitate to cut down our trees for forage. This is not in line with sustainable development.

What are the urgent things for you, in terms of adaptation?

I am very pessimistic. We are not prepared to go towards sustainable development or to adopt ways of life that have a small impact on the climate. We farm right to the banks of the rivers, we clear much woodland, we cultivate our land with much less labour than before, some people even use herbicides, hybrid seed, GMOs, and so we are losing control of our production circuit. Our incessant little tribal wars and our post-electoral quarrels do nothing to improve things. What's going to happen to us when climate change hits Africa hard, like 'the Big One' that the Americans have been waiting for years?

You westerners are hyper-developed—and your factories send us carbon dioxide—and you think that you can reconcile climate change and development, but not necessarily sustainable. Here, everything comes from the land and only from the land. We have 80 percent illiteracy and so how can you explain the problematics of sustainable development to a farmer or say that he can't grow as much as in the past because of climate change? They say that the pack ice is melting. Do I know where the pack ice is? How does it melt, like butter? I don't know at all. Why on earth are you talking to me about a climate change?

So all this requires first and foremost a very great effort in education skills, teaching and training. The western countries, and France in particular, have a responsibility to help us to warn populations of what is threatening them and to provide them with the means to adapt.

▲ Dian Fossey Gorilla Fund International caregivers feed orphaned gorillas in Kasugho, eastern DRC. Four gorillas were transported from Goma to Kasugho by a UN MONUC peacekeepers' helicopter. © 2009 Tim Freccia

◀ The loss in Kenya's biodiversity is a threat to the country's tourism industry, which is the mainstay of the economy. © Peter Prokosch/UNEP-GRID Arendal

Biodiversity is life

'Biodiversity is one of the planet's greatest and yet least recognized riches,' wrote the American entomologist Edward Wilson in 1992. This is particularly true in Africa where biodiversity is 'useful' insofar as it is a primary need of the population. Rural households depend on farming, fishing, hunting and gathering in their daily lives. These contribute to subsistence and generate income, completing other sources such as earnings in the form of wages or cash remittances from elsewhere.

This clearly shows the importance to be awarded to natural produce and ecosystems in general. The latter can form a 'social security safety net' by protecting families from poverty and famine, especially in case of natural catastrophe.

Biodiversity is also a reservoir of economic resources that can be used today to make agrifood products (*Irvingia gabonensis* Aubry-Lecomte, known as wild mango), pharmaceuticals (*Prunus africana*, Hook.f., a tree of the Rosaceae family whose bark is used in phytotherapy), cosmetics (*Baillonella toxisperma* Pierre, which gives a product similar to shea butter), etc. Finally it has contributed to the development of African cultures in many ways (sacred forests for example).

However, biodiversity is in danger. In Africa, the threats come mainly from increasing over-exploitation of natural resources: over-fishing, the increased use of wood as fuel by artisans working [illegible] fields and [illegible]

What is biodiversity?

Biodiversity indicates the diversity of the living world in nature. It has been defined as 'the variability of living organisms of all origins including, amongst others, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part'.

▲ The active ingredients of *Prunus africana* are used to treat benign prostatic hyperplasia and prostate gland hypertrophy.

◀ 'The end of the masks'. 'With the cutting of trees and the drying out of water-courses, we shall have no more crops. The masks, often representing ancestors with good practices, are sounding the alarm'. Youssouf Cissé (Bamako, Mali), denounces the threat to biodiversity.

Associated with increased demand for foodstuffs, this change will be the main cause of the impoverishment of biological diversity in the coming years.

This is especially so because the increase in the prices of imported goods is resulting in increased demand for local products. Water is another subject for concern. The quality of that of watercourses has worsened in Africa since the 1980s while it has improved in Europe, North America, Latin America and the Caribbean.

The promising development of biotechnologies must be accompanied by appropriate resource management. If this is not done, the disappearance of these resources is to be feared, with new conflicts concerning the rules for the sharing and appropriation of these riches.

Why protect biodiversity? In addition to the economic and cultural reasons that have been mentioned, the future of humanity depends on it. The Millennium Ecosystem Assessment enabled the analysis of the state of 24 functions served by ecosystems that contribute directly to our well-being. It concluded that 15 of these 24 functions are declining, including those concerning fresh water supplies, the production of marine fisheries, the number and quality of sites of spiritual and religious value, the capacity of the atmosphere to eliminate pollutants, the regulation of natural dangers, pollination and the capacity of agricultural ecosystems to fight pests.

The indicators of the IUCN (International Union for the Conservation of Nature) are often put to good use by managers of protected areas as there are strong financial and political incentives from national and international conservation programmes to monitor and 'produce' populations of endangered species. The creation of protected zones makes it possible to fight the continuous regression of ecosystems and the impoverishment of biodiversity.

Goals for men and women

The programmes and bodies involved in Africa are represented by numerous stakeholders (financial, institutional, technical, political, etc.), including civil society. Programmes focused on biological diversity are set up in the light of changes in concepts and observations and also of trends. The IUCN and other bodies are currently working on how to make understood the 'governance' concept applied to the management of biodiversity.

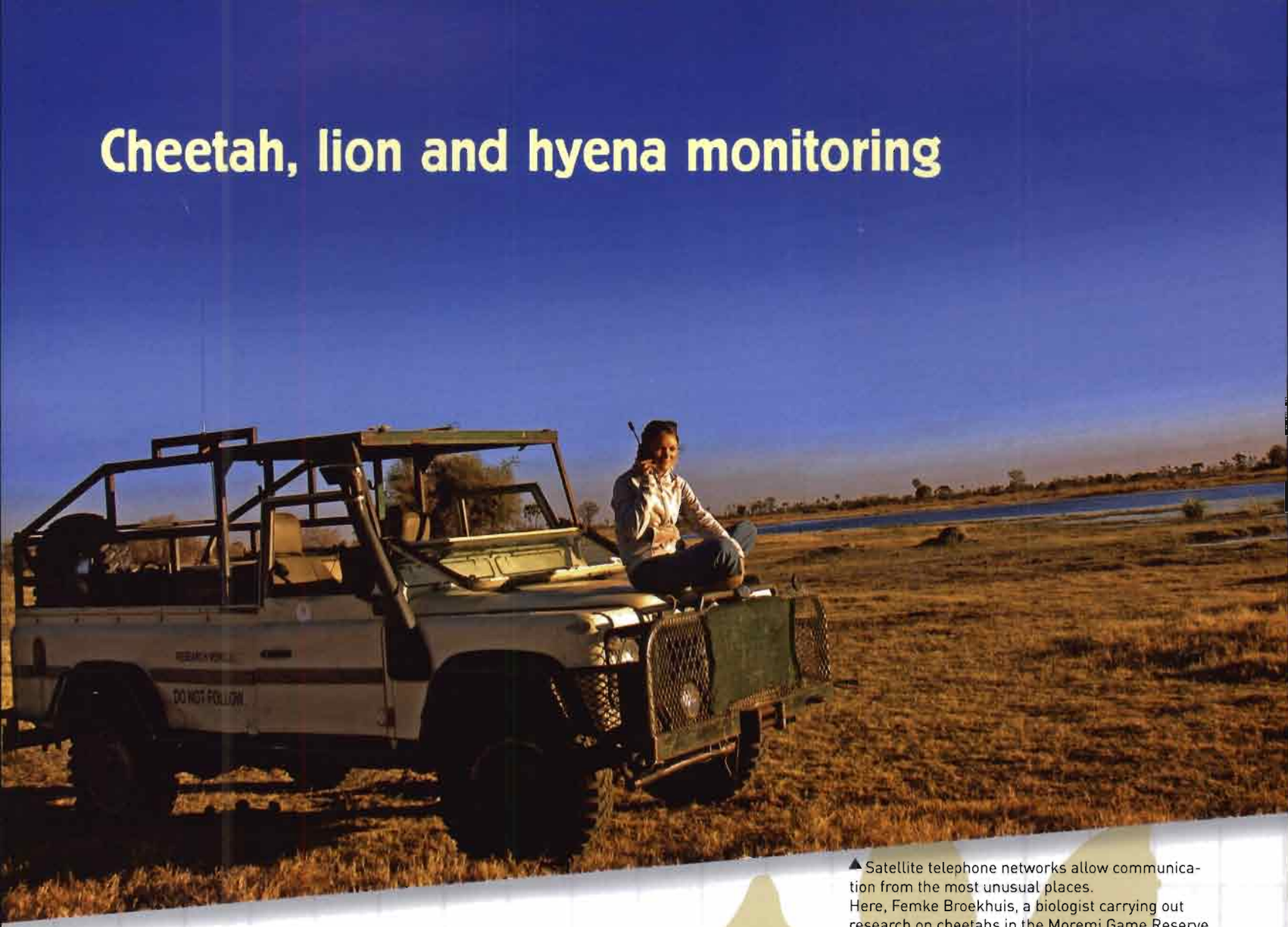
The following question must be asked when the 'tools' aspect is addressed in biodiversity: can we assemble the theoretical foundations, the practical effectiveness, the innovation capacity and the political will to go forwards and to attain the objectives set for reducing loss of biodiversity?

Here are a few goals for the men and women involved in the protection of biodiversity:

- arouse the political will necessary to halt the degradation of ecosystems. This is to be done with a clear demonstration to decision makers and to society in general of the importance of the contribution of ecosystems to national economies;
- selling services provided by ecosystems could form considerable progress when protection of the environment has been undertaken. This initiative will encourage the parties involved to allow for measures that are justified in economic terms and that afford better protection of biodiversity;
- pay attention to the fair and equitable sharing of the benefits arising from genetic resources (this is one of the three objectives of the Convention on Biological Diversity). These benefits could encourage the conservation of biological diversity and its sustainable exploitation;
- mobilise the financial and technical resources necessary for the better implementation of the different recommendations of the Convention.

Florence Palla
RAPAC (Réseau des Aires Protégées d'Afrique)
Libreville, Gabon

Cheetah, lion and hyena monitoring



▲ Satellite telephone networks allow communication from the most unusual places.
Here, Femke Broekhuis, a biologist carrying out research on cheetahs in the Moremi Game Reserve region, using an IRIDIUM 9555 satellite phone.
© Femke Broekhuis/Suds-Concepts

FEMKE BROEKHUIS, biologist, is carrying out research about cheetahs in the Okavango Delta in Northern Botswana, in collaboration with Botswana colleagues, the Wildlife Conservation Research Unit (WildCRU) at Oxford University and the Botswana Predator Conservation Trust (BPCT).

How did you come to Botswana?

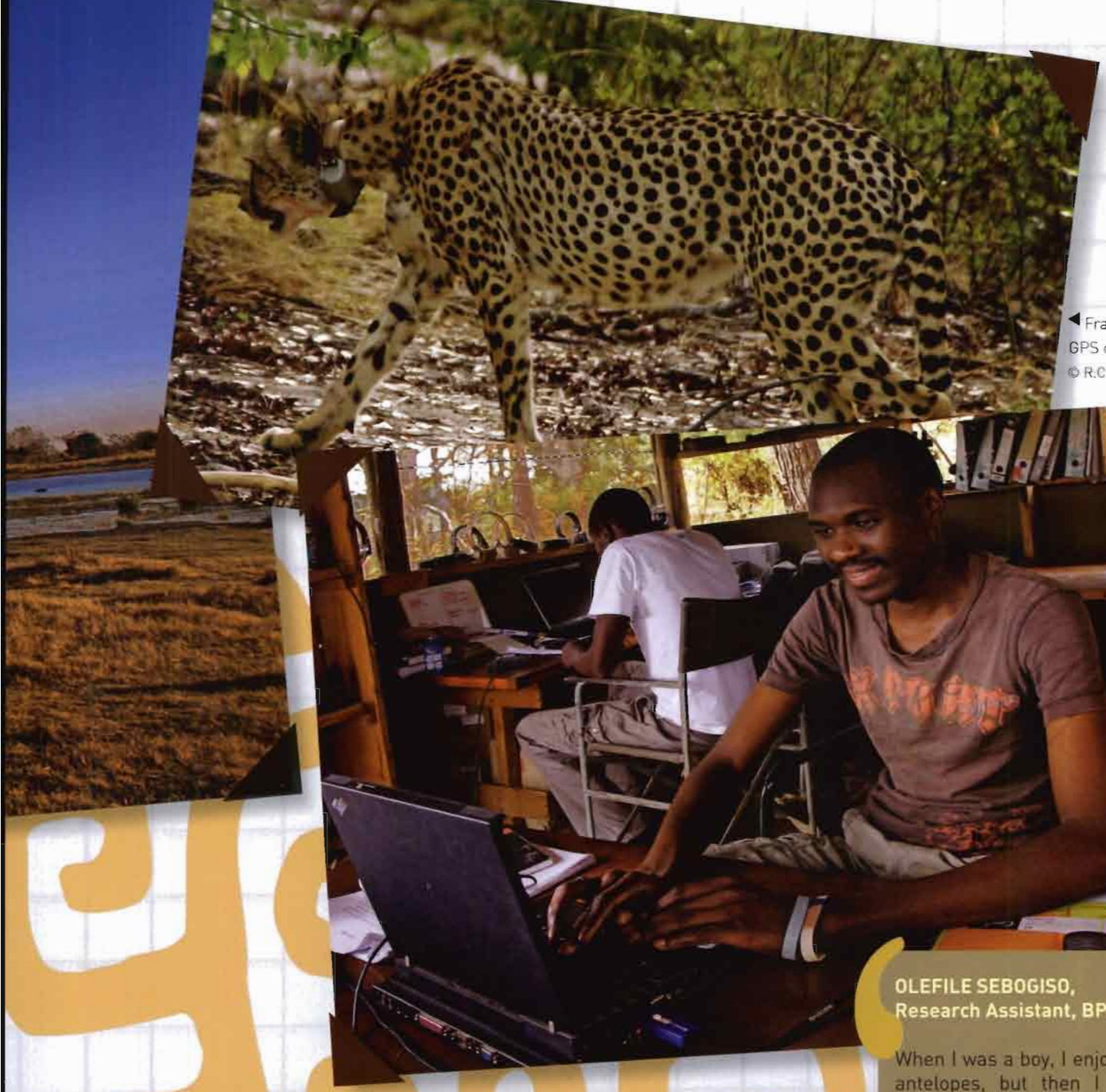
I have been living in Botswana since I was about six years of age. I moved to the United Kingdom in 2007, to obtain an MSc in Wild Animal Biology. After completing my degree I was asked to join the BPCT to take the lead on the cheetah research. The study site is situated in the Okavango Delta ecosystem, a unique permanent inland delta and the world's largest site protected under the Ramsar convention on Wetlands of International Importance.
The core study site encompasses an area of approximately 3000 km^2 on Southern edge of the Moremi Game Reserve, where human impact is still minimal.

What is your research about?

In the past, cheetah ranged from southern Africa to North Africa and all the way into India where they were used for hunting. Due to threats such as human-wildlife conflict and habitat degradation the cheetah population is quickly decreasing The current estimate is around 10 000 individuals of which approximately 2 000 are resident in Botswana. As areas where cheetah are able to live are decreasing because of human activities they are forced into smaller areas with other predators such as lion and spotted hyena. They have a negative impact on cheetah as they kill up to 73% of cheetah cubs and often steal their food. This may lead to the local extinction of less dominant species like the cheetah. The aim of the research is therefore to investigate how lions and hyenas influence the distribution and behaviour of cheetah.

What kind of tools are you using?

Apart from our usual field equipment such as research vehicles, we heavily depend on GPS technology and satellites, both for our own navigation and for collecting data. Carnivores such as cheetahs and lions are elusive, live at low densities and have large home-ranges making it very difficult to collect behavioural data on these animals. To go around this problem we have fitted GPS collars on several individuals that collect data on where the animals go and what habitats they use. At the moment we still have to physically find the animals to upload the data. This is expensive both in terms of fuel consumption and time. Using satellite collars would have been more efficient as has been demonstrated by my colleague in Zimbabwe who is using Argos collars to study the dispersal behaviour of young male lions. Other satellite-based technology that is extremely useful for wildlife research is equipment such as satellite internet link to receive data and an Iridium satellite phone for emergencies.



◀ Franky, was fitted with a GPS collar by BPCT scientists.
© R.Clavaud/Suds-Concepts

What about human experience?
Local participation is essential in conservation. We need more local experts to help study and monitor wildlife which is why the project employs people from the neighbouring community. By getting the local community involved they start valuing their wildlife resource and protecting it.

Can your research results be applied for management and conservation in other areas?
Yes. Understanding the requirements of each of these species in a natural system can be used elsewhere as a tool for planning and management strategies. This is especially important for small, protected areas where the species need to be actively managed. This knowledge can be useful for instance for parks management or for countries such Malawi, Angola and Uganda where information on cheetah are still scarce.

▲ Olefile Sebogiso organizes community workshops addressing conflicts between humans and wildlife.
© J.D Dallet/Suds-Concepts

Some people wonder about the necessity to preserve biodiversity...
Everything has its place in the natural world. The loss of biodiversity can have significant economic, environmental and social consequences. Often without knowing it, we depend on biodiversity in terms of food sources, environmental services and medicine. By removing or altering key elements of an ecosystem the natural balance is altered; leading to long-term and permanent changes that can be detrimental.

OLEFILE SEBOGISO,
Research Assistant, BPCT

When I was a boy, I enjoyed hunting antelopes, but then I understood the importance of preserving wild life. I graduated in Nature Conservation and joined BPCT in 2009. I am in charge of an insurance program aimed at addressing conflicts between large carnivores and livestock as well as between humans and wildlife. People think it is government responsibility to keep wild life away from livestock. Government says: "you don't keep your cattle away predators".
So I meet farmers and organize community workshops to try to reduce these conflicts. The insurance program will be managed by the community: participants will be investors and will confirm or deny claims by community members. We hope this will help for conservation of the rich wildlife of Okavango.

▲ Mangrove at Bassin Léon, Le Morne, Mauritius. This picture won a prize in 2011 at the Acclimate (IOC) regional project photo competition, an Indian Ocean Commission initiative for adapting to climate change. © G. Manuel/COI, Acclimate

Mangroves need protection

Mangroves are forests that grow in the sea! They occur along the sheltered regions of tropical and subtropical coastlines, often being replaced in more temperate latitudes by salt marshes. Worldwide, mangroves are estimated to cover less than 185 000 km^2 and dominate approximately 50% of the tropical coastline between latitudes 32°N and 38°S. The total mangrove area in Africa is estimated at 3,2 million ha, representing about 19% of the world mangrove cover.

Mangrove areas play significant ecological, socioeconomic and environmental functions. They are among the most important intertidal habitats for marine and coastal fisheries. Local communities gather, from mangroves, molluscs such as oysters, cockles, crabs, and shrimps for local and commercial needs. In the mangrove channels and adjacent lagoons, finfish such as mullets, anchovy, snappers ands rabbit fish among others are widely caught. Other wildlife includes seabirds, alligators, and thousands of insects and other invertebrate species. Floristically, there are more than 70 species of mangrove trees worldwide. The genus *Rhizophora* and *Avicennia*, occur in most mangrove areas of the world.

Mangroves provide direct wood and non-wood products and services in terms of building poles, charcoal, tannins, firewood, and shoreline protection. Their complex root systems help in binding and consolidating sediments as well as breaking waves, reducing erosion and providing a buffer during storm events. Due to their high rates of productivity and long term carbon deposition in the soil, mangroves serve as reliable carbon sinks.

Despite these functions, mangroves in Africa have been severely impacted over the years, with West Africa reporting a 20-30% loss and Eastern Africa an 8% loss within the past 25 years (FAO, 2009). Major causes of degradation and loss have been over-exploitation of wood products, conversion of mangrove area for other land uses such as pond aquaculture, agriculture, coastal landfill, urbanization as well as indirect effects of pollution and upstream land use. Loss of mangrove has negative effects to food security, shoreline stability, biodiversity conservation, and livelihood. Many reasons why we need to protect them.

Management plans

Remote sensing applications have been applied to mangroves for inventory and mapping, change detection, and management of aquaculture activities. A team from Kenya Marine and Fisheries Research Institute and the School of Geosciences at the University of Edinburgh in Scotland is testing the use of airborne LiDAR (Light Detection And Ranging systems) technology in assessing the status of East African

mangrove forests and their potential for delivering ecosystem services for local people. As a major objective, the temporal changes in forest area and biomass for Kenya mangroves will be determined. The data will be used to classify mangroves of the pilot area into productive (high biomass) and non-productive stands. Such a classification is useful in the development of management plans for sustainable utilization of mangrove resources.

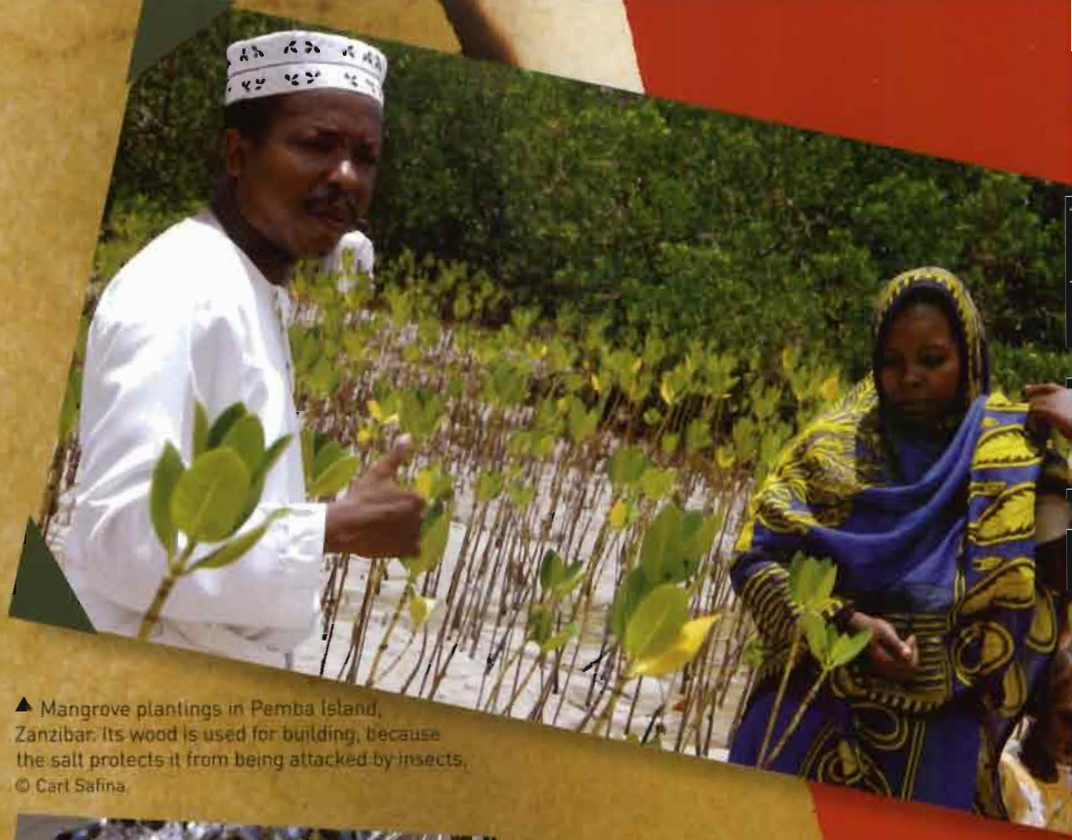
Need for high resolution

Earlier initiatives, in the 1990s, to map world mangroves with sufficient details failed because satellite data with coarse spatial resolution (approximately 1 km) were used. The current World Atlas of Mangroves produced through FAO and other organizations used Landsat imagery and other sources to map 98,6% of the world's mangroves. It is a major milestone in mangrove conservation, with data of broadly consistent age and resolution.

The database enables comparisons over geographic space and sets down a baseline for assessing future change over time. Such a global initiative could be validated using local data sets and high-resolution satellite data such as QuickBird, IKONOS or even SPOT XS imageries. In Kenya, high resolution Quickbird imagery was successfully used to characterize species composition of mangrove at Gazi bay.

The high costs of most commercially available high-resolution satellite imagery preclude their routine use in many developing countries. Projects without substantial funding resort to using freely available Landsat imageries and Global Land Cover for vegetation mapping. This might cause particular problems in habitats that are fragmented or linear, such as mangroves. In addition extensive cloud cover (which is particularly common in coastal areas) reduces the accuracy and usefulness of the Landsat in mapping mangroves and the associated biodiversity.

Gitundu Kairo,
Mangrove Management consultant
c/o Kenya Marine and Fisheries
Research Institute, Mombasa, Kenya



▲ Mangrove plantings in Pemba Island, Zanzibar. Its wood is used for building, because the salt protects it from being attacked by insects.
© Carl Safina

◀ Submetric resolution optical instrument Pleiades in assembly room. The two satellites Pleiades -HR 1 and 2 are each equipped with this instrument.
Thales Alenia Space © Yoann Obrenovitch

▲ Envisat/MERIS image showing the vegetated coastal plains of Guinea-Bissau (with its Bijagos Archipelago), the Gambia and southern Senegal (in red). Serpentine, mangrove-lined tidal rivers feed the rias. The 'hook-shaped' Cape Verde peninsula appears to the north.
© ESA 2004

▲ ▶ It takes two days to make butterfly pictures like the one above and three days for the more complicated ones as on the next page. Building rearing houses would help this craft to continue to exist.
© Philippe Annoyer

Small is beautiful

DIEUBÉNI OMONOMA, butterflies pictures artist.

The *Dzanga Sangha Réserve Spéciale de Forêt Dense* (Special Dense Forest Reserve) some 500 km from Bangui in the Central African Republic houses thousands of species: mammals (elephants, gorillas, bongos, etc.), tropical birds (touracos, parakeets, hornbills, etc.) and insects. It is the land of the pygmies who live in primary forest. Numerous multi-coloured butterflies are also found and their wings are used to make pictures. This craft activity, thought to have started in Mexico, reached the Central African Republic in 1965. Working about biodiversity in the Dzana-Ndooki National Parc, the Sangha scientific expedition met the artist Dieu béni Omonoma.

Dieubéni, when and how did you start to make these pictures?
I have been catching butterflies for 20 years. I started with a net and then learned trapping techniques with the help of my father, who bought me my first net. He was a recognised artist in the Central African Republic and his nickname was Pompidou. When I started, there were 24 butterfly hunters but now there are only 12 of us.
Collection today is mainly in the Ombéla-Mpoko region in the Lobaye, in Haute Sangha and Basse Kotto. It takes two days to make simple pictures and three days for the more complicated ones.

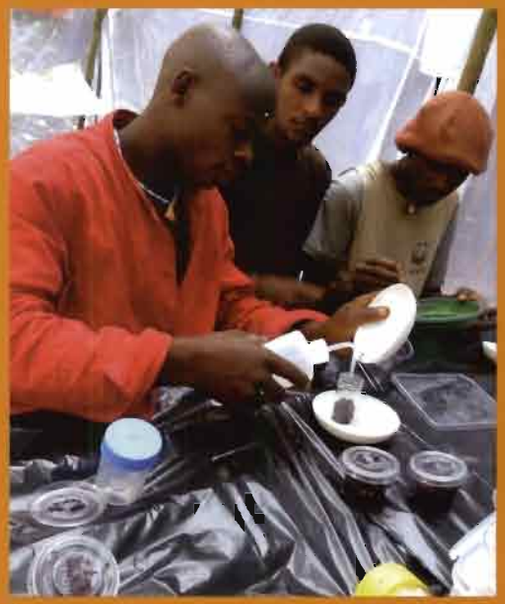
What is your actual analysis of the environmental impact in the places where butterflies are collected?
Insects should be protected in the same way that elephants and gorillas are. For people from the other countries in the world they form true riches in the Central African Republic. However, there is no law governing the making of pictures with butterfly wings. In 1987, a German proposed one to stop this craft activity but it came to nothing. It is not the right solution. This craft must continue to exist. With the regulation of catches, we can reconcile its existence and the respect of biodiversity. It is a valuable thing for us and for our children.
We often talk about this and we can draw up a bulletin of health of the biodiversity in the areas in which we hunt butterflies. There are fewer species in several sites but we do not know if we are really to blame. Forest exploitation, the cutting of trees and shrubs for firewood, the settling of people and various resulting impacts certainly cause more damage than us.

▲ The Dzangha-Ndoki National Park forms a unique and outstanding scientific study area because of its pristine condition and its location in the heart of the Congo Basin rainforest. © Philippe Annoyer

Do you think that it is possible to reconcile the continuation of this craft and the conservation of butterflies in their natural environment?
We have some ideas. For example, building one or more rearing houses would mean that we could have many more wings for making our pictures. And

hence create many jobs. I think of the pygmies whose knowledge is very useful for the recognition of food plants for the caterpillars in our forest. And also of the sale of our pictures in the Central African Republic and for export. We would make ourselves known all over the world. It is possible. This solution would be a relief for us. It would put an end to discussion of a law that would be difficult to apply and would make our work sustainable. And in addition to conserving the various species of butterflies, we would learn a lot about their biology.

▲ *Lobobunaea acetes* (*Lepidoptera - Saturniidae*), collected by the Sangha expedition, is one of the largest and most spectacular of the moths. © Philippe Annoyer



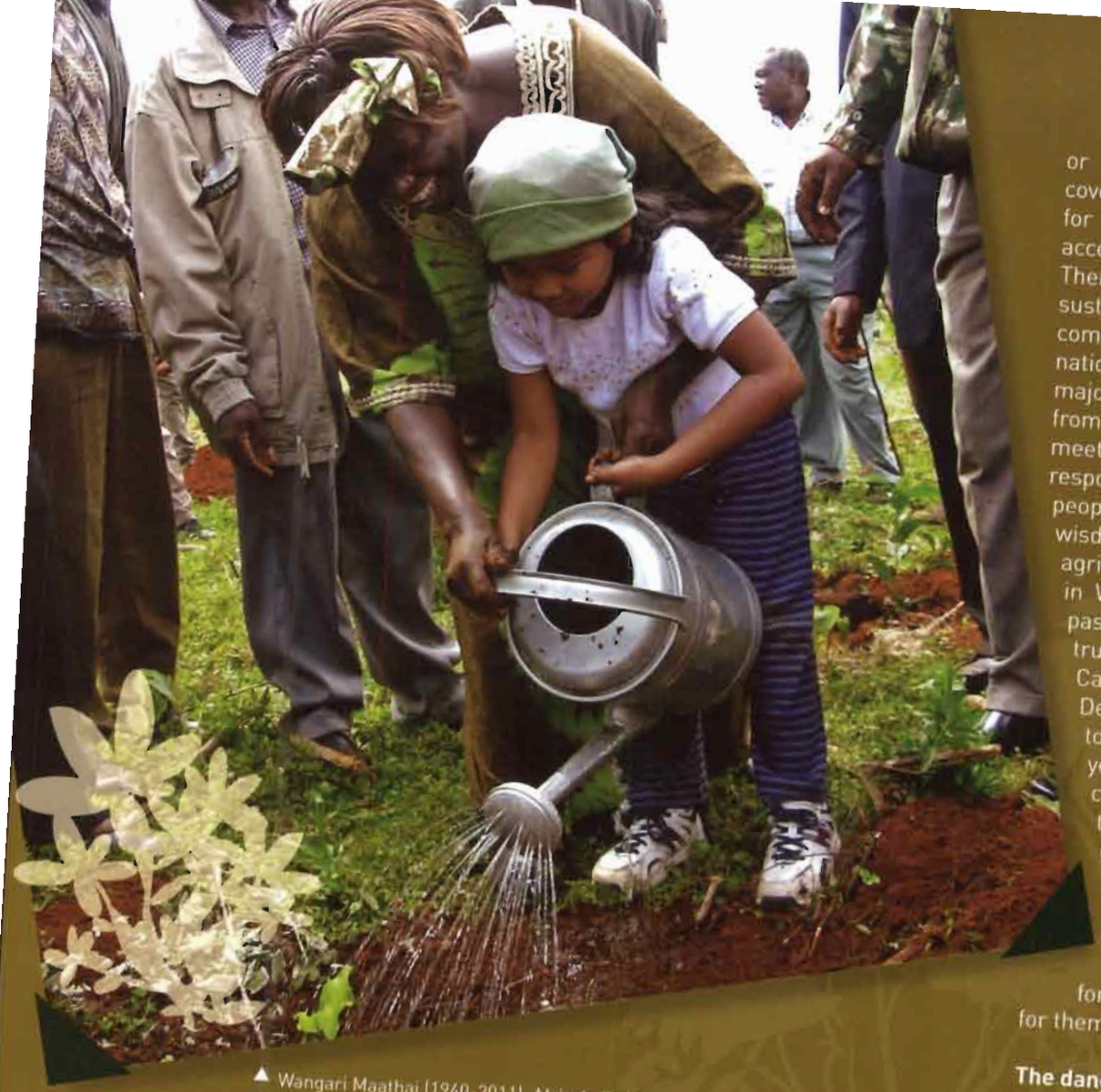
▲ Sangha scientific expedition. © Philippe Annoyer

From the field to the lab

Samples of termite nests from the Sangha scientific expedition were brought to University Paul Sabatier (Toulouse, France). The nest stands upright on the soil like a mushroom, and its gallery system extends into the surrounding soil towards the different food sources.

The *Centre de Recherche sur la Cognition Animale* (CRCA) is analysing their structure and growth, using X-ray tomography. Scientists obtained this image network representation where each chamber is mapped to a node and each tunnel to an edge. This network is sparsely connected, but the edges are chosen such as to keep the distances between any two nodes very short. This study could be useful for sustainable development studies. Courtesy Dr. Christian Jost

© Guy Theraulaz, CRCA



▲ Wangari Maathai (1940-2011), Africa's first female Nobel prize laureate, planting a tree in Kenya. Planting trees grew into the Green Belt Movement, dedicated to safeguarding the environment, protecting human rights, and defending democracy. Image from the film 'Taking roots'. Courtesy of Marlboro Productions, Lisa Merton and Alan Dater.

Forests, our hope

▼ Protection of the environment also involves schools and children who can encourage awareness by their parents. Drawing by Mamadou Sadou Bah, Complexe scolaire Saint Georges, Republic of Guinea.

The value of tropical forests for sustainable development may often appear to be self-evident in national policy and global environmental discourses. Despite this, deforestation or deliberate elimination of forest cover by man for agriculture, especially for smallholder agriculture, is widely accepted as a fully rational decision. Therefore, forests in the context of sustainable development remain a complex, even a divisive issue at local, national and international levels. The major threats appear to be changing from actions brought about by people meeting their needs to society's rational responses to decades of separation of people from their forests. Conventional wisdom holds that smallholder agriculture is a major threat to forests in West and Central Africa. Over the past two decades, this may have been true for 0,1% rate of forest loss in Cameroon, and about 0,04% in the Democratic Republic of Congo. But today and over the next five to ten years, plantation agriculture and collateral infrastructure are likely to become more important causes of forest loss in West and Central Africa, as they were a few decades ago in Brazil and Indonesia.

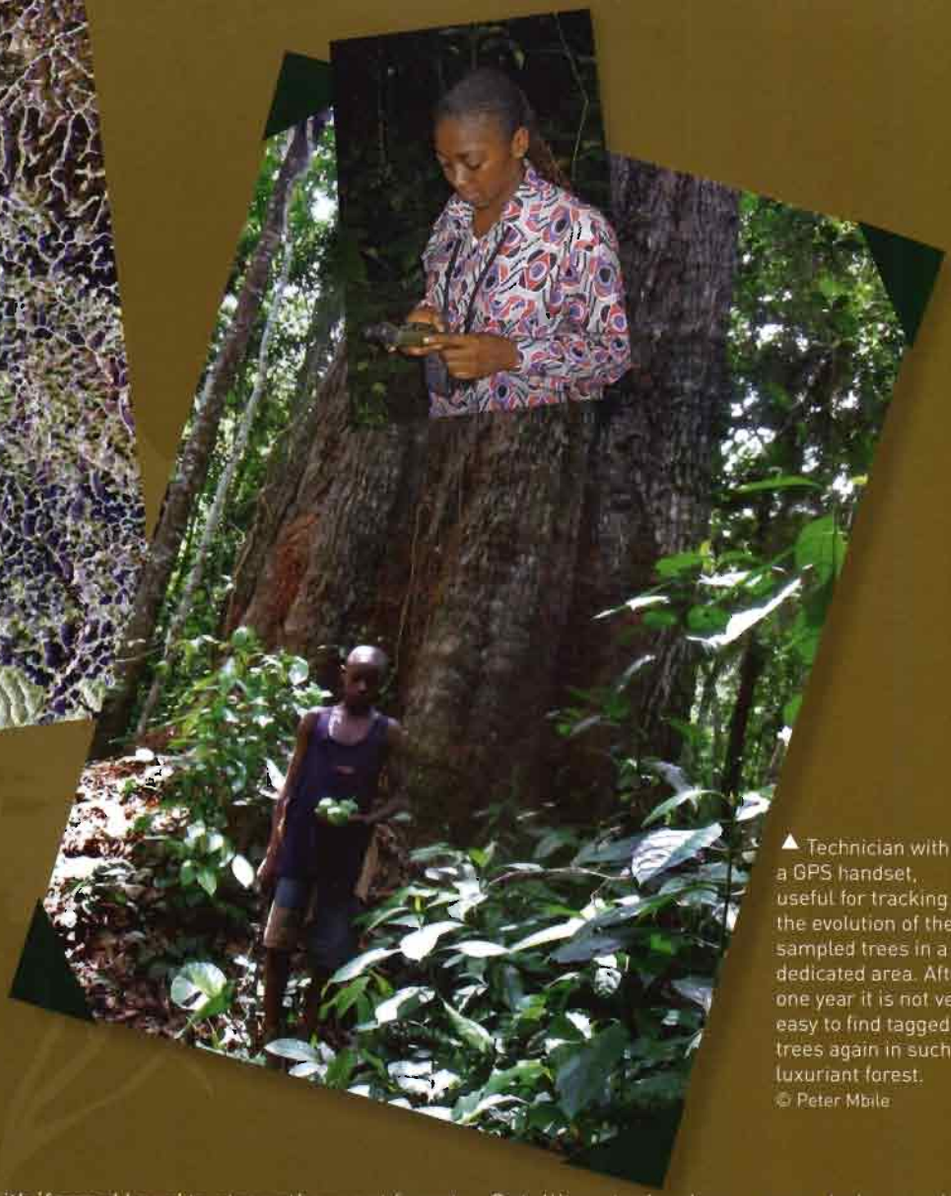
But the real drivers are the laws which separate people from the forest, thereby undervaluing forests for them.

The danger of archaic policies

Some conservation policies keep local people in poverty, rendering them so vulnerable that they welcome large-scale plantation investments with open arms. These action policies and alliances that propped up conservation two decades ago actually prepared the ground for today's rapid forest loss. Archaic and exclusive forest conservation policies and their implementation will effectively remain the greatest dangers unless professionals can urgently develop mechanisms which make managed forests and forest lands more valuable to people standing than destroyed.

The problems of forest loss stem from a historical and colonial perspective. The countries that occupied West and Central Africa implemented an exclusivist policy, separating communities from forests and usurping their ownership and territorial rights. After independence, a common strategy to secure state ownership of forests, favoring an internationalization of access, has been to ignore, trivialize and disregard indigenous knowledge and practices and in many cases replace it with

▲ ALOS-PALSAR image of the Adamawa site in central Cameroon. Mosaic of two image tracks acquired at the end of 2009 and the end of 2010. The area encompasses the interface between humid forest in the South (bright green colour) and savannah (dark purple colour) with narrow gallery forest in the North. A mosaic of forest patches and savannas on plateaux lies between these two ecosystems.
© CESBIO



▲ Technician with a GPS handset, useful for tracking the evolution of the sampled trees in a dedicated area. After one year it is not very easy to find tagged trees again in such a luxuriant forest.
© Peter Mbile

'scientific knowledge'. There are attempts today to build bridges between scientific and indigenous knowledge about forest species as a part of sustainable forest management. Nevertheless, these remain subsidiary to 'official' state protocols, and partly consist of re-branding local and indigenous knowledge as scientific knowledge, thereby inadvertently disempowering local people.

Satellite mapping

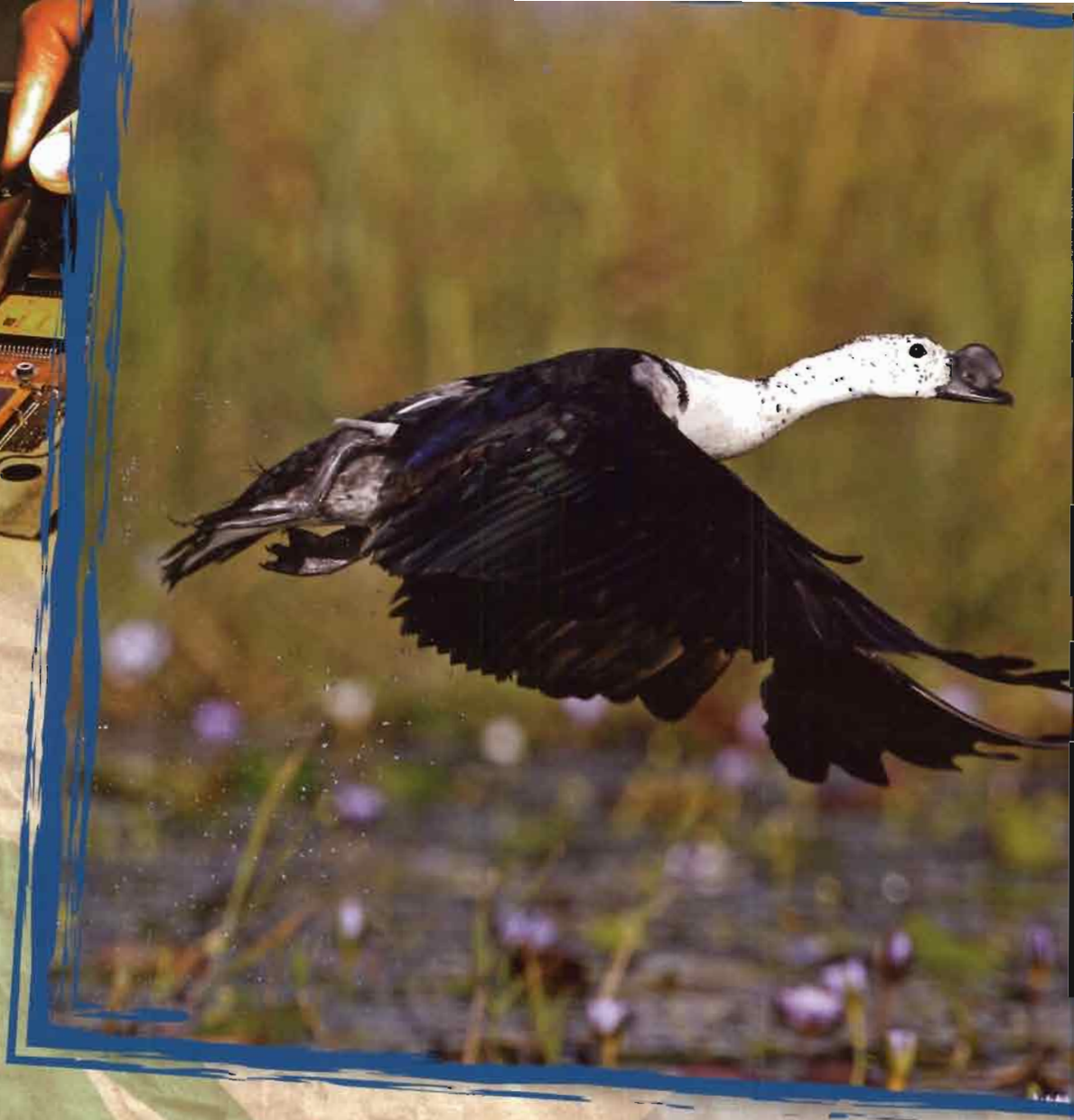
Who protects forests in West and Central Africa? If the perceived enemies are local communities, then the *de jure* 'protector' is the Ministry of Forests. Even then, plenty of cases exist at local level where by-laws developed as a part of local traditions and customs are used to protect forests from 'outside' users and from over-exploitation. In such cases the local communities are the *de facto* protectors of the forests, as states do not have the logistics required to ensure comparative effective presence enjoyed by local communities. In more progressive countries, some of these by-laws have been mainstreamed and linked with 'formal laws' to strengthen, not forest protection *per se*, but community-based forest management, bringing together state and local actors.

Satellites have and continue to help in managing forests as a unique source of information. However their actual usefulness in managing and protecting forests is over-sold. Satellites can help in more accurate mapping of forests, detection and quantification of forest dynamics such as loss and degradation, not necessarily because their accuracy is self-evident but because they can be more cost-effective, given acceptable accuracy levels, than orthodox means. Real-time work in monitoring forest dynamics like fire, encroachments, etc. are being promised but remain more challenging in practice than may seem in theory. Especially challenging is translating satellite imaging and information into concrete ground action. Unless this transition happens, the role of earth observation satellites in forests management will remain strong on potential or pictorial value but of limited value in practice.

Satellite technology can help make Reducing Emissions from Deforestation and forest Degradation (REDD) become a reality. One of the current problems with this mechanism however is what the scope of consensus should be with regard to minimum acceptable levels of scientific accuracy in deforestation, degradation detection and carbon emissions estimates. This lack of clarity in scientific consensus is compounded by lack of leadership by national institutions and capacity to receive satellite data of known quality and regularity, to produce information of known and acceptable accuracy. The unknowns remain too many. There is still considerable latitude however for negotiations about satellite imagery availability, scope of decisions and levels of acceptable accuracy, quality control, logistics and human resources available for their handling.

Peter Mbile
Integrated Natural Resources Management specialist
Cameroon

▲ Digital processing card forming part of the equipment of the latest generation of ARGOS4 being manufactured. It quadruples system capacities.
© J.D Dallet/Suds-Concepts



▶ Movements of tropical waterfowl such as this Knob-billed Duck are less predictable than those in temperate regions.
© Peter Ryan

Keeping an eye on bird routes

For ornithologists, Africa is fascinating. It supports more than 2 500 species of birds, and is home to 24 families that are found nowhere else on Earth. This huge diversity is due in part to the wide range of habitats, from deserts and tropical forests to the rich waters of the Southern Ocean. Unfortunately Africa is also economically the poorest continent, and habitat is lost as land is cleared, wildlife populations are impacted by exploitation and pollution, and native species struggle to compete with invasive species introduced from other parts of the world.

In the face of such threats, it is crucial that we protect our birds because of their immense cultural, spiritual and economic value. Birds provide pest control, plant pollination and seed dispersal services, generate tourism revenue and are sensitive to environmental change, acting as indicators of broader ecosystem health. Knowing where birds go is crucial to understanding their populations – how far they disperse, where their breeding grounds are, and how they use their environment. Since the early 1990s, satellite telemetry has been used to track individual birds through the CLS-ARGOS system. Recent advances with GPS technology give positional data accuracy of a few metres, and enable recording of heading, altitude and speed.

Regular migrations

At the Percy FitzPatrick Institute of African Ornithology, a DST/NRF Centre of Excellence at the University of Cape Town, we use satellite tracking to study bird movements for a range of applied projects. Ducks and other waterfowl are potential vectors for bird-borne diseases such as avian influenza, but their movements remain poorly understood in sub-Saharan Africa. Unlike the northern temperate zones, where regular migrations are linked to strong seasonal signals, duck movements in Africa appear to be driven mainly by local variation in rainfall. A study of satellite-tagged Egyptian Geese is currently helping to address this knowledge gap.

The iconic Southern Ground-Hornbill is being studied at a much finer scale, with the emphasis on identifying key habitats in their large home ranges, some of which exceed 100 km².

By using GPS-transmitters, we are able to see exactly where the group-living hornbills spend their time. The Fitz hopes to use this data to understand why some groups are able to breed successfully almost every year, whereas

▲ Scientists Jessica Shaw and Ross Wheeler tagging a Ludwig Bustard with an Argos/GPS battery powered PlatformTransmitter Terminal.
© Delia Davies

◀ Flying Ludwig Bustard. This little known species is now considered endangered. The main threat is collision with power lines.
© Peter Ryan

others seldom raise any young.
In collaboration with the Royal Society for the Protection of Birds and Dalhousie University, we track the movements of several seabird species of conservation concern breeding at the Tristan da Cunha archipelago. Renowned for hosting the world's most remote human settlement, the Tristan islands provide breeding sites for millions of seabirds, including several endemic species of albatrosses and petrels, which are at risk from accidental mortality on fishing gear.

Power line collisions

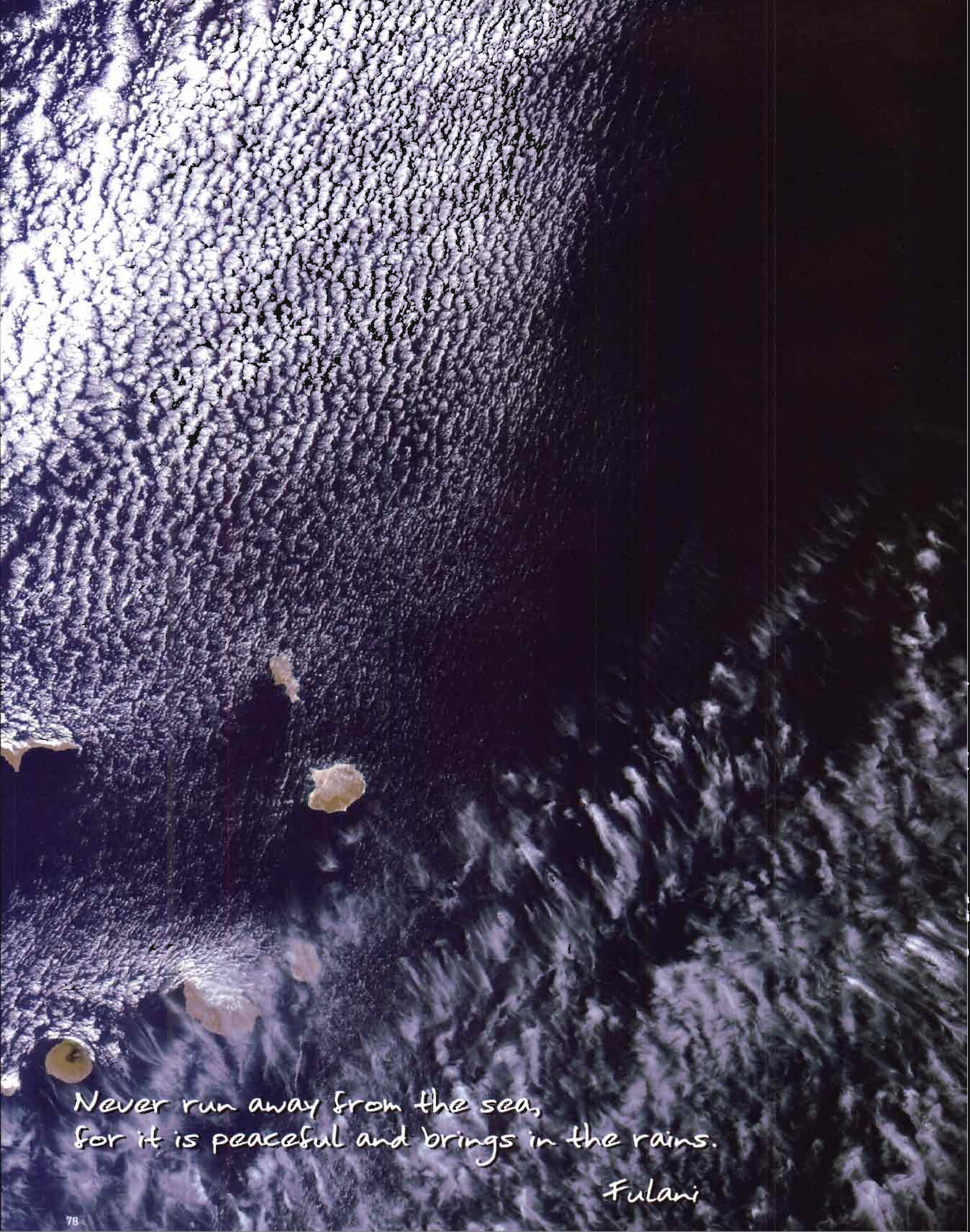
The most recent Fitz tracking project focuses on the little known Ludwig's Bustard, which is confined to the semi-arid plains of western South Africa and Namibia. These large birds undertake a seasonal migration into the winter rainfall area of South Africa, but movements in other areas are less predictable. Power line collisions pose a huge threat to Ludwig's Bustards: in the Karoo region of South Africa, one bird is killed per kilometre of line per year. Tens of thousands of kilometres already criss-cross their remote homeland on an ever-growing power network, resulting in an enormous toll on the population. As a result, Ludwig's Bustard was recently listed as globally endangered, but what can be done to help this bird in a country where the needs of people without electricity must be balanced with conservation?

Conservation benefits

In 2010, GPS satellite transmitters were successfully deployed on three bustards. By gaining several precise positions for each bird every day, we now have the first evidence for movements that were only suspected. We are also learning more about their day-to-day habits, roost site preferences and different foraging habitats. This information is crucial to understanding the collision problem, mitigating the dangers posed by existing power lines and advising on the position of future ones.

In 2011, we hope to deploy more devices funded by Eskom, the national power company. However, with the quality of the spatial data already generated, we are confident that the use of this technology will translate into real conservation benefits for one of southern Africa's special birds.

Jessica Shaw and Peter Ryan
Percy FitzPatrick Institute of African Ornithology. University of Cape Town
Rondebosch
South Africa



Never run away from the sea,
for it is peaceful and brings in the rains.

Fulani

Volcanoes and boardsailing

This ENVISAT/MERIS image captures the North Atlantic Ocean with the coast of Senegal and the Republic of Cape Verde. Due to their position, some 600 km off Africa's west coast, this group of volcanic islands has windy conditions and the northeast trade wind can be particularly strong at times. That is why Cape Verde is famous for boardsailing.

Seas

Coastal and marine management

▲ An estimated 100 000 traditional fishers live and work in coastal communities in Madagascar. They work at a distance of no more than 10 km from the coast. They use wooden dugouts called pirogues, powered by oars, and nets. This small-scale fishing supplies 70% of the national fish consumption.

Dr ROLPH A. PAYET, President and Vice-Chancellor, University of Seychelles and Special Advisor to the President of Seychelles, Victoria (Mahe), Seychelles.

Could you give us a few facts about the coasts of Africa and the role played by the sea?

Africa is a massive continent with very different coastlines—on the Indian Ocean, the Atlantic Ocean and the Mediterranean. Different communities living along these coasts and across Africa have in common a high dependency on fish as a source of protein as the protein diet is very important in Africa. And in many countries the construction materials for building houses, medicine and other kinds of products come from the coastal environment.

But challenges are very different. Along the coast of West Africa, they concern fisheries, the oil industry, as well as mining industries. Along the East Coast of Africa, there are also fisheries, a growing gas industry and soon there might be an oil industry. Along the South African Coast, there is more mining but also fishery industries. In North Africa, there is a variety of industries ranging from shipping to fishing and of course tourism, which plays an important role along the Mediterranean coast, the Eastern coast of Africa and Southern Africa.

It is also important on the West coast of Africa but still developing. Madagascar is the largest island. Then we have islands all around Africa, starting from the North with Socotra, all the way down to Seychelles, Reunion, Mauritius, and around the tip of Africa, going up, we have the islands along the coasts of Africa, Guinea-Bissau, Sao Tome and Principe and Cape Verde. And of course we consider them as entire coastal zones. In terms of governance, we have a regional structure. For East Africa, the Nairobi convention, for the West coast, the Abidjan convention, and then for the North coast of Africa we have the Barcelona convention.

These three conventions cover the protection and management of the coastal and marine environment. Now of course many organisations are involved in the management of the coast around Africa. The other initiative is the Large Marine Ecosystem approach (LME), which looks not only at the physical but also the ecosystem, the resources and the pollution aspects of the management on the coastal line and the immediate marine environment.

▲ Fish market in Victoria, the capital of Seychelles.

What part do activities along the coasts represent in African economy?

Fisheries are very important. You have the subsistence fisheries, where fishermen depend on this only source of

▲ Praslin Island in the Seychelles is famous for its soft white sandy beaches and its 'Coco de mer' coconuts which only grow on the ancient giant palm trees in the *Vallée de Mai* nature park. Tourism provides about 25% of Seychelles' GDP. © Ax Lange

▲ Protective stone wall by the roadside, Seychelles. © UNEP, GRID Arendal/Lawrence Hislop

income for their living. So problems with fish resources can throw the community into extreme poverty. Then the local fishermen, who are seasonal fishermen, go out to fish and then they sell it on local markets and once the fish season is over they go into something else like agriculture. These career fishermen play a very important role; they use very low impact fishing methods and we interact with them for example for protecting areas.

Third category, the industrial fisheries, with big boats, are long range and they fish big fish like tuna which is for canning factories, often exporting to Europe and other countries.

50% of the world's population will live within 100 km of the coast by 2030. Is it true in Africa?

Yes. In fact there's a high migration of people towards the coast, obviously because there are a lot of economic activities related to tourism. In some places like Somalia, the economic activities are related to piracy, so people are moving where the money is. This creates problems for the local communities as well as there is increasing competition for food, for labour... It also brings a number of issues like crime, inappropriate housing, and all sorts of problems.

What type of organisation is the Indian Ocean Commission (IOC)?

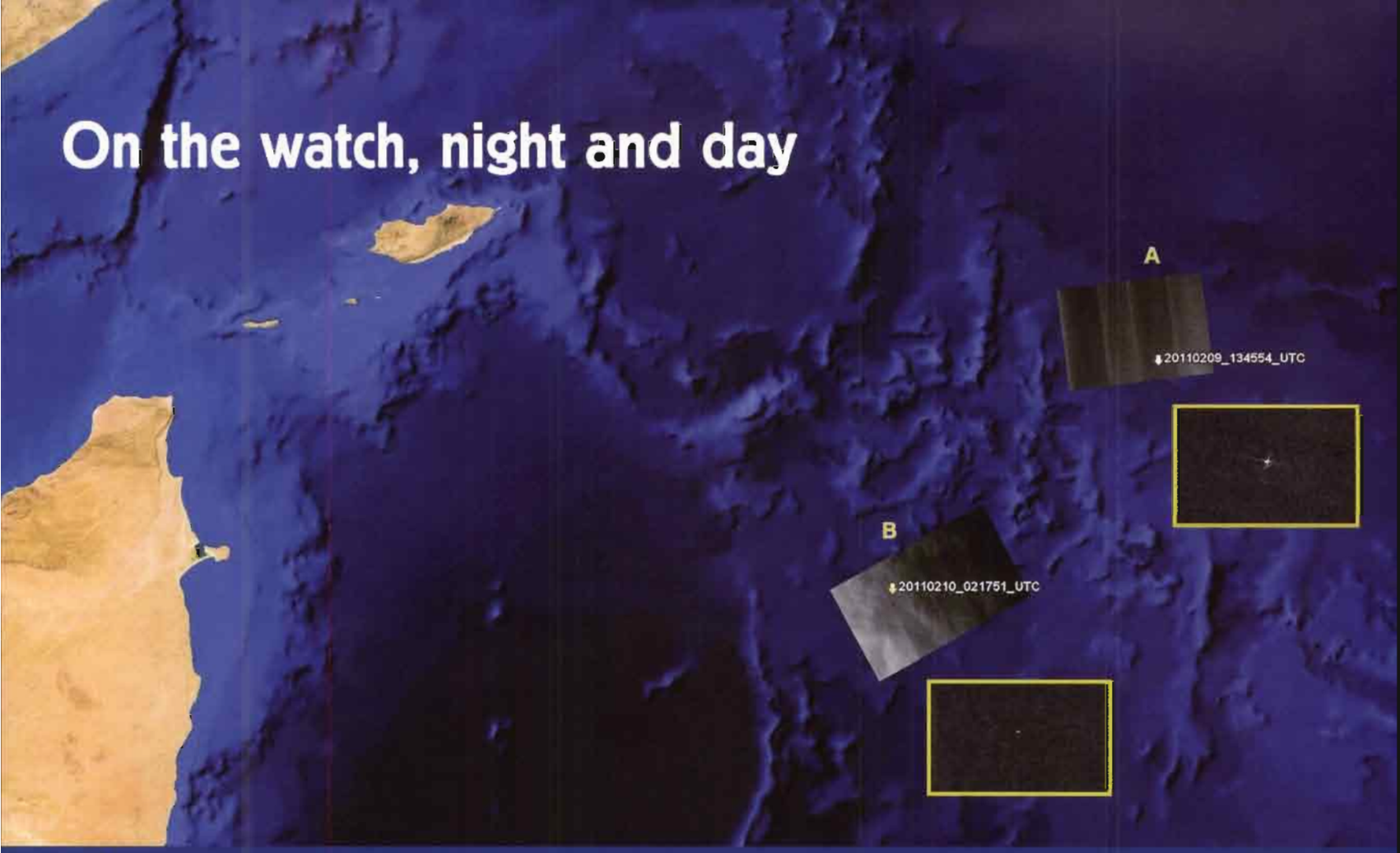
The IOC is a regional organisation with a very wide role concerning political, environmental, social and governance aspects. It provides support, networking, exchange of information, trade... for the development of all the member states.

Concerning coastal fisheries, the Seychelles and Mauritius are more advanced in their management than Comoros and Madagascar for example. Primarily due to political stability and of course better management and training. Mauritius invested a lot in agricultural development—e.g. the sugar cane industry—in the last 50 years or so. So they had a serious pollution issue. Now they are investing a lot in mitigation and remedial measures for the coastal environment.

They have a very strong and growing tourism industry which also contributes to a number of impacts on the coastline, such as pollution and conflicts with the local people.

Both Madagascar and Comoros have serious issues with marine debris and waste because of poor waste management systems put in place. They also have a very high level of poaching (or subsistence fishing) and they still use poisoning or dynamiting methods for fishing, which are no longer very widespread in the Indian Ocean countries. ▶

On the watch, night and day



▲ Satellite images of the Italian oil tanker 'Savina Caylyn', captured by pirates in the Indian Ocean. A and B represent successive positions of the boat, seen as a white dot on the zoomed views. The Emergency Team of e-GEOS, an ASI/Telespazio (Finmeccanica/Thales) company, acquired these COSMO-SkyMed images in February 2011. © ASI/Italian MoD

Dr ROLPH A. PAYET

What is the role of satellites and satellite-based applications?

These are very, very important for research, planning, ecosystem management and also enforcement. They can save us because we have limited capacity. We can develop the right algorithm to detect changes, for example ecosystem threats like extreme weather events, before the damage happens. We have for instance significant algae blooms and these can destroy fisheries, or beaches. We had a project with fishermen combining the use of planes and satellites to determine the impact of bleaching on coral reefs.

Then on the issue of management, satellite imagery will help us determine places which have been eroded the most, land use, urbanisation. But a lot of the planning tools lack up-to-date satellite information and that is why they are never used. Mauritius has just completed its area mapping. The last one we did was 15 years ago and a lot of things have happened since.

Another example is the piracy issue. For example, Reunion Island developed applications which can identify legal and illegal boats and other kind of activities around fisheries in the West Indian Ocean. In satellite information we do not use only pictures but also data: temperature, pressure, weather, wind... These parameters help us to manage the coast, the resources along the coast and also movement of people, urbanisation.... So we need to develop satellite-based applications that are for us one of the most important tools to manage an area of sea greater than France and Spain together.

What are the main satellite data you use and what difficulties do you encounter?

We are using European data (SPOT from CNES) and a little data from Indian satellites (like IRS from ISRO). It depends on what we are looking for and on the region. Apart from cloudiness, the first difficulty is the cost: satellite data are still very expensive. The second one is processing capacity for interpretation of the data. We will only be able to install a server with submarine cable allowing the data to be processed elsewhere and sent to the stations in two years time.

Concerning the environment, one of the most important continental programmes is AMESD that addresses five regions of sub-Saharan Africa. In the IOC region, the Mauritius Oceanographic Institute leads the development of operational services for the management of fisheries resources and the control of fishing activities but also for physical oceanography and marine climatology. Those services will benefit not only IOC member countries — Mauritius, Seychelles, Comoros, Madagascar (Reunion Island as associate)—but also Kenya, Tanzania, Mozambique and two small associated island states: São Tomé and Príncipe and Cape Verde.

▲ European Union Naval Force in action off the coast of Somalia. Operations against piracy are conducted in accordance with UN Security Council's resolutions. © EU NAVFOR

▲ Envisat in ESA ESTEC centre. Launched in 2001, this Earth observing satellite vastly improved the range and accuracy of scientific measurements of the atmosphere, oceans, land surface and ice.
© ESA/A.Van Der Geest

▶ **What are the main stakes related to sustainable development in IOC?**

They are primarily supported by the European Union through the Cotonou Convention which is the European Union Agreement with the African, Caribbean and Pacific group of states (ACP). The EU channels a lot of regional initiatives through the IOC; for example, we had a tuna tagging project in the West Indian Ocean to look at their migratory patterns in order to determine sustainable fisheries.

We have had a very long—to be completed at the end of 2011—EU-funded coastal zone management project called RECOMA. The aim is to develop a protocol for the management and protection of the coastal zone of eastern Africa. There were a series of demonstration sites set up, an extensive educational programme and also a training programme in all the countries.The other platform is the Nairobi convention (IOC is a member of the Nairobi Convention). Through that also, a number of regional projects funded by the Global Environment Facility (GEF) have been implemented at the regional level to look at sources of pollution, marine debris and trans-boundary issues when it comes to migratory species and other organisms.

The Global Ocean Observing System (GOOS) is a UNESCO initiative. They coordinate ocean-observing activities, and we do have sometimes research vessels and monitoring vessels here in the Indian Ocean. GOOS funded the project called "WIO-Lab" West Indian Ocean land sources of pollution.

One of the biggest projects we had in a region was the Angola and Somalia Current Ecosystem Project. The vessels undertook research and collected marine biotype in order to determine the status of the marine environment.

What are the main challenges you face?

The first is capacity, the capacity of the people, adequate training. The second is awareness at all levels. There is a lot more now than before, particularly among young people. Schools train the teachers so that they can have a very integrated approach to management and introduce sustainability principles. Right now at the university we are developing a professional course in sustainable development and management and also specific modules of sustainable development.

The third issue is enforcement and management and planning. As a result of lack of capacity and knowledge, you end up with poor planning, no land use plan, no development plan which allows development to proceed in a desultory manner or stimulates conflicts between different activities like fisheries and tourism. So proper planning and proper investment in waste management, in pollution control, are all some of the critical challenges.

What are the concrete risks in fact?

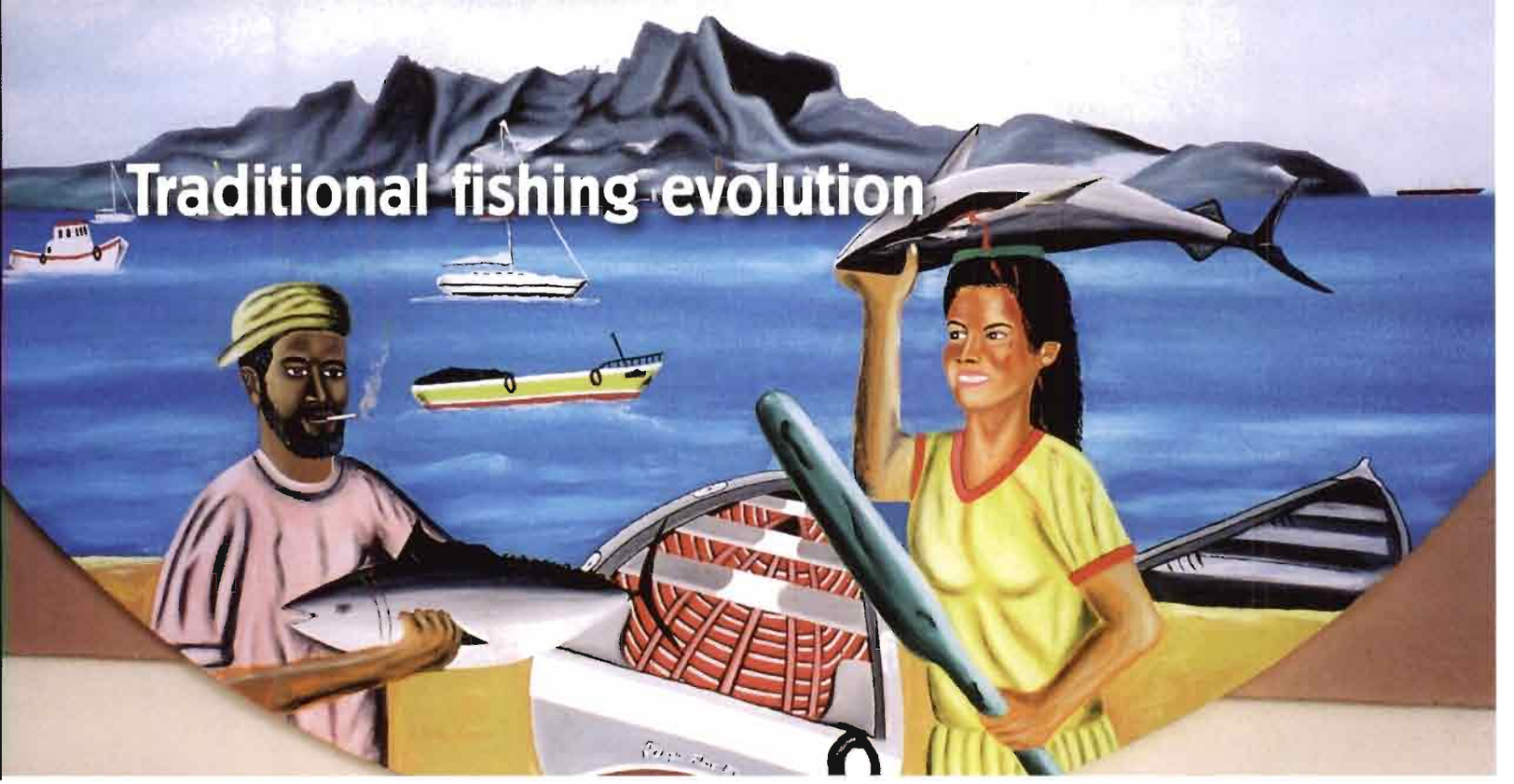
It is of course climate change, which is an external cause, but we have had significant coral bleaching in the region, and that has an impact on fisheries as well as on diving industries. Sea level rising and extreme weather events have an impact on beaches, on the coastlines, and damage corals and built up areas.

The impression of people who live on the coast is that it is for the holidays and they forget about the actual challenges happening there. In fact, the coastal zone will remain one of the most significant hot spots in the planet in the next decade or millennia. And more and more people will want to live on the coast and there will be a lot of pressure and of changes along the coast. People will make investments and all sorts of developments to deal with the issue of climate change.

The impact of pollution as well will be important. As we see in the case of Japan with the tsunami, the destruction caused by extreme events can have a significant impact for people who live on the coast. And I think the coastlines are not adequately addressed and represented even at the political level because people are more concerned with city and urban issues or mainland issues than with what is happening on the coast.

▲ SEAS-OI antenna being installed (November 2011). The *Surveillance de l'Environnement Assistée par Satellite dans l'Océan Indien* remote sensing project involves IRD, the Regional Council and Université de La Réunion.
© J.P. Caminade, IGR, IRD-Réunion

Traditional fishing evolution



▲ Santa Maria fishing port (Cape Verde). Wall painting showing the importance of fishing in the island and especially tuna. © Marie-Noëlle Favier / Indigo / IRD

Located in central Africa south of the equator, the São Tomé and Príncipe archipelago possesses fishery resources that could play an important role in its economy and in food self-sufficiency. The archipelago has an exclusive economic zone (EEZ) that is large for the region (160 000 km²) in which abundant fishery resources are concentrated from May to October as a result of the local mingling of masses of water in the Gulf of Guinea. The catches of small-scale fishing represent 70% of the animal protein required by the population and nearly 30 000 people (20% of the population) depend directly or indirectly on this sector for their survival. However, São Tomé and Príncipe profits little or not at all from its rich waters and small-scale fishing is experiencing an inevitable crisis with disastrous effects in the short term for the population of this small country that is one of the poorest in the world.

The first problem is that the state does not have sufficient capability to control this vast maritime territory and, unfortunately, the resource is pillaged by a foreign industrial fishing fleet with few scruples. Then there is a lack of means. Fishing is still carried out on a small scale by under-equipped, little-organised fishermen. Their dug-out canoes are heavy and not easy to manoeuvre and they cannot go far enough from the coast to exploit pelagic resources that are nonetheless abundant in the EEZ. To this is added the use of techniques with disastrous effects—explosives, seine fishing with a net whose mesh is too small—that regulations that are too timid cannot control. On land, the female fish sellers, going by the local name 'Palaiés', have difficulty in selling the catches. There are no storage facilities for fish and processing capacity is small, conditions of hygiene are inadequate in village communities, the local market is small, etc.

Since the end of the 1990s, a small São Tomé non-governmental organisation has nonetheless tried to change the situation. The goal is the modernisation of traditional techniques and the stimulation of sales chains. The NGO MARAPA (Mar Ambiente e Pesca Artesanal) has thus succeeded in introducing prao type outrigger canoes that

▲ Small-scale fishing provides 70% of the animal protein required by the population of the archipelago. © MARAPA

are more suited to navigation conditions. For several years it has tested the use of fish aggregation devices (FAD) in the high seas that will in the future enable fishermen willing to sail far from the coast to maintain reasonable catches. With the support of various partners, it has performed numerous actions to promote awareness and to provide training in responsible fishing techniques that conserve marine and coastal ecosystems at the national scale, has shown fish sellers better practices for processing (drying, salting, smoking) and better sale of catches.

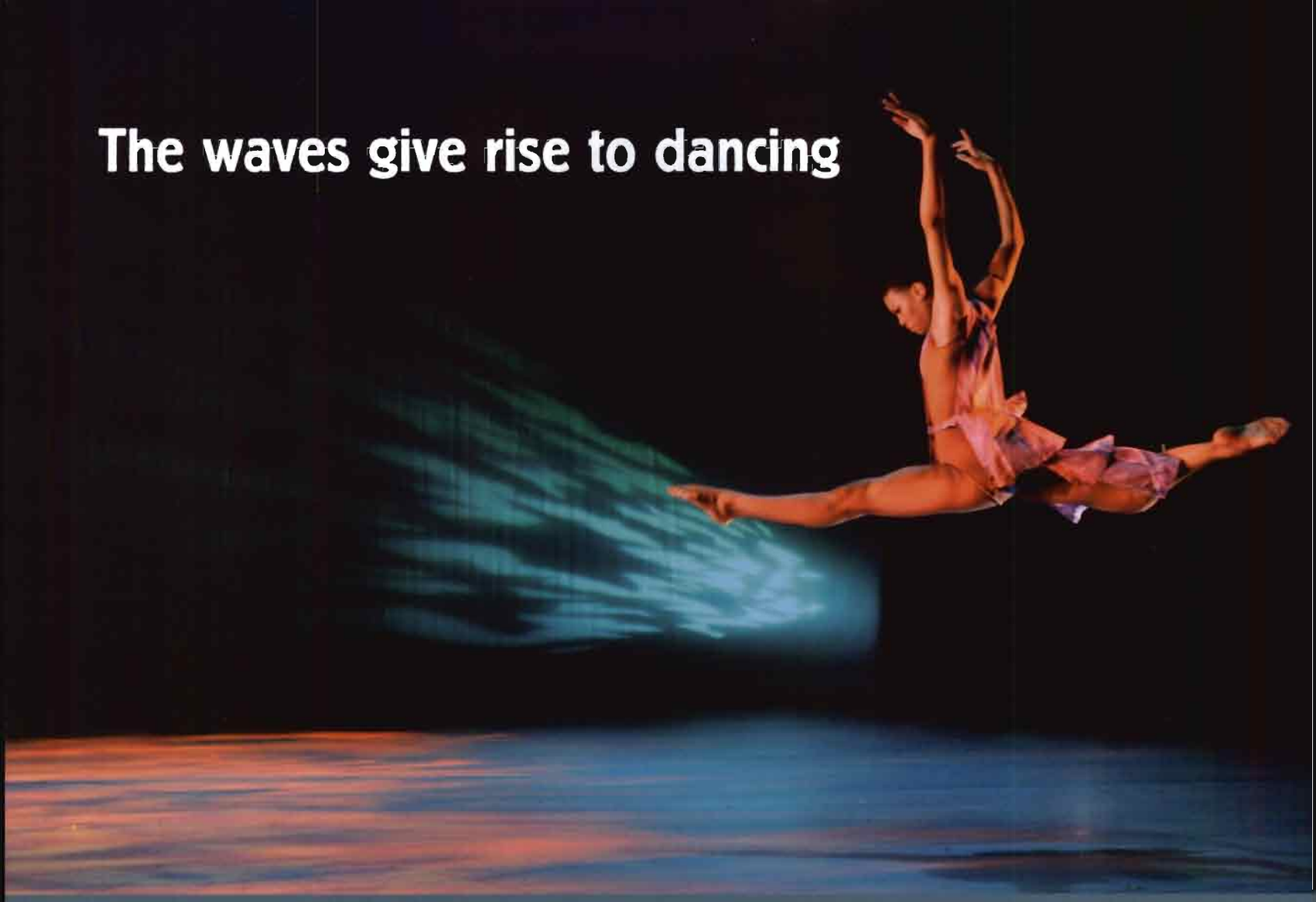
In recent years, with the support of the government of São Tomé and Príncipe and IFAD (the International Fund for Agricultural Development), MARAPA has concentrated its work on the structuring of a chain for the sale of fresh fish packed in ice between the capital and the isolated, richer fishing zones south of the island of São Tomé. A fish selling cooperative has had technical assistance from the NGO since 2005, especially for the conservation of fish in ice and transport to the capital.

However, MARAPA runs up against numerous obstacles. For example, strong resistance to change in village communities with deep-seated traditions and enormous logistic difficulties in a country with decaying infrastructure. This means that the achievements of the project are mixed and its survival cannot be guaranteed in the long term.

But São Tomé fishing does not have the choice if it wishes to survive. Current practices are not viable and there are already signs of the exhaustion of coastal resources. Ongoing rural exodus towards coastal urban areas will irremediably increase the food dependence of a strongly growing population on fishery products. In the light of the issues, the actions of MARAPA are terribly necessary but seem clearly insufficient.

Bastien Loloum Zuntabawé
Lda Bom Despacho
República Democrática
de São Tomé e Príncipe

The waves give rise to dancing



▲ Ghrai DeVore performs a solo choreographed by the Artistic Director of Alvin Ailey American Dance Theatre, Judith Jamison. Performance by Ailey II.
© Eduardo Patino

Given the relationship of traditional African societies with the natural environment, it is unsurprising that the qualities, mysteries, and stories of the rivers and the sea have been translated into the rhythms, patterns and gestures of dance. In one of the languages of the Bamileke people of Cameroon, the word for water – N'shi - is the same as the word for 'dance' and the word for 'music'. Water, Dance and Music intertwine as metaphors for the flow of life.

Many dances inspired by water reflect the occupations and folklore of people from riverine and coastal areas. According to the theologian and historian Engelbert Mveng, the Lihongo dance celebrates the marine exploits of a folkloric hero from the Bassa region in Cameroun. He created the first canoe, launched an expedition and opened up new lands. The dances of the Ijo people of the Niger-Delta reflect their environment. When dancing they move lightly and skillfully like one balancing in a canoe or negotiating stepping-stones. Intricate footwork is co-ordinated with swift, sharp, hip shakes and an inclined torso.

A section of the Su dance of Birnin Kebbi people of Northern Nigeria is derived from the stance and actions of a fisherman casting a net. The ethnomusicologist Doris Green describes the dance as being performed in the river itself by the female descendants of fishing families. Also inspired by the fishing lifestyle is the Kpanlogo dance of the Ga people of Ghana. Presently cultural dance troupes perform this dance amongst others to entertain tourists on the beaches of Accra. Possibly, however, the most famous water-inspired dances from Africa are those that honour the Yoruba river goddess Osun. Beyond Nigeria, her dances are performed in Diaspora, most notably Brazil and Cuba.

It is the fluidity of water-inspired dances that make them some of the most beautiful in Africa's cultural repertoire. The dance named after the river Nesshoue left the anthropologist Geoffrey Gorer awe-struck when he saw it in Dahomey in the 1930s. The spectacle comprised of rhythmically co-ordinated lines of slowly undulating, beautifully adorned dancers. Also famous for its beauty is the Efik people's Ekombi dance in which intricate back and shoulder movements send ripples through arms bent gracefully at the elbow and wrist. The quick foot pattern that turns the body from side to side, is punctuated by a gentle rise and fall of the body – a study of the constant, swell of the sea.

In the theatre as in traditional society: spirituality, community and sustainability are reoccurring themes in dances inspired by water. No wonder at the centre of 'Revelations', the famous choreographer Alvin Ailey's celebration of the African-American spirit, is the scene of a river baptism. Choreographers such as Abdel R. Salaam, the artistic director of 'Forces of Nature' raise awareness of environmental issues through dance theatre. Dances inspired by the rivers and seas engage with the cycle of life and rejoice in its mysteries.

Funmi Adewole Kruczkowska
Writer, Nigeria
with James Carlès Nganou,
choreographer, Cameroon / France

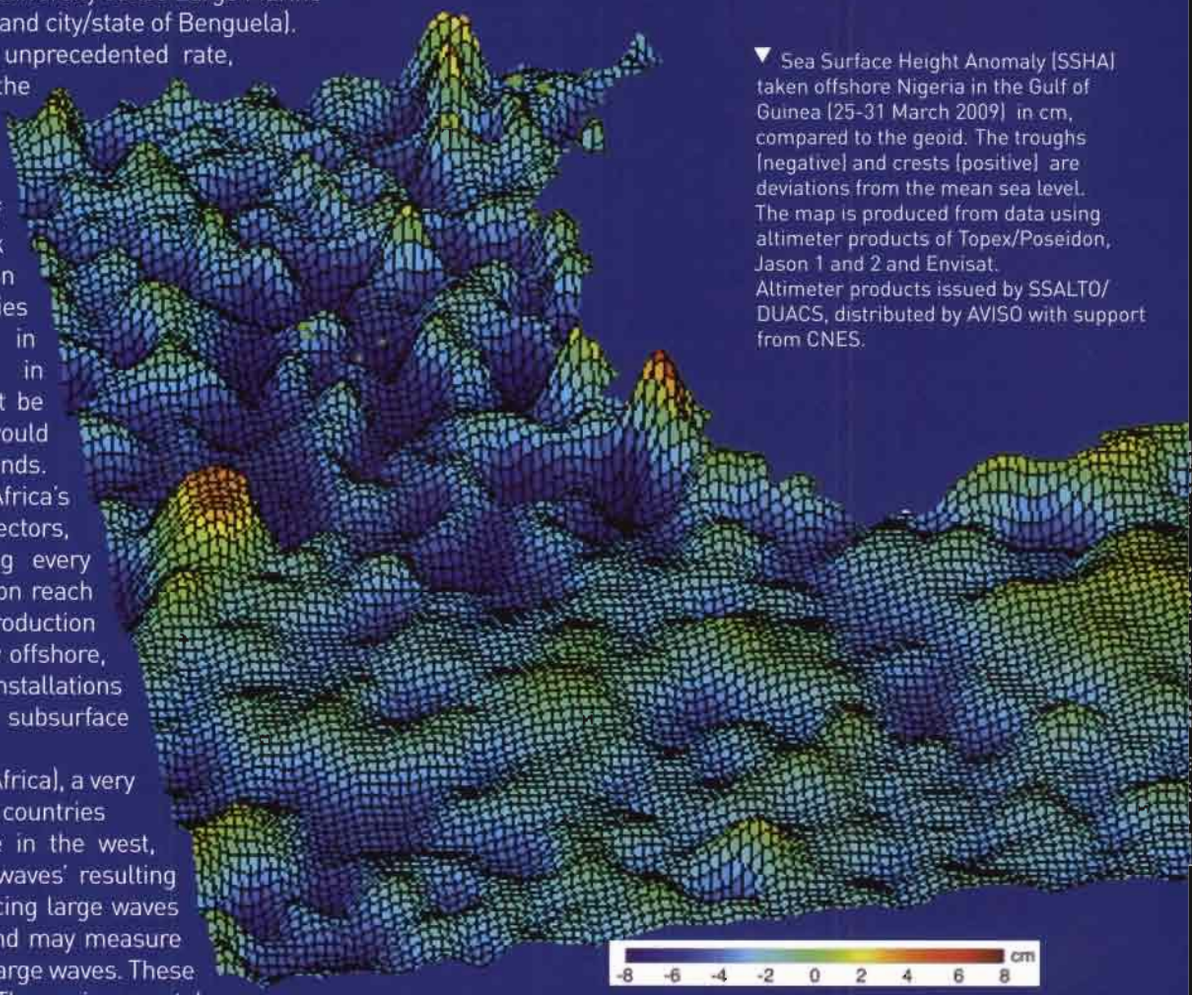
Coasts and altimetry

The African continent is bounded by oceanographic regions internationally recognised as requiring detailed analysis and monitoring. These are regions of wind-induced upwelling with high marine productivity and biodiversity called Large Marine Ecosystems (LMEs- Guinea, Angola and city/state of Benguela). The global climate is changing at an unprecedented rate, affecting economies and hence the livelihoods of people through the increase of natural disasters such as droughts, floods, coastal surges, sea level rise as well as the sinking of islands. According to the World Bank Report on sea level rise and ocean surges in 2009, many African countries would be recording an increase in storminess. Coastal agriculture in Nigeria (area of 1365 km^2), might be totally swept away, while Ghana would lose about 67% of her 268 km^2 wetlands. Coastal zones carry over 50% of Africa's population as well as the industrial sectors, with coastal population increasing every year. For example, Lagos, could soon reach 20 million inhabitants. Oil and gas production in the Gulf of Guinea is increasingly offshore, and storm surges could affect the installations such as the offshore rigs and subsurface pipelines.

The region of Cape Agulhas (South Africa), a very important shipping route linking the countries bordering Indian Ocean and those in the west, is subject to the threats of 'killer waves' resulting from the strong westerly winds forcing large waves against strong opposing current, and may measure more than twice the size of normal large waves. These waves also destroy the coastlines. The environmental agencies and research institutions of coastal countries in Africa (like NIOMR Nigerian Institute of Oceanography and Marine Research) have studied sea level change for many decades using tide gauges within the GLObal Sea level observing System (GLOSS) data network.

Other measurements of oceanographic features include ship transects and moorings that sample the ocean to various depths. But such measurements present limitations in terms of space and time coverage and there is no continued data flow over decades. Due to this unreliability as well as poor coverage, use of satellite altimeter data becomes necessary, like the ones provided by the JASON mission and soon SARAL. It provides a synoptic view of the ocean and lands with unprecedented accuracy and repeatability. This essential data is indispensable for decision makers to use in helping not only to mitigate risks at the densely populated coastlines but also to aid in the development of infrastructure that supports life.

For example, major offshore oil and gas companies use satellite altimeter gravity data to locate offshore sedimentary basins. In combination with other survey data, this helps them to know exactly where they will acquire or purchase seismic data. To encourage the use of satellite resources in exploring the environment, the African Association of the Remote Sensing of the Environment (AARSE) has very wide objectives that also include coastal zone

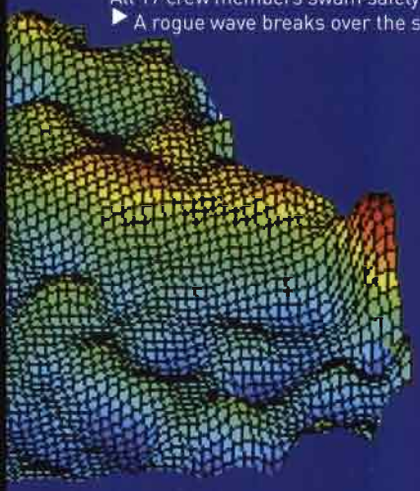


▼ Sea Surface Height Anomaly (SSHA) taken offshore Nigeria in the Gulf of Guinea (25-31 March 2009) in cm, compared to the geoid. The troughs (negative) and crests (positive) are deviations from the mean sea level. The map is produced from data using altimeter products of Topex/Poseidon, Jason 1 and 2 and Envisat. Altimeter products issued by SSALTO/DUACS, distributed by AVISO with support from CNES.

◄ With a population of 8 million, metropolitan Lagos (Nigeria) is growing rapidly and the urban poor population living in its coastal areas are at risk in front of climate change and sea level rise. © Afritramp

▲ The Meisho Maru, a Japanese tuna fishing vessel wrecked in 1982 at Cape Agulhas ('Cape of Needles' in Portuguese) well-known for its rogue waves. All 17 crew members swam safely to shore. This southernmost point in the continent of Africa is now an attraction of the Agulhas National Park.

▶ A rogue wave breaks over the supertanker Esso Languedoc in the Agulhas current off Durban, South Africa, in 1980.



◀ The Rosa field, 135 km off the coast of Angola in water depths of 1350 m.

▼ SARAL satellite, cooperation between CNES and ISRO (the Indian space agency) will study oceans with an altimeter in Ka band. Here, the payload module during integration.
Thales Alenia Space © Suds-Concepts

management. Space agencies also started to produce altimetry products dedicated to coastal areas such as PISTACH (CNES), COASTAL (ESA), ALTICORE (EU/INTAS) and the forthcoming ALTICORE Africa.

Ocean Data and Information Network for Africa (ODINAFRICA) is a centre that brings together over 40 marine related institutions from 25 countries in Africa. The aim of the centre, with the data and information management unit based at the University of Ghana is to ensure that local, regional and global marine and coastal data are made accessible to users in Africa. It serves as the regional sea level monitoring facility. ODINAFRICA also developed the African Marine Atlas where all tide gauge and other geospatial data are collected to form an atlas suite.

With the coordination of organisations such as the Europe-Africa Marine Earth Observation Network (EAMNet), the Global Ocean Observing System in Africa (GOOS-Africa), African Monitoring of the Environment for Sustainable Development (AMESD) and other African marine and academic institutions, a new generation of young scientists will be making greater use of satellite altimetry data than ever before. AMESD for example, extends the use of operational Earth observation from the meteorological point of view to environment and climate applications.

To strengthen a broader participation in climate studies, countries in Africa that have space agencies, which include Algeria, Egypt and Nigeria, might incorporate ocean-observing systems in their research. This would enable African researchers or academic institutions to cover all aspects of environmental studies and be an integral part of the data collection, dissemination and validation essential for the monitoring and prediction of environmental change.

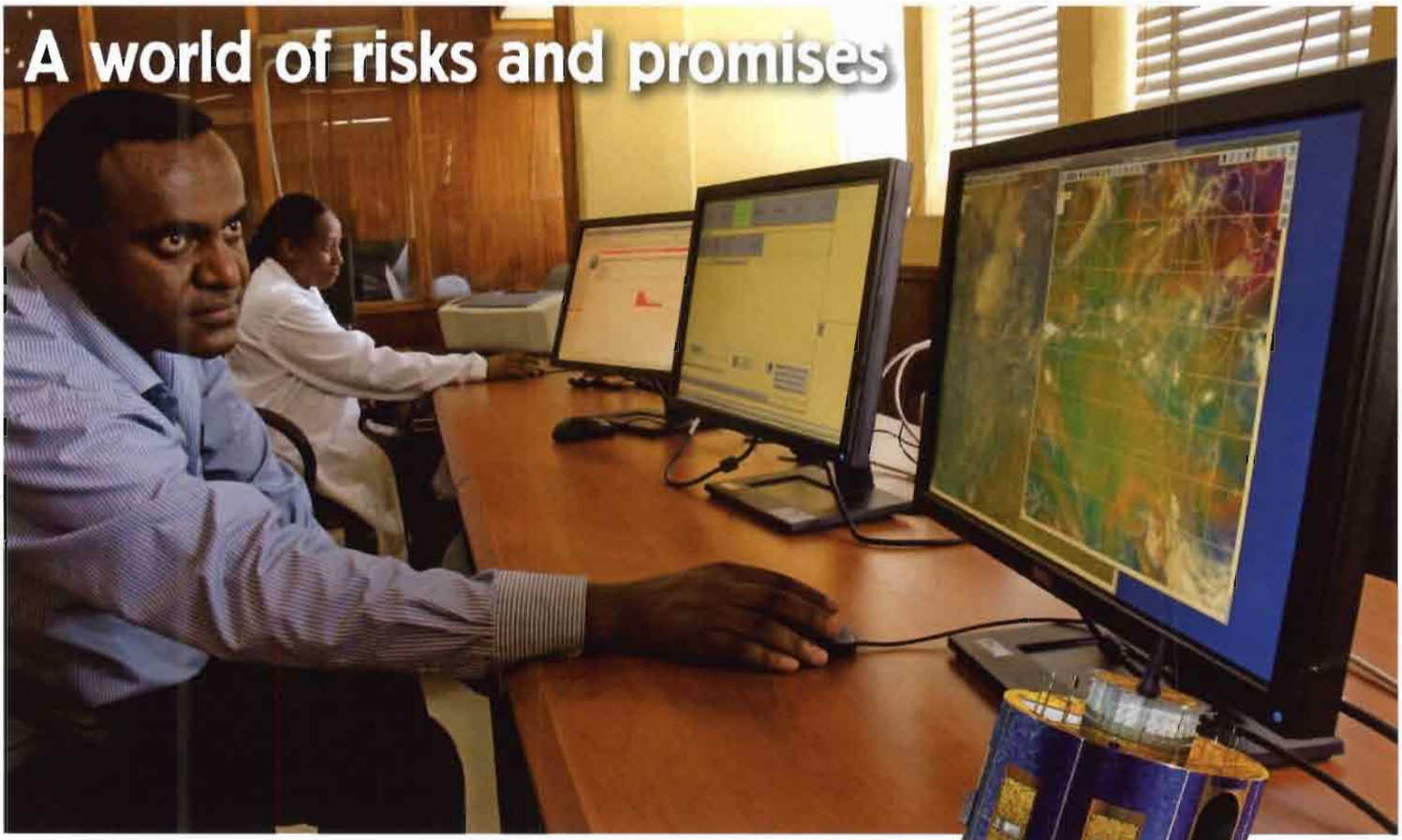
Ibrahim Muhammed (Nigeria)
PhD student at National Oceanography Centre University of Southampton (UK)

Land of colours

The pastel colours and soft, flowing shapes in this Envisat radar image of the Tanezrouft Basin in the Algerian Sahara contradict the harshness of the terrain that has led to it being commonly referred to as the 'Land of Terror'. Envisat/ASAR combination of 3 radar images taken in 2009 reveals surface roughness. Darker areas represent softer rock with a sandy or small-stoned surface. The colours result from changes in the surface between acquisitions.


Risks

A world of risks and promises



▲ Mr Kassa (National Meteorology Agency in Addis Ababa, Ethiopia) is working with satellite receiving stations providing meteorological information for short term forecasts.
© J.D Dallet/Suds-Concepts

Africa is a huge continent and participates in global environmental monitoring and economic development efforts. So Africa has to accept to comply with international agreements such as the implementation of Agenda 21 on Sustainable Development and the Millennium Development goals. Sustainable Development is based on three pillars — the environment, social issues and the economy — and all are concerned by risks.

Devastation by floods, earthquakes or fires have impacts on the environment, goods and services and lead to destruction of social services such as roads and schools. Drought affects food security and livelihood in general; drought and locusts invasions affect crop production. To these we have to add man-made disasters such as deforestation, urbanization and land degradation.

A lot of people are concerned by risks. During the years 2000-2001, 35 million people were affected by disasters in Africa. Disasters or risks have become an impediment for Sustainable Development.

What should Africa do? It has to address risks. If they are natural, you cannot avoid them but you have to reduce their impact on the economic, social and environmental sectors. How? First, you have to develop a risk reduction strategy and integrate it into development frameworks. To do so, you must see what the areas are and where the strategy should focus.This has to come up with your policy; you need to have the overall political commitment of policymakers. Without it you cannot do anything.

Strengthening institutions

The second objective is to improve the governance of institutions dealing with disasters or risk reduction issues. You have to enhance their knowledge, to assess and identify the kind of risks and disasters and the total impact they would have on the economy. Then you must also try to integrate all that into emergency response mechanisms.

Nowadays, countries have come up with institutions at different levels. To some extent, appropriate policies to address risk reduction and development in

▲ Artist's view of a Meteosat Second Generation (MSG). The European weather satellites operate in geostationary orbit at 0° longitude over the West coast of Africa.
© ESA-D. Ducros

Africa have been initiated. However these institutions have limitations: some of them have low capacity; others do not do their jobs properly. We need to strengthen them at continental, regional and national levels. This is the challenge. But we do not need to create new institutions to develop the

▲ Somali women wash clothes in flood-waters at an internal displaced persons camp in Arare, 12 km from Jamame, southern Somalia (2006). Thousands of Somalis have been displaced by what is described as the worst floods in the country in 10 years. © Manoocher Deghati/IRIN

▲ This man arrives in July 2011 in Badbaado camp (Mogadishu, Somalia), established for internally displaced people affected by the worsening drought in Somalia. African Union-United Nations Information Support Team. © Start Price

right strategies and mechanisms to address disaster risks. We also want to improve our use of new technologies like satellite data/information, not only for risk assessment and management but also to increase awareness of policy makers of the issues at hand. If you want to achieve their political will, you can use satellite data/information or satellite images to show the extent of disasters. Africa is a big continent and with satellite imaging you can show a large affected area in one scene. This is a good tool for supporting the cause of Sustainable Development. In addition to the policy makers, we have to increase the awareness of the general public. Satellite data can help here too. By using time series showing the impact of disasters such as deforestation, drought and erosion, we can explain 'This is what is happening because you are doing this or that; you have to refrain from putting too much stress on the environment'.

Monitoring the environment

We can present this to technicians but I think that schools would be the best because they are the most outreaching structures. Secondary and elementary schools in remote areas where you can show a film are most suitable. Pupils will tell their parents, the community and help to initiate the move towards Sustainable Development.

This is what is happening in Nganyi Village in western Kenya where community level interaction includes schools, youth and community in indigenous knowledge integration in disaster risk reduction after the release of local level seasonal climate forecasts.

Satellite data/information can be used as an early warning system or tool by identifying risks before consequences occur, for instance for drought, floods or food security. You can then integrate disaster risk in emergency responses.

Applications can even be broader: it can be used for monitoring the environment as is seen in AMESD. Satellite technology can provide data/information for integrated planning. For example if you have achieved good territorial planning and land use planning, you are in a good position to implement Sustainable Development. Africa is too big to have this kind of detail planning on the ground. The use of satellite data/information makes it easier and cheaper.

Of course there are limits. The main ones are education, awareness and creation: we need to show people what happens after a certain time of mismanagement or action. Look at forests: there is a movement to make sure that every piece of wood used is certified as coming from sustainably managed forests. But this generates a big debate about priorities. People agree that access to market is a development issue and it is difficult ▶

Preventing land degradation

▲ Degradated land between Mojo and Nazareth near Addis Ababa, Ethiopia. Worknesh and his nephews Tirunesh and Solomon, on their way to get wood for cooking.

Ethiopia is endowed with a wide variety of soil types lying in juxtaposition on plains, valleys, undulating and rugged hills and mountains, and other landforms. The increased loss of forests and vegetation cover in natural and farming landscapes over the last three to five decades resulted in high rates of soil erosion, loss of soil fertility, decreased crop and livestock productivity and siltation and contamination of water resources.

Rugged terrain, heavy human and livestock pressure, and poor conservation measures have further aggravated the soil deterioration. Appalling scenes of land degradation are consequently witnessed today in vast areas of the country. These interwoven problems will directly affect the sustainability of natural resource management and the livelihoods of the rural poor.

The Ethiopian highlands are the most intensively cultivated areas, with more than 88% of Ethiopia's population depending on these areas for agriculture. The cereal, livestock, 'enset', coffee, pulses, root crops and chat cultures are among the most prominent in the country. Of these, pulses, coffee, livestock and chat are sold to the international market, contributing significantly to the Ethiopian GNP. Some 27 million ha representing approximately 50% of the highlands are already highly degraded. The Hararghie highlands (Oromia Region, eastern Ethiopia), Tigrai (Tigrai Region, northern Ethiopia), Wollo and Semen Shewa highlands (Amhara Region, north-central and northern Ethiopia), Gamo Gofa highlands and the Bilate River Basin (Southern Region, southern Ethiopia) are among the most seriously degraded land surfaces in Ethiopia.

Loss of organic matter

Poor soil and water conservation measures coupled with little vegetation cover, sloping terrain and bad farming practices have resulted in the land degradation for example between Modjo and Nazareth, near Addis Ababa.

Because of serious deforestation in the area the surface soil material has been completely removed, leaving the land bare and subject to erosion. Consequently, the land has become totally unproductive, and as a result the community is abjectly impoverished.

The amount of annual soil movement (loss) by erosion is estimated to range from 1248–23400 million tons per year from 78 million ha of pasture and range lands and cultivated fields which account for about 65% of Ethiopia's land surface. Associated with the soil movement is the loss of 15,6, 2,16, and 5,85 million tons of organic matter, nitrogen, and phosphorus, respectively. Of lesser importance is chemical degradation of soils in urban settings resulting in soil contamination from toxic compounds released from industrial and municipal wastes.

Unless timely measures such as conservation tillage, planting of appropriate trees for restoration purposes, composting, crop rotation, terracing, constructing micro-dams, and soil chemical amendments, etc. are taken, most of the Ethiopian land under the current environmental pressure will continue to be further degraded and at some places may even turn into desert. Such concerns are raised at conferences held by the Ethiopian Soil Science Society (ESSS),

▲ Balainesh and Adelgaino picking coffee at their plantation in Wondo Genet, in the Sidamo region, famous for its high quality coffee. Coffee is Ethiopia's largest export, which generates 60% of its total export earnings. © J.D Dallet/Suds-Concepts

the Forum for Environment, Forum for Social Studies and others. The Ministry of Agriculture, the Ethiopian Environmental Protection Authority (EPA), regional colleges and universities of agriculture, and individual researchers at universities, research organizations and NGOs are quite often the ones taking the lead in addressing this issue.

An example of mitigation of land degradation could be seen beginning from Arsi Negele up to Awasa and further South. This is mainly due to traditional soil conservation practices such as agroforestry, mulching, crop rotations and other similar measures. We were able to observe a good amount of ficus trees mixed with a variety of both vegetable and agronomic crops. Moreover the farmers have a tradition of growing crops such as onions, soybeans and potatoes during the early rainy period which they replace with wheat immediately after harvest; thereby, introducing crop rotation in their farms at the same time keeping the land covered with vegetation throughout most of the year. Coffee is known to be an important source of income to many farmers. It also brings substantial amount of foreign earnings to the country. Farmers in Wondo Genet tend to grow coffee together with other crops which could be considered as a soil erosion mitigation measure tool.

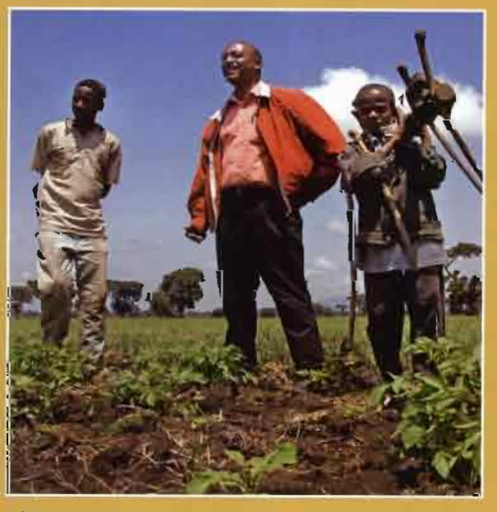
Satellites will help in the near future to manage the land degradation risk. The Ministry of Agriculture started using satellite imagery to assess the woody biomass of the country in mid-1990's, which was active until about 2004 when the Project phased out. The Woody Biomass Project was supposed to build capacity in using satellite data to assess the status of woody vegetation cover, which could have been expanded to cover documenting and monitoring land degradation. But this did not materialize and there has not been any effort to build capacity of the Minsitry to make use of the satellite data.

Building capacity with AMESD

In this sense AMESD IGAD service may help in building capacity to enable member countries to assess and monitor land degradation.

The first objective is to identify extent and severity of land degradation at the regional and national levels and to identify local spots for comprehensive assessment. Its outputs aim to support policy decisions for combating land degradation at regional level. It will also give more detailed information of the sections of IGAD countries experiencing severe degradation so that appropriate planning of the national resources could be instituted.

Pr. Fisseha Itanna
Faculty of Life Sciences
College of Natural Sciences
Addis Ababa University
Ethiopia



▲ F. Itana examining crops with farmers Abdusa Kedir and Faruk Adan, near Arsi Negele, Ethiopia. © J.D Dallet/Suds-Concepts

▲ Dissection of Anopheles mosquitoes in the village of Maga in northern Cameroon using a portable binocular microscope. © Carlo Costantini/Indigo/IRD

▶ to find the right balance between environment protection and boosting the economy.

Concerning the use of satellite data, we need a policy framework and strategy at the continental level and countries must develop national strategies, adapt the continental strategy to regional specificities.

One of the areas where disaster risk institutions fail is access to data / information. When it is available and used properly, it can ameliorate their capacity. So improving access to data/information is a challenge. In some cases, it is available freely, like Meteosat data which is given to Africa. However, it is of low resolution and to complement it you have to buy high resolution which is still very expensive. Nevertheless, with what we have, we can already do a lot. Implementation at the country level, i.e. in the environment and agricultural sectors, is difficult. This is as a result of lack of access to satellite data / information as satellite data ground receiving stations are located in the Meteorological Services, which are not networked with other institutions.

More trained experts needed

Linkage between institutions is deficient. The question is 'who should use the data/information?' For instance, the national level might sometimes have capacity but when it comes to district level it is different. We have to network and enhance capacity at that level by training. We have trained a number of experts with PUMA, and now there is training with AMESD, but there are not enough trained experts. This is partly because, when trained, they leave for better opportunities. Staff turnover is high and affects the project or sector. The solution is to train more experts. Financing is also a limitation. Whatever we have is not implemented as desired due to the lack of resources and capacity.

Disasters seriously affect development. We have to keep reserve funds for emergency situations and relief activities. Rather than financing Sustainable Development alone, we need to support efforts that would reduce disaster risks and their consequences. For instance, we lack funds for buying equipment and if we get some through foreign support it simply becomes obsolete after the project expires. It is a very vicious circle. But if we are dedicated to achieving Sustainable Development goals as well as participating in international environment monitoring systems, particularly those based on satellite technologies, we need to maintain the infrastructure put in place with the help of foreign support, such as AMESD.

Dr Debalkew Behre
IGAD (Intergovernmental Authority on Development)
Djibouti, Republic of Djibouti

▲ A police commander explains the action of the Anti Stock Theft Unit (ASTU) and of the police in Karamoja, Uganda. © Khristopher Carlson/IRIN

Traditional practices

Cultural practices, traditional knowledge and technologies are used to cope with risks. During floods, people construct structures with sandbags and stone or move to higher ground to avoid damage. When confronted with drought or locusts they turn to their crop reserves or sell their livestock. That is why pastoralists keep huge livestock numbers.

Whenever calamities occur, people get together and pray in churches and mosques. Some go to witchcraft and slaughter an animal as sacrifices. Whether it works or not, it is part of the culture. African society is evolving but you cannot get rid of such cultures overnight.

Globally, the percentage of young people is increasing. Very often, they are without employment. And, due to social change, the authority of the elders is destroyed. Moreover, in remote areas, certain communities, mainly pastoralists, feel totally marginalised from the national economy. For example, before, cattle rustling was used by pastoralist tribes when you wanted a wife from another tribe, to show you were strong. You needed the agreement of the elders, otherwise you were thrown out of the community. But cattle rustling has become an organized business: this year around 30 000 cattle were stolen in Eastern Africa region.

More positively, wild animal protection has improved. Killing an elephant or a lion used to be a sign of strength, dignity and bravery. Look at my earring: it belonged to my father and showed that he was very brave because he killed a lion. There were plenty at that time. But our wildlife resources have decreased dramatically and we now conserve our lions and elephants and monitor their movements and numbers with satellites.

D.B.

We must unite

AFROGEEZ

The nine members of Afrogeez live in Abidjan. Gbao Gbao, their first album, a joyous mixture of reggae and ragga dance hall recorded live, was released in May 2011. They want to awaken awareness of the socio-cultural problems of their country. They were revealed to the public in 2006 in a series of concerts sponsored by a telephone operator. In 2007 the group won the Musical Creation competition at the Fête de la musique in Abidjan and played at the Grand Concert de l'indépendance de la Côte d'Ivoire. © Afrogeez

Allah would like us to agree and unity to live in us to build a radiant future
God would like us to tolerate and forgive each other to unite and to encourage unity
The children of the most high and mighty should be able to pardon each other
To conserve real love and give us a better future

The Amazonian policy of men makes conflict and war in the world
When there is no more agreement there is no more love while we should remain together
If there is no longer any unity among men I wonder what will become of our world
It will be a dump, something dark I beg you to listen

With riddim I preach one love of Jah between all countries oh Lord, do we really want that for us?
We fight all the time and hurt each other we make life complicated day and night with scandals
I talk to you about it because it muddles my mind it's not normal na na na na na
Not right, it really is too much, times are really serious the damage is enormous
It's a mess everywhere/we must unite, we must louuuu

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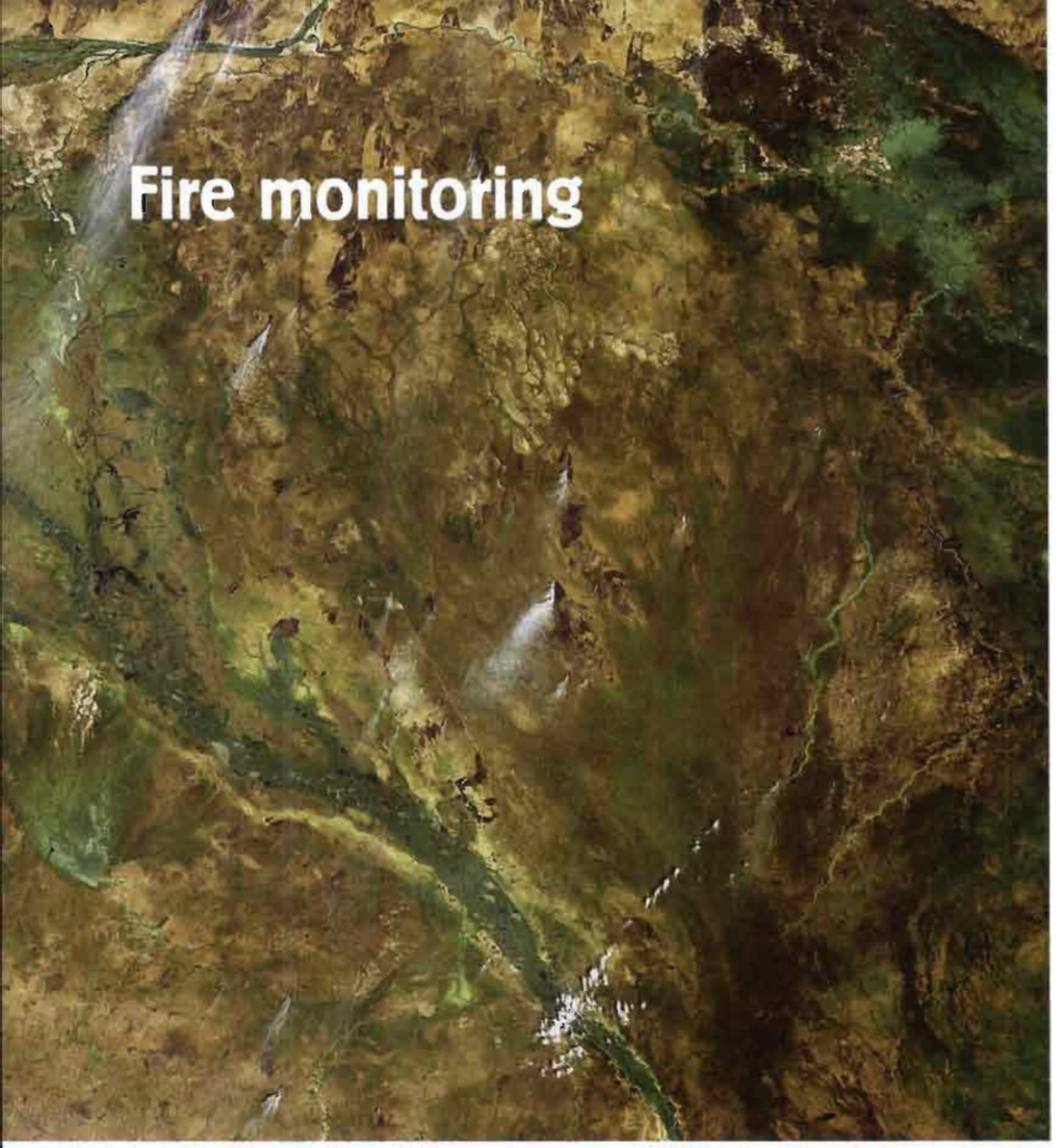
Fire monitoring



▲ Smoke plumes from burning fires over South Sudan. Agricultural fires in the region are common during the dry season beginning in November. The lush green area running from the top left to the bottom centre of the image is the Sudd, one of Africa's largest floodplains, providing watering and feeding grounds for migratory fauna. Envisat/MERIS image © ESA 2006

Approximately 600 people die and over 4 000 are injured annually in South Africa as a result of fire, and these blazes cause more than 50 million Euros' worth of damage to property every year. Fire is responsible for many diseases related to constant smoke, like asthma. It also has an impact on climate change, land cover, the productivity of the vegetation and it opens up the landscape. When you fly a plane or you look at satellite images you can see a river of smoke coming from Angola, flowing over Zambia, Botswana and Mozambique. It stays all the year and can reach Australia. A dramatic event convinced me to devote my career to fire. In September 2001 a very big fire disaster killed 23 people in the Kruger Park. At that time we received NOAA satellite data. As I had to write the final report on this event, I mapped this data and could clearly see where the fire started, when it crossed the road, the change in wind direction that killed people miles away from where it started. I understood that we could prevent this kind of disaster if we had a more pro-active information system, integrating more data sources.

So in 2003 we started developing the Advanced Fire Information System (AFIS) as a service module of the Wide Area Monitoring Information System. WAMIS provides continuous data streams captured and processed by the South African National Space Agency (SANSA formerly CSIR — Satellite Application Centre) at Hartebeesthoek, near Pretoria, as well as by the Meraka Institute in Pretoria. It aims to deliver fire information products to researchers, Fire Protection Agencies and Disaster managers all over Southern Africa in support of decision-making in the monitoring of fires. It is the first near real time operational satellite fire monitoring system in Southern Africa. We were looking for financing and heard that Eskom, South Africa's biggest power company, had problems with fire developing underneath their 28 000 km of transmission lines. The smoke ionises the air, creating a path through which electricity arcs to the ground. Wild land fires can then cause flashovers, which severely affect electricity supply to industries, causing important economic losses. We told Eskom: 'we can prove to you that we can do something and we will do it free for a start'.

The architecture of the system was originally based on the MODIS Rapid Response Web. But MODIS (Moderate Resolution Imaging Spectro Radiometer) only flies over for fifteen minutes twice a day. So it may miss many. So we decided to integrate data from METEOSAT Second Generation (MSG), which provided data every 15 minutes. At first, people were sceptical. But the CSIR SAC (Satellite Application Centre) in collaboration with David Taylor developed the MSG Fire Tracker software package and it worked perfectly: over the next year, the alert system detected 65% of all fires that caused outages. So Eskom agreed to assure the main funding for the development and implementation of AFIS.

Technically, one of the problems to solve is the difficulty to give access to the data online via Internet.

EUMETCast receiving station

So we look for an alternative system using EUMETCast, the dissemination mechanism for the EUMETSAT satellite. South Africa has about 20 receiving stations. We produce data and send it through Internet to EUMETSAT in Darmstadt (Germany), they send it to the satellite which distributes it to every EUMETCast receiving station. Within a minute or two we can distribute our information to all the South African countries. All it needs is a very low cost fixed antenna and with our application the client can display and analyse the information on his desktop.

The AMESD project provides the key function of both providing EUMETCast stations to all fire-related institutions in SADC and to provide additional funding to expand on the existing AFIS field terminal concept. It also provides key training to regional users. Concerning cooperation and partnerships, SAFNET, the Southern Africa Fire Network, of which I am one of the coordinators, brings together scientists from the region as well as from abroad to work on satellite-based

▲ Top, Philip Frost, near a satellite data receiving antenna at the CSIR of Pretoria, South Africa. Bottom left, his colleagues Bruno Meyer and Daniel Matsapola in the Satellite Application center at Hartebeesthoek. © J.D Dallet/Suds-Concepts.
Bottom right, a fire danger billboard used to warn population. © All rights reserved

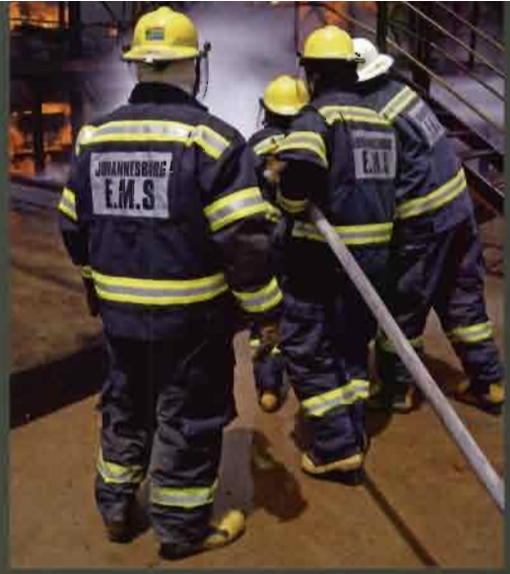
fire products that could provide a better understanding to countries governments on the importance of fire management. People cannot understand why 64% of the country burns every year in Angola, 58% in Zambia...

We are going to produce for each country 10 years of data on a DVD with vegetation time series, after fire time series, burned area and give it to fire specialists with the open source software. People will be able to analyse all that and produce maps and images they can show to politicians. This will help their country for better fire management and, globally, adopt sustainable development policies.

More globally, concerning disaster management, the CSIR has promoted the data democracy initiative since 2008, under the responsibility of my colleague Daniel Matsapola. It is based on four pillars: data access, software and tools, data dissemination and capacity development. The first output of data democracy is the FUNDISA (teach in local language) disc. It is a hard disc containing data that we now receive free from the USA, Japan, China and Brazil and software that we distribute freely to local tertiary education institutions. European participation has not yet materialised due to budget reasons. But, for the SADC region, data democracy is now supported through AMESD for dissemination of data and training.

Philip Frost
Senior scientist
CSIR Meraka Institute, Pretoria
South Africa

▲ South African power company conducts controlled burns at night to clear brush near the lines. © Hein Vosloo/Eskom



▲ Hot fire training at the Emergency Care Training Centre, City of Johannesburg, South Africa. ©Jan Liebenberg/Firefighter Nation

Education and training

Many of the fires burning in South Africa are caused by activities such as harvesting of crops (sugar cane), preparing fire breaks, burning refuse and arson. Cultural reasons such as the belief that good grass fires cause good rains are especially evident in the rural areas. Fires are also set by smoking out bees, killing mice and poaching which is very damaging. Now, the main users of this information are the Parks, plantation people and fire protection associations. Companies like Eskom don't have their own fire fighting teams. Thus, working on fire is a government-based program with the idea to empower and to train people without jobs, previously disadvantaged communities specially, to become fire fighters.

Training and fire fighting requires a lot of organization. South Africa climate ranges from Mediterranean in the south-western corner to temperate in the interior plateau, and subtropical in the northeast. So we have two 'fire seasons': the dry summer months in the Western Cape, and the dry winter months throughout the rest of the country. Trainers and fire fighter teams have to keep moving all the time.

The biggest thing is education about the danger of fires. So, for communities, we have big billboards with blue, orange and red colours for fire danger days and in the morning, someone sets an arrow indicating the level of this fire danger. And kids learn "on those days you shouldn't go for fire, because it's bad".

Ph.F

Fires regenerate land

NAVASHNI GOVENDER. Programme Manager Fire Ecology and Biogeochemistry, South African National Parks (SANParks) Kruger National Park, Skukuza, South Africa.

Africa is often referred to as the 'Fire Continent' due to the widespread occurrence of biomass burning. For thousands of years, fire has been shaping the landscape, selecting for fire resistant/tolerant flora and fauna. Previously only lightning was considered as a natural fire source, but humans — pastoralists, tourists, migrants and poachers—are now the dominant reason for the ignition of wildfires.

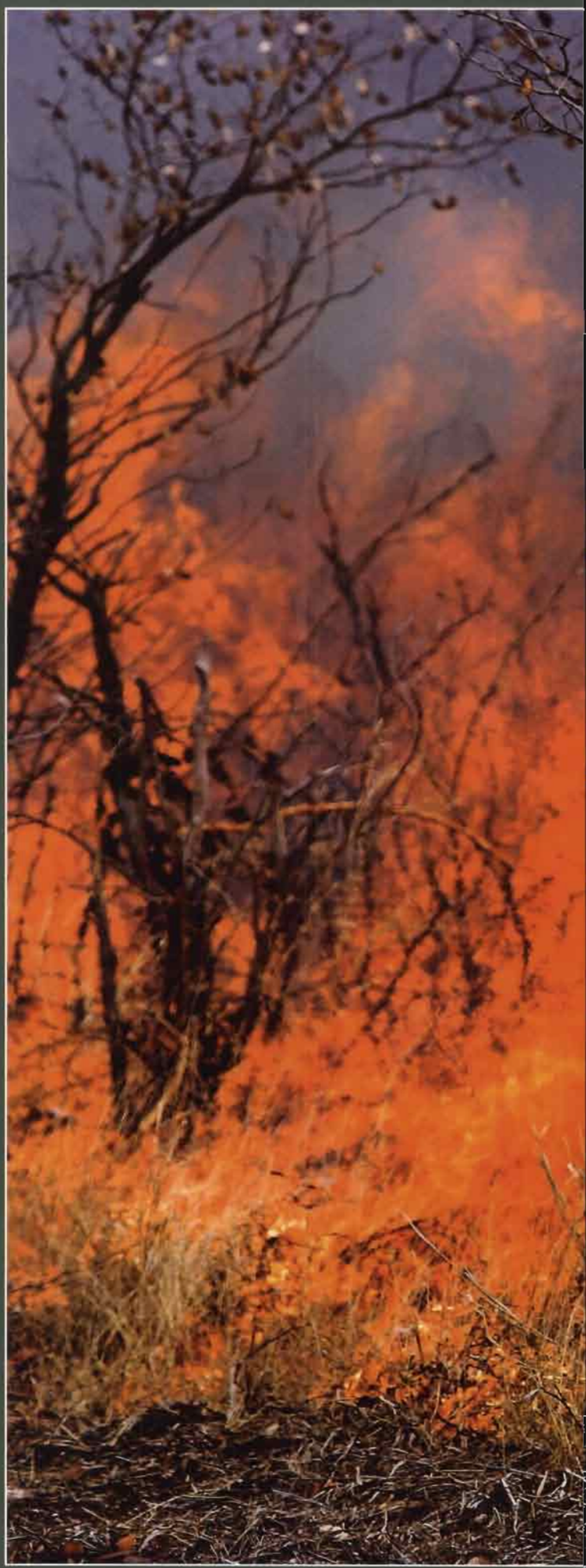
South Africa has a long fire history: the Kruger National Park started research in 1954 and as soon as 1957 regular prescribed burning was practiced. Today, it has become a usable tool in conservation. To use fire more effectively as a management tool we need to know what effect it has on trees, grass, ants... how it behaves, how the landscapes react. Knowing how hot it burns is important because it affects ecology. We are also working on post-fire effects. For example, we want to know if we can use high fire intensity to control bush encroachment. Maintaining biodiversity is today our ultimate aim.

Technology helps. In the past, we had hand-drawn maps and then we used ground-based and aerial photography. Now we associate satellite monitoring and photography to record fire behaviour and fire effects. We do pre-fire measurement, fly a LiDAR with a plane, burn and then we do post fire measurements. We have a remote sensing scientist specialist, using NDVI (Normalized Difference Vegetation Index) to study fire severity. These tools are easy to use. I just have to log on to Phillip Frost's site with my computer in my Skukuza office to get maps and data.

People are very emotional about fires, so we get criticism from ecologists and tourists. But when you make lectures, they understand that fires are useful for regenerating land, like rain. They are also conscious that temperatures are increasing and rainfall is decreasing so we have more high fire index days. If we do not perform burnings we will have more uncontrolled fires.

We think beyond our fences. We have a Fire protection association to share resources and strategies and a joint management board with Mozambique. We welcome local and foreign students from many countries. We receive 200 to 300 research projects every year!

South Africa National Parks manage and maintain the land for the benefit of the population, but the land belongs to the community and they manage accommodation and get revenues. Sustainable development benefits people. Saying 'look how beautiful it is' is not enough, they want tangible benefits.



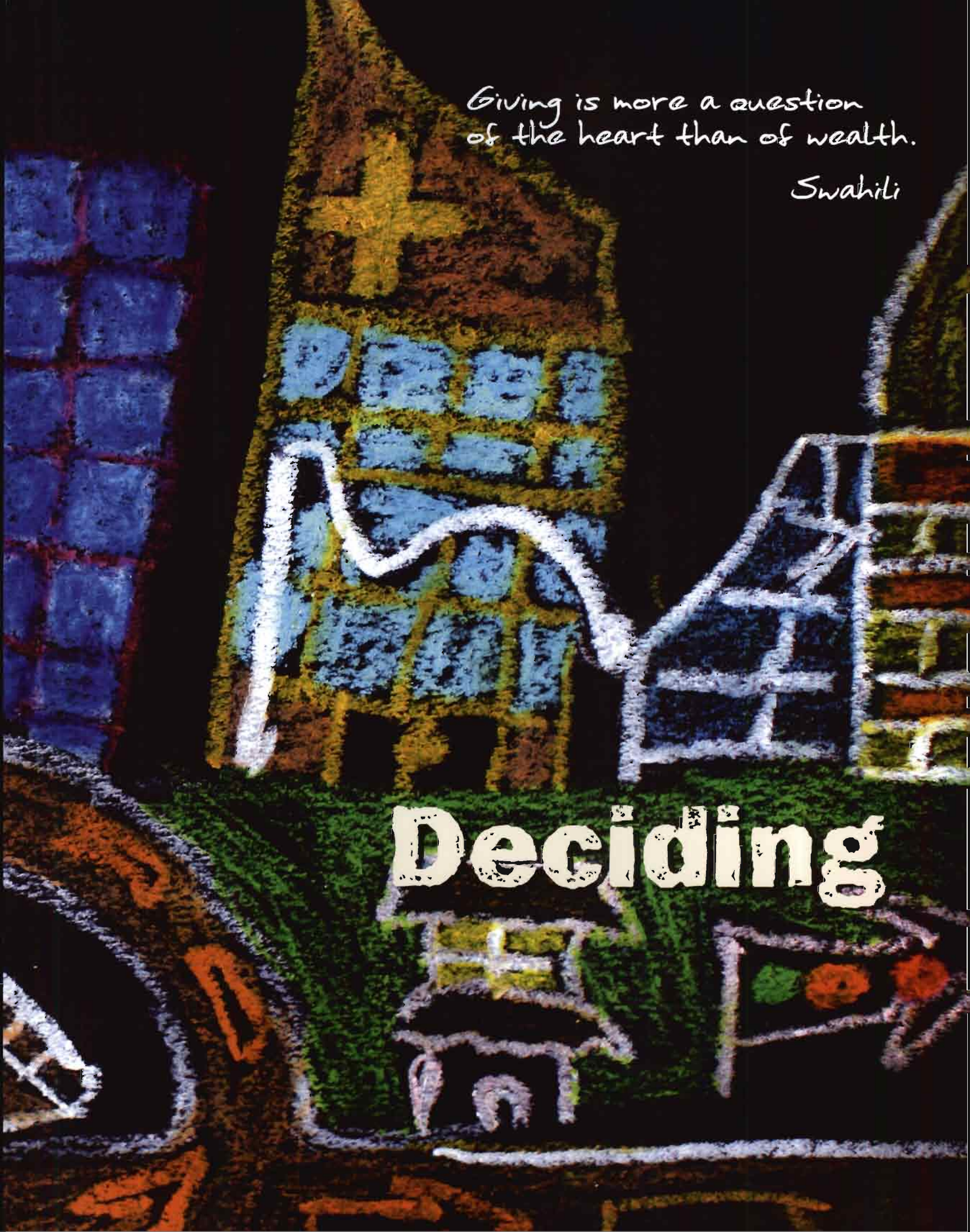
Trained team in the Kruger National Park setting fires in a controlled way as a means of providing a practical solution to the occurrence of extensive and highly dangerous unplanned wildfires.

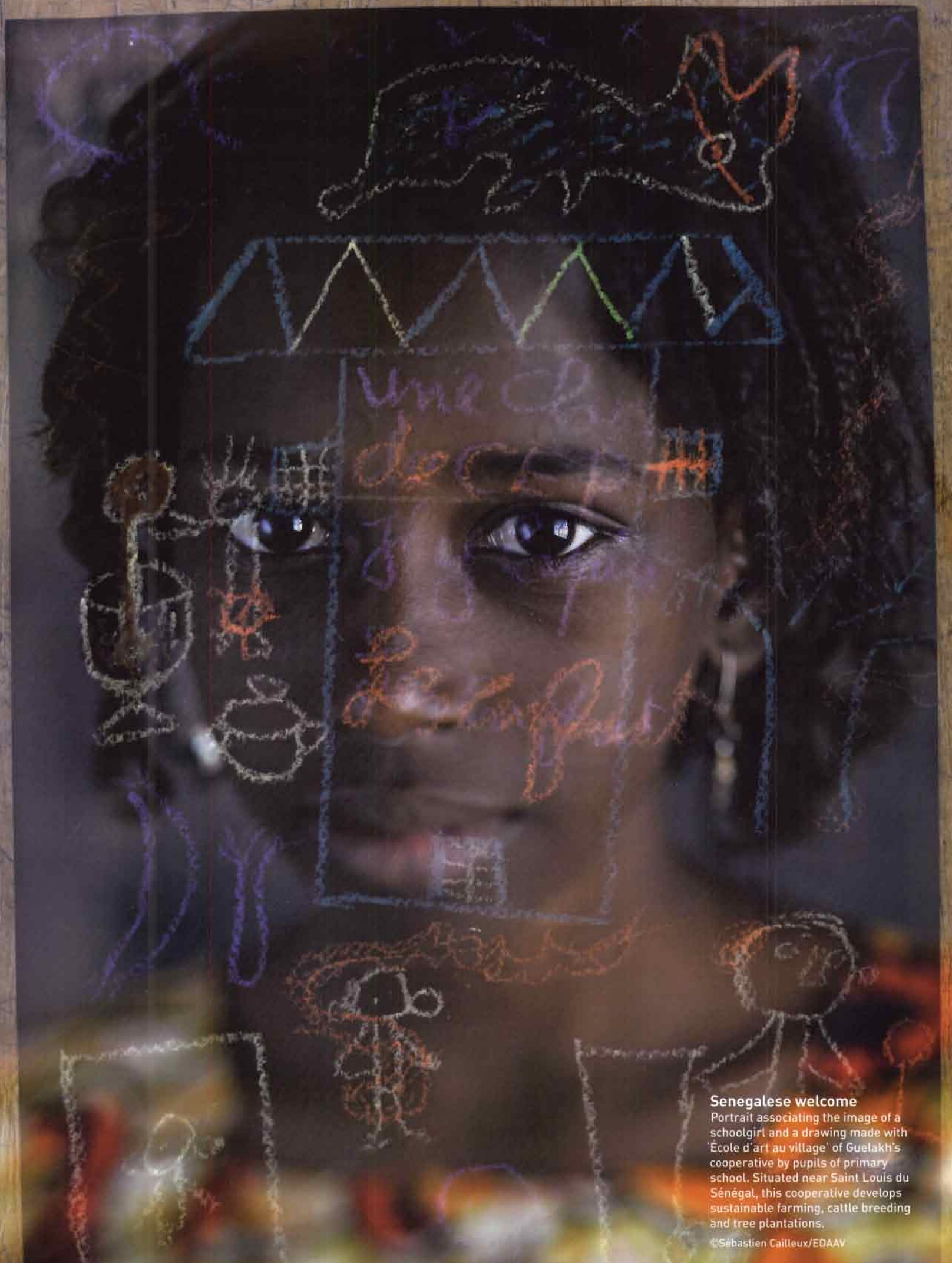
Top left, Navashni Govender in her Skukuza office.

Futuristic city

The 'École d'art au village' association is opening 'Atelier - Galerie Edaav' (studio-galleries) in different African countries. The aim is to enable children and associated artists to conduct an educational and artistic project that lasts in time. More than twenty 'École d'art au village' have been created and a new one will be opened in Addis-Ababa (Ethiopia) in 2012.

Here in Lambaréné (Gabon), pupils at the primary school of Doctor Albert Schweitzer foundation were asked to work on the two topics 'Draw nature, draw the city'. All the children chose nature for their first drawing, as if the idea of the city appeared remote and abstract to them. The second drawing session revealed this futuristic vision of the city.


Giving is more a question
of the heart than of wealth.
Swahili
Deciding



Senegalese welcome
Portrait associating the image of a schoolgirl and a drawing made with 'École d'art au village' of Guelakh's cooperative by pupils of primary school. Situated near Saint Louis du Sénégal, this cooperative develops sustainable farming, cattle breeding and tree plantations.

ICT for sustainable development

Africa faces significant deficit not only in Information and Communication Technology (ICT) but in all major infrastructures in general, resulting in increased production and transaction costs, reduced competitiveness of businesses, therefore affecting the rate of economic and social development on the continent. Numerous ICT statistics point to the fact that Africa is the most unconnected continent: low numbers of households with computer and working internet, low access to internet for age group of 16 years and above, low numbers of customers with access to broadband, etc.

Challenges facing Africa in ICT:

- Lack of connectivity, accessibility and affordability in all rural and remote areas constituting over 70% of the total population of about 900 million people;
- Lack of appropriate access networks due to the geographical terrain of the continent;
- Connecting Africa to Africa and within African countries themselves in a cost-effective way;
- Africa is an island in the middle of the ICT sea and the landlocked countries are an archipelago of islands;
- The development of ICT in Africa is a driver for socio-economic development but remains a burden for the fragile populations;
- Low broadband penetration leading to very high costs.

Addressing these challenges it requires a continental integrated approach which not only focuses on connecting Africa to the rest of the world but also connecting Africa to Africa and within African countries themselves. Regional integration is necessary to overcome the limitations of Africa's small and fragmented economies.

PIDA'S objectives

This drive is contained in Africa Vision 2040 of the Programme for Infrastructure Development in Africa (PIDA) which aims at enabling *'Any African anywhere in Africa to reach the IP world (voice and data) at affordable price. It also aims at efficient usage and management of ICT resources for increased literacy, poverty reduction and support of socioeconomic development and regional cooperation. It is estimated that Africa's population will jump to 1,5 billion, more than China and more than India!'*

PIDA was launched on 24 July 2010 in Kampala, Uganda, on the sidelines of the 15th African Union heads of state and government summit. It is a joint initiative of the African Union Commission (AUC), the New Partnership for Africa's Development (NEPAD) Secretariat and the African Development Bank (AfDB) Group.

PIDA's objective is to merge all continental infrastructure initiatives into a single coherent programme for the entire continent. The overall goal of PIDA is to promote socio-economic development and poverty reduction in Africa through improved access to integrated regional and continental infrastructure networks and services. Increased regional integration is important in ensuring sustainable development in Africa. ICT is considered as an enabler crosscutting through infrastructure programmes like Energy, Transport, etc. in view of its inherent multiplier effects.

The PIDA programme is a continuation from the Connect Africa Initiative which was launched in October 2007 in Kigali, Rwanda. This is a continental initiative for mobilizing resources for the implementation of infrastructure development programmes related to connectivity in Africa. In both cases, PIDA and Connect Africa, there was a good support from the leadership of Africa which is an indication of political will. These initiatives/programme focus on development of huge capacities around and inside Africa to support broadband communication, and at the same time create more access to the large population. While various submarine fiber cable projects are being implemented, several satellites earmarked for launch will provide coverage for Africa. Together with other technologies, all of them will be complementing one another.

▲ RASCOM-QAF 1R satellite under integration. Placed in geostationary orbit at an altitude of 36000 km, the satellite provides telecommunication services at the scale of Africa.
Thales Alenia Space. © Serge Henri

▲ Attoungblan sacred drum players monument near Abidjan Airport (Ivory Coast). The sound of this powerful twin talking drum is a call to action.
© Jones Killimbe

The dream of the future

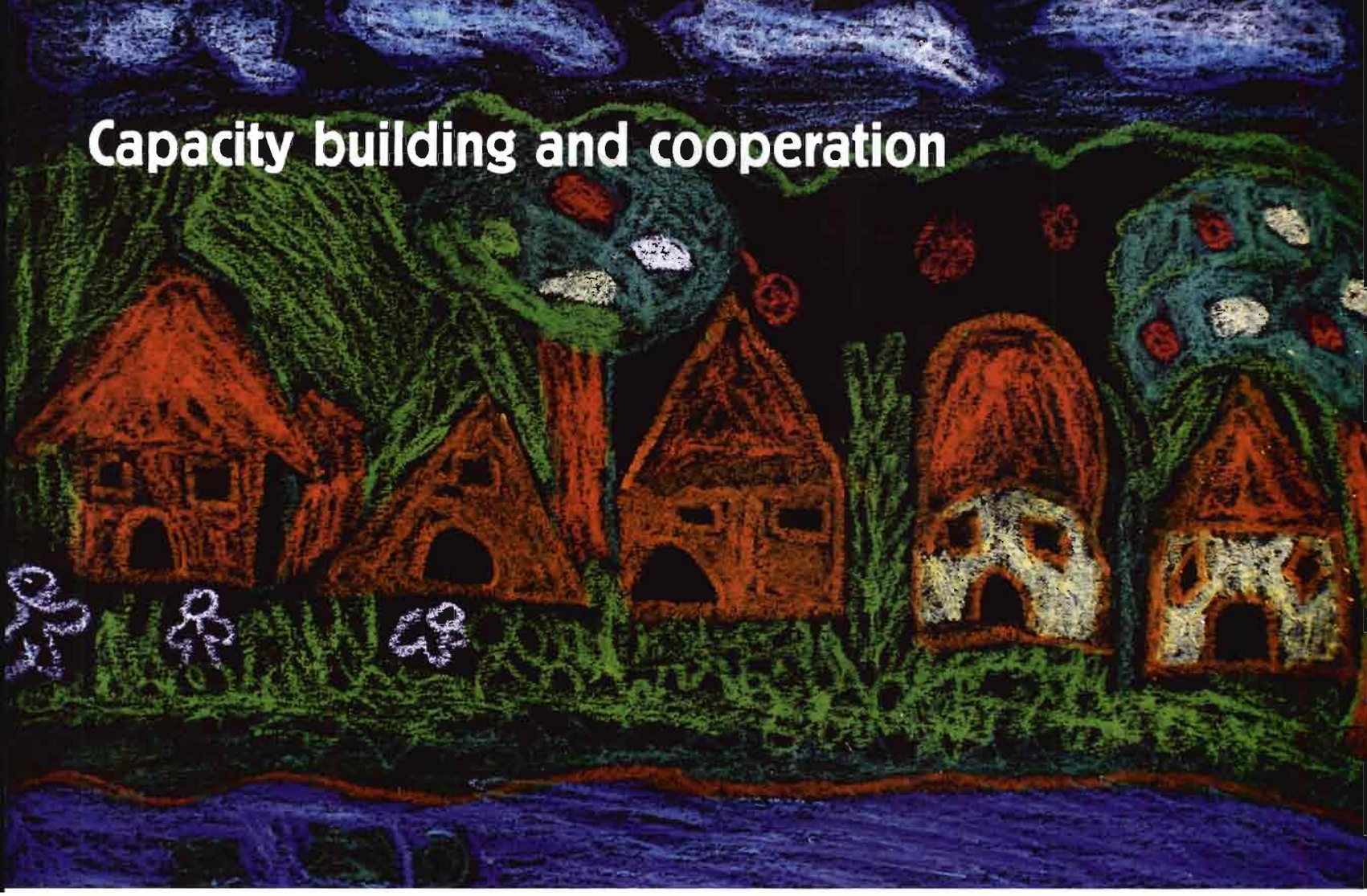
This reminds me of the drum which has been producing drumbeats as a means of communications for one hundred years until today. The sounds produced are like bitrates which send different messages at different times. These are talking drums. They still exist today in numerous African countries in villages to announce somber news, to call a meeting and as a herald. The manner of beating the talking drums conveys important prior information.

People admire drums and the beats because they have been sustained for many years. We now know that ICT, which is a source of information, communication and knowledge, can be a vital tool for sustainable development and Africa needs the drum and drumbeats in other words more than ever before to be part of the world information society. Welcome to the drums and enjoy the sounds of the drumbeats.

Dr Jones Killimbe
Director General & CEO, RASCOM
Abidjan
Ivory Coast

Palaver satellite dish
Students preparing exams near a satellite dish at Addis Ababa University, Ethiopia. This University was founded in 1950.

Capacity building and cooperation



▲ Art training is part of education. This village painting was presented during the 'Draw the city' project by primary school pupils of the Doctor Albert Schweitzer foundation. © Sébastien Cailleux/EDAAV

Today, Africa must face the challenges of sustainable development and adaptation to climate change. It is also a developing continent but suffers from major handicaps such as weak infrastructure and higher education and inadequate resources devoted to training and research. These problems of resources are accompanied by and possibly cause a brain drain. Although this is a global phenomenon, in Africa it is a serious problem for the development of the continent.

Our environment is subjected to natural and man-made disturbances operating on very varied temporal and spatial scales. They can cause serious imbalances and trigger catastrophic and sometimes dramatic situations, especially in zones with high population density, with serious consequences for the various socioeconomic sectors.

The Indian Ocean zone is particularly exposed to natural risks that threaten populations and the environment in a recurrent and random manner. In the present context of climate change, these risks may evolve, multiply and/or intensify and even become a daily reality. They must be taken into account urgently and in a coordinated manner. In addition, the increasing populations of developing countries and accompanying explosive urban growth contribute to aggravating the vulnerability of our environment.

Initiation of capacity building policies

Remote sensing is a particularly appropriate tool for facing the urgent challenge of adaptation and the everyday management and monitoring of risks and catastrophes at various local and regional scales. It is also an essential tool for the monitoring and assessment of environmental changes and for prevention. With the ever-increasing precision of digital images, an increasing number of satellites devoted to observing the Earth and the environment, spatial remote sensing images are turning into everyday items. They are becoming the most effective, simple and cheapest method of obtaining information about the surface of the world. Applications for images and spatial data are thus developing strongly.

The CNES, an active player in spatial remote sensing, sets up and participates in projects using imaging and observation. It is also involved in the Indian Ocean region via concrete research and training actions and has special relations with scientists. In Madagascar, it supports the *Comité National Télédétection* (CNT) and participates in training workshops and teaching for an international master's in 'Remote Sensing and Natural Risks'. One of the main preoccupations of this programme is the initiation of capacity building policies in Africa to achieve a critical mass of experts capable of conducting processing and analysis locally.

Research programmes

The CNES also carries out actions in Reunion Island. Another example of cooperation is the Kalideos/BD Isles project aimed at providing regional researchers and stakeholders with a database of pre-processed satellite image data. The regional community has since adopted this concept and decided to set up a multi-satellite receiving

▲ The Sentinel-3 satellites of the GMES European project will provide high-accuracy optical, radar and altimetry data for marine and land services. They will come out from this Assembly Integration and Tests (AIT) room. Thales Alenia Space © Yoann Obrenovitch

station. Universities and research centres are also following and must take up their part of the challenge by setting up training as well as operations and research programmes.

In the Indian Ocean zone, a large project for setting up an installation for the reception and processing of satellite images is being carried out in Reunion Island, the SEAS-OI facility (*Surveillance de l'Environnement Assistée par Satellite dans l'Océan Indien*). This technological platform is a regional cooperation tool in the south-west Indian Ocean and involves the Reunion Regional Council, *Institut de Recherche pour le Développement* (IRD) and *Université de La Réunion*. The SEAS-OI facility will receive images and data from sensors on board satellites, with broad geographical coverage of all the islands in the western Indian Ocean, a large part of Mozambique, part of Tanzania, Swaziland, part of Zimbabwe and part of South Africa and the two major maritime zones formed by the western Indian Ocean and the Mozambique Channel.

Regional and international cooperation and support for research and the development of spatial applications must all be continued and amplified. However, it also seems clear that the success of Africa also requires the education and training of Africans in Africa. This needs ambitious policies and programmes to support and develop African universities in partnership with their counterparts in the northern countries.

There are obviously numerous brakes to this, especially as there are problems of governance in many African countries; in addition, higher education and research are not among the priorities of those who govern. North-South partnerships must be developed in Africa to provide high-level training and to halt the brain drain.

Pr Hassan Bencherif
Université de La Réunion, Laboratoire de l'Atmosphère et des Cyclones (LACy)
CNRS / Université / Météo-France
Saint-Denis La Réunion

Pr Solofo Rakotondraompiana
Remote Sensing and Environmental Geophysics Laboratory Institute & Observatory of Geophysics
Antananarivo (IOGA)
University of Antananarivo
Madagascar

Training engineers and technicians

Set up after African independence at the initiative of 14 countries in French-speaking Africa, the *Institut International d'Ingénierie de l'Eau et de l'Environnement* (2iE, International Institute for Water and Environmental Engineering) has been an international foundation under the law of Burkina Faso since 2005 and is based in Ouagadougou; its mission is the training of the engineers and technicians that the continent needs for its development. Supported by international partnerships with leading universities and companies, 2iE is a reference in Africa in training and research in the fields of water, energy, civil engineering, mining and the environment. The 2iE engineering degree has been recognised since 2009 by the French Engineering Degree Commission and the courses have European EUR-ACE® accreditation for engineering degree programmes. In order to meet the growing needs of companies and the public authorities for qualified persons, 2iE recently became associated with HEC and Medef International for the creation of an 'Institut d'Afrique' devoted to professional training in Africa.

Pr Amadou Hama Maiga, Mali, Deputy General Director, 2iE

Genius loci, the spirit of a place

▲ *Back from the market*, 'École d'art au village' of Poto-Poto (Brazzaville, the Republic of the Congo). The Poto-Poto school of painting originates in the French painter Pierre Lods atelier, created in 1951. His liberal teaching combined with respect for traditional African cultures created a new form of art. Pierre Lods opened his atelier to children, and a new 'École d'art au village' was born. © Sébastien Cailleux/EDAAV

Can a minister of education decide to have a school demolished in the name of respect of the spirit of a place (*Genius loci*)—the belief that some places have a tutelary spirit? Yes, replied the minister of education of Benin in the late 1990s. Located in one of the historical districts of the town of Porto-Novo (Lokossa), the school in question had been built recently but on the square of the district and the locals wished to free this.

Indeed, the area had been reserved since time immemorial for traditional festivities: weddings, baptisms, funerals, etc. It was also next to the town's large market and was used as a welcome overflow on busy days. The building of the school made the square smaller, making the holding of community festivals difficult in the district and at the same time the lively market was a handicap for the school. Its demolition was a strong symbolic act that no minister of the Republic would have dared to implement without massive support from the population. Nevertheless, the school was rebuilt elsewhere.

There are many similar examples in Africa of developments that disorganise social life and destroy places that are important for beliefs or identity. In fact, people very often express silent resistance, a kind of inertia that it would be wrong to understand as just a refusal of 'progress' or 'simplistic resistance' to change.

'I wore out the patience of the missionaries
Insulted the benefactors of humanity (...)
The breadth of my perversity leaves me confused!'

Aimé Césaire (*Cahier d'un retour au pays natal*) ◉

Alain Godonou, Benin
Director, Division of Thematic Programmes for Diversity, Development and Dialogue, Culture Sector
UNESCO

Towards a green economy

▲ For the young artists of 'École d'art au village' of N'Djamena (Tchad's capital), a smiling environment is part of sustainable development goals.
© Sébastien Cailleux/EDAAV

All current development systems have shown their limits. A two-figure rate of development for Africa is mentioned that should result in the rise in the standard of living of the population. But poverty is increasing continuously. And twenty years after the Rio Summit we are still thinking about the policies to be set up to approach sustainable development.

The environment is considered as being one of the three pillars of sustainable development, alongside the economy and social aspects. At the level of the United Nations Programme for the Environment, we consider it to be more the foundation. Whence the notion of 'green economy' defined as 'one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities'.

Setting up a green economy requires revision of the methods used to assess economic performances that do not currently incorporate natural capital, which is nonetheless the basis of the economies of numerous countries, especially in Africa. For example, calculation of GDP does not allow for the fact that production and consumption activities amputate this natural capital. Public and private investments should thus not have increased income and employment as their sole targets but should include the reduction of carbon footprints and pollution, the rational use of resources and energy efficiency.

The potential is very large in agriculture, forest management, the building industry, transport and renewable energy; this applies in sectors such as the pharmaceutical industry and new flavours in the agrifood industry whose development is based on biodiversity. Resources are found in Africa and also in South America, which is positioning itself as a biodiversity superpower. Equity is needed in the exploitation of species. Industries must therefore undertake to pay royalties on derived products.

Africa producing technology

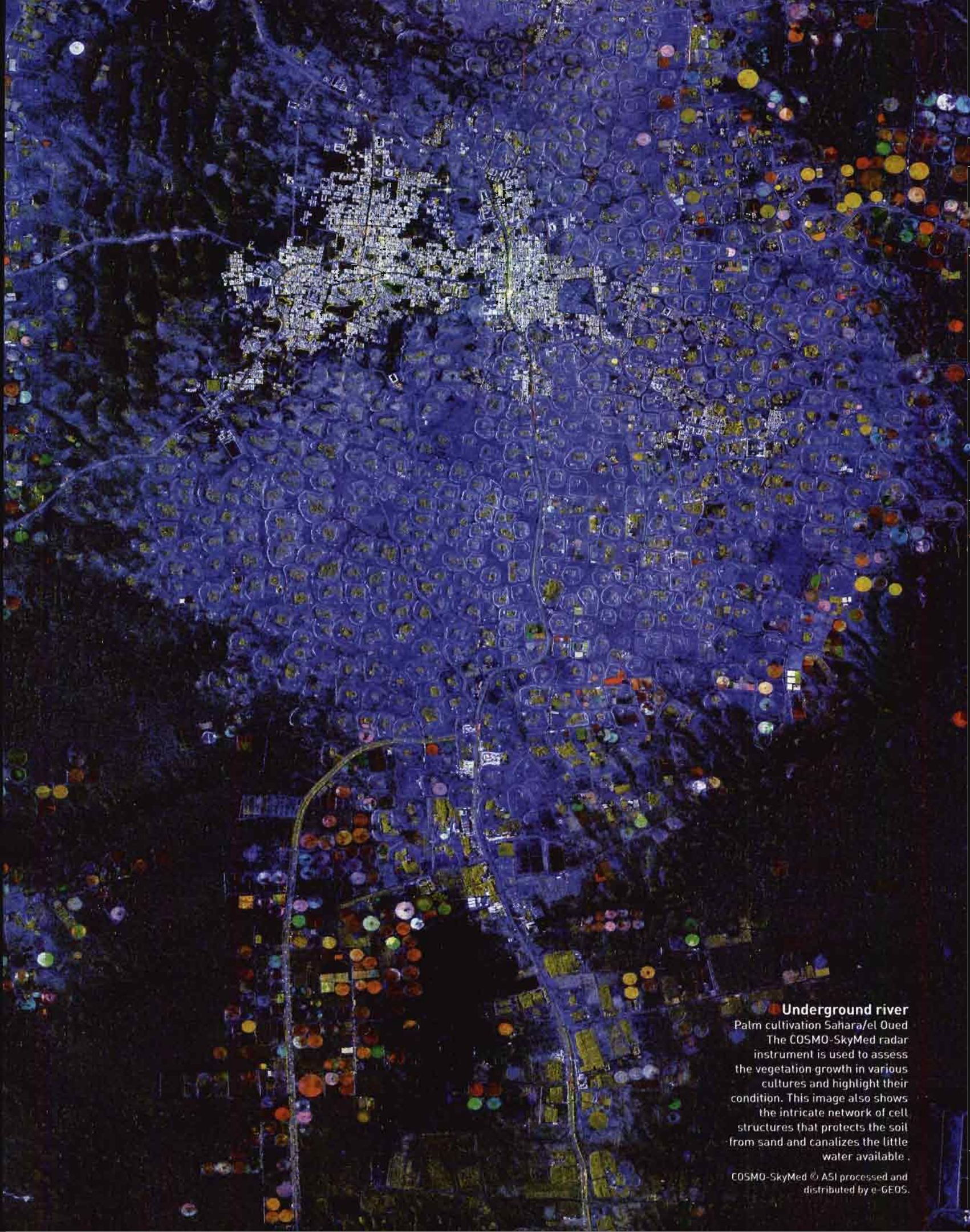
The development of a green economy also involves access to cutting-edge technologies, such as space technology. This is the case in particular for the management of forests, a green resource with considerable potential. The forests in the Congo basin form the second largest 'green lung' of the planet and their world strategic interest is obvious. When the cloud masses formed above these forests cross the Atlantic they bring rain for American farmers. This is therefore of capital importance for food security in North America: no rain, no crops. The Americans understand the point well. It led to the launching of the Congo Basin Forest Partnership (CBFP) in 2002 by South Africa and the United States, joined by France and Germany.

International cooperation and transfer of technology can help in the development of green economy.

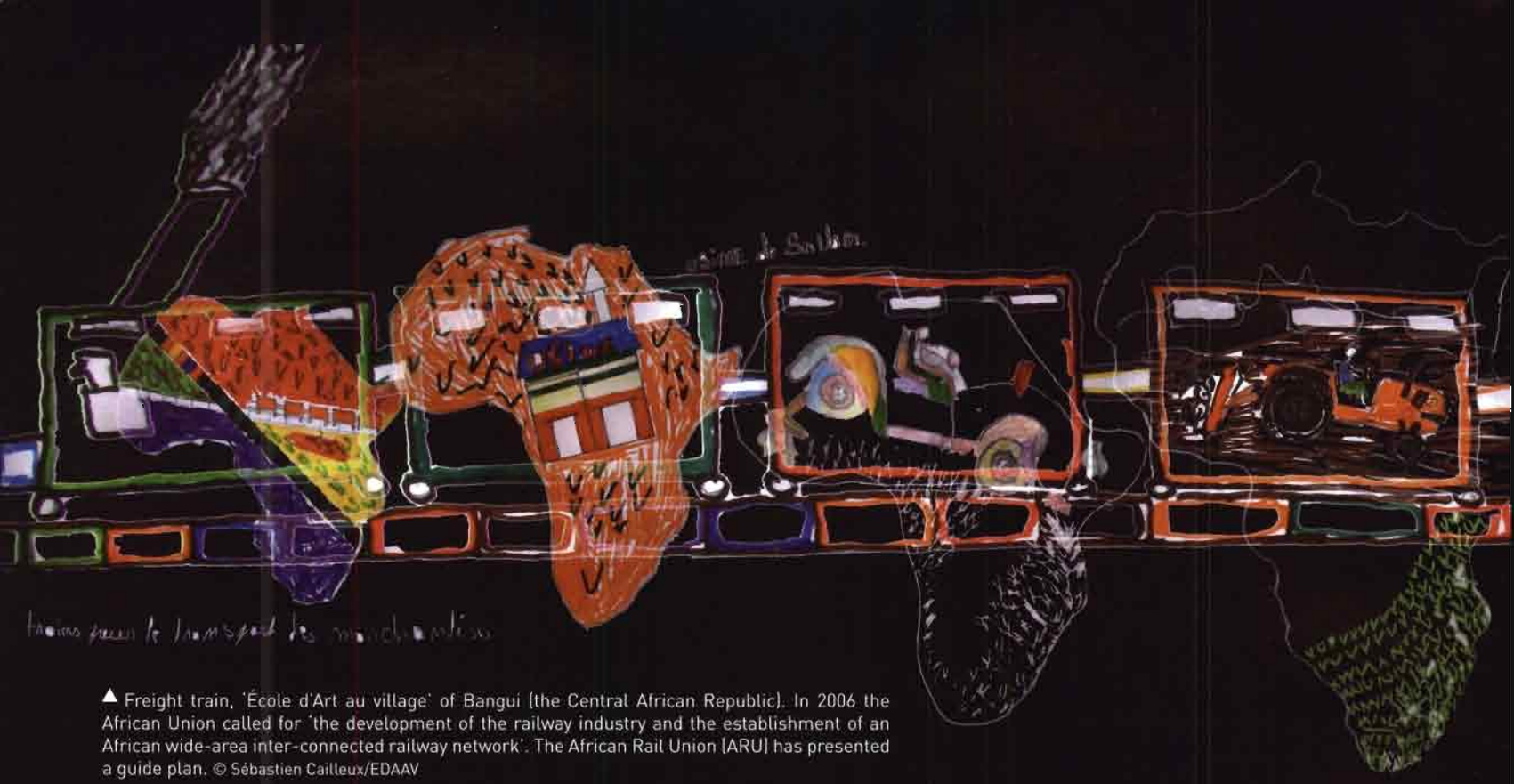
However, one of the challenges is that Africa is no longer the continent that continues to purchase technology but rather the continent that produces technology.

This requires investment in capacity building, training, research and governance. The green economy will thus become the new driving force leading to sustainable development by fighting persistent poverty while conserving biodiversity.

Constant-Serge Bounda
(The Republic of the Congo)
Head of the UNEP Liaison Office to the AUC, to the UN Economic Commission for Africa (UNECA)
and Representative to Ethiopia.
Addis Ababa



Underground river
Palm cultivation Sahara/el Oued
The COSMO-SkyMed radar instrument is used to assess the vegetation growth in various cultures and highlight their condition. This image also shows the intricate network of cell structures that protects the soil from sand and canalizes the little water available .



▲ Freight train, 'École d'Art au village' of Bangui (the Central African Republic). In 2006 the African Union called for 'the development of the railway industry and the establishment of an African wide-area inter-connected railway network'. The African Rail Union (ARU) has presented a guide plan. © Sébastien Cailleux/EDAAV

The empires of the mind

It was the British wartime leader Sir Winston Churchill who once remarked that "the empires of the future are the empires of the mind". By this he meant that knowledge and ideas would be the great factors deciding the fate of nations. International society in all its ramifications – technology, economics and the structure of world politics –has been transformed beyond what Sir Winston would have recognised in his day.

In the last two decades alone, science and technology have occupied a prominent sphere globally, driving phenomenal growth in international trade and enhancing improvements in information and telecommunications technologies. Exponential growth in knowledge has led to worldwide increases in output growth, creating unprecedented opportunities as well as challenges.

The forces of globalisation and technology have created an integrated global market in which capital, finance and information travel at the speed of light. For the first time, human civilisation is approaching what the French political thinker Maurice Duverger has termed 'the society of abundance'. The paradox, however, is that poverty continues to afflict over a billion people in our planet, most of them on the continent of Africa. It is also clear that our hydrocarbon-based industrial civilisation cannot sustain the biosphere as we have always known it for millenniums.

Among the ancient West African people of Guinea, it is said that "Knowledge without wisdom is like water in the sand". In our divided world, leaders need all the wisdom they can marshal to solve the critical challenges posed by Climate Change and the imperatives of long-term sustainable development for present as well as future generations.

Sustainable Development's imperatives

Sustainable development, which is 'the ability of present generation to meet their obligations without compromising the ability of future generations to meet their own need', involves the generation and application of knowledge for efficient management of ecological and human resources for the long-term improvement of the social and economic welfare of the population. Technology (including space technology) and associated scientific information and knowledge, is clearly one of the vital ingredients for promoting accelerated economic growth, social change, governance, poverty reduction, and, indeed, enhanced livelihoods.

Africa is arguably the richest continent on earth if judged purely by the magnitude of natural resources endowments. The paradox, however, is that it remains the poorest region where wars, conflicts and poverty have imposed a heavy toll on vulnerable populations. The accumulated wisdom of the last five decades of world development makes it clear that possession of natural resources in itself does not translate into improved human welfare. Of course, some progress has been registered in a good number of countries. In my own country of Ghana, for example, the restoration of democracy and the consolidation of good governance is spurring growth and expanding opportunities for the vast majority. The youth of Ghana are becoming more confident and more forward-looking about the future of their country. For much of Africa, what is needed is a strong institutional environment combined with a stable economic framework in which knowledge, skills and human ingenuity flourish. Crucially important is the need for economic diversification and structural change so as to enhance the value-added of raw materials for domestic and world markets while enhancing jobs as well as wealth-creation.

It is evident that the lack of technological learning and implementation of technological policies that optimise local knowledge and resources remain a major challenge for most countries. Meanwhile, desertification, deforestation and poor

environmental policies are degrading the eco-system and causing further impoverishment for fragile rural populations.

Within the context of the outcomes of the September 2002 World Summit on Sustainable Development (WSSD), Africa has renewed its quest in this matter through the NEPAD initiative. Its framework was crafted with built political arrangements focused on repositioning African economies on sustainable growth and development trajectories within the triple pillars of good governance, infrastructures development and partnership with the international development community.

The Johannesburg Plan of Implementation was adopted at the conclusion of the World Summit on Sustainable Development. It provides a framework for implementing the original UN Conference on Environment and Development commitments, with special focus on Water, Energy, Health, Agriculture and Biodiversity (WEHAB). The Johannesburg Plan of Action recognises NEPAD as providing a framework for sustainable development in the African continent. It also recognises that achieving sustainable development requires action at all levels to create an enabling environment at the regional, national and local levels for sustained economic growth and development.

In Africa as elsewhere, sustainable development requires access to data, information and knowledge, where technology – including satellites – could play an important role. Application of technology will have a high-value impact on the various developmental sectors, in particular the environment, agriculture, health, security, education, disaster management and emergency response.

Enhancing welfare

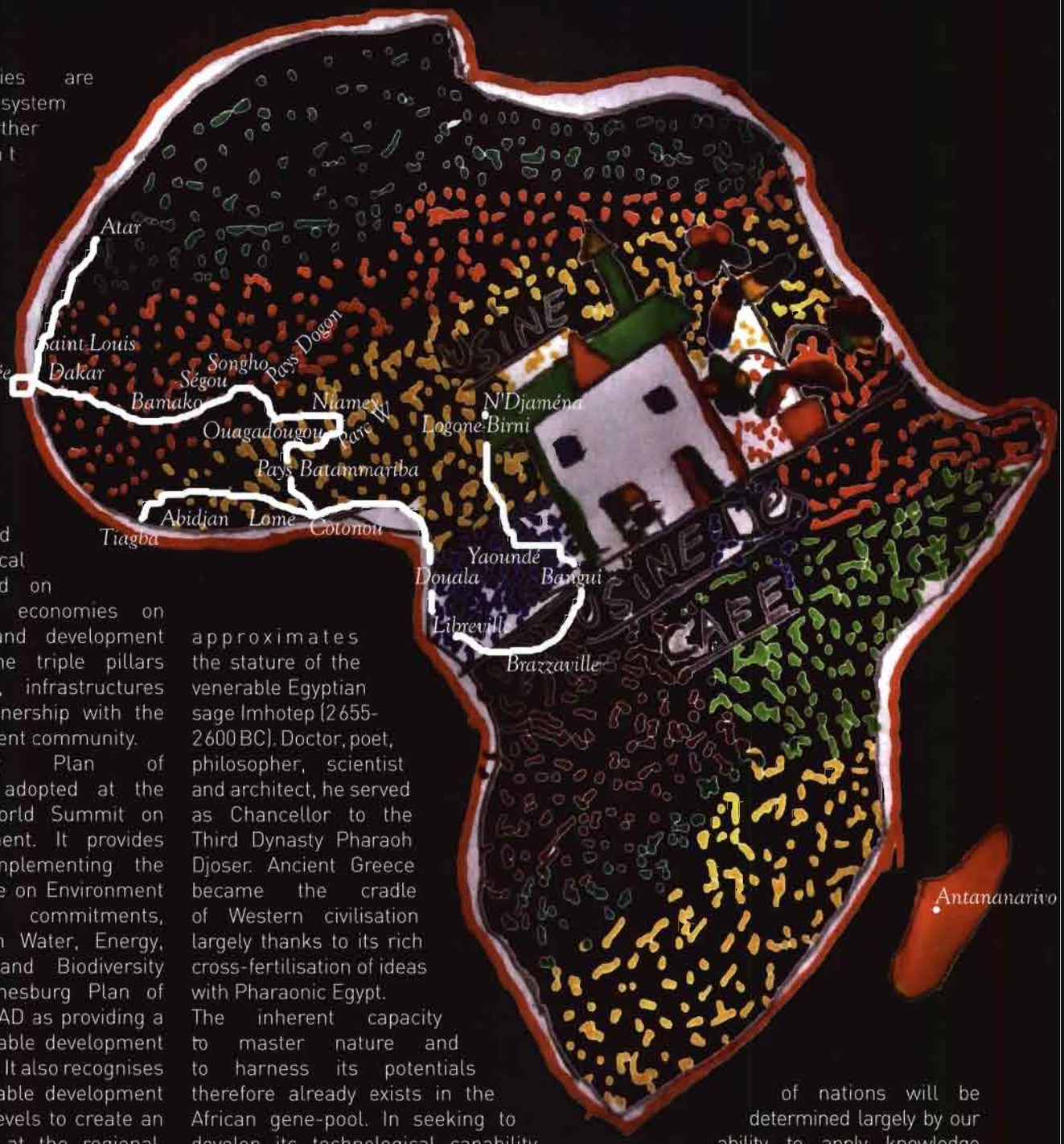
It is sometimes forgotten that science and the scientific temperament had its flowering on the continent of Africa before anywhere else. The civilisations of antiquity provide no figure that approximates the stature of the venerable Egyptian sage Imhotep (2655-2600 BC). Doctor, poet, philosopher, scientist and architect, he served as Chancellor to the Third Dynasty Pharaoh Djoser. Ancient Greece became the cradle of Western civilisation largely thanks to its rich cross-fertilisation of ideas with Pharaonic Egypt.

The inherent capacity to master nature and to harness its potentials therefore already exists in the African gene-pool. In seeking to develop its technological capability Africa will have to look into its own inner resources while also cooperating with others. Africa's natural resources are part of the heritage of humanity. It is in everyone's interest to help Africa overcome its manifold challenges; to build strong foundations for sustainable economic development and enhanced welfare. Best practices could be shared by liaising, networking, partnering and collaborating with industrialized, industrializing and other developing countries. This will also facilitate the deployment of internationally agreed standards and method in the pursuance of Africa's technological objectives.

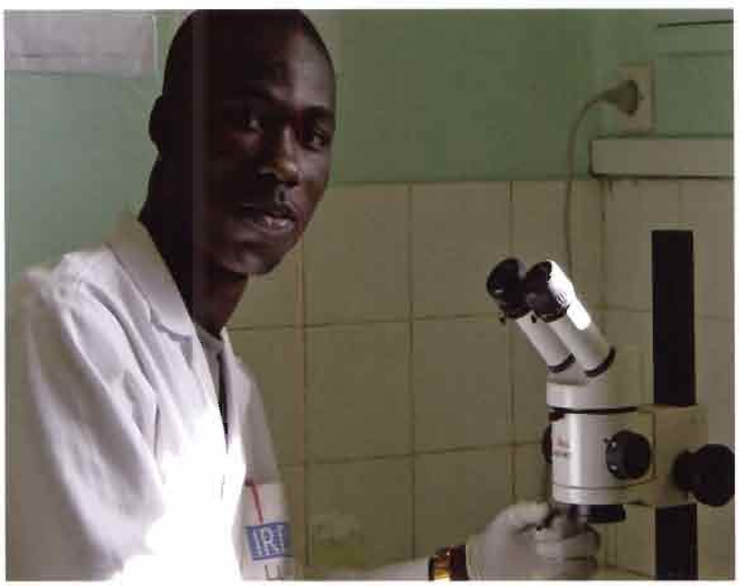
According to an African proverb, 'a stream cannot rise about its source.' The future of Africa and indeed of the ACP family of nations will be determined largely by our ability to apply knowledge and technological capability to solving our practical problems, building on indigenous knowledge systems and through collective learning and innovation.

We in Africa are in that happy position where our population is predominantly youthful, energetic and vigorous. Tapping into our endogenous knowledge systems and the wisdom of our ancestors while cooperating with the rest of the world is the best way to build prosperous societies that harmonise with nature and with the rest of the human family to which we belong.

Dr Mohamed Ibn Chambas
Ghana
Secretary General of the ACP Group



Enhancing Africa's technological capacity



▲ Pape Makhtar Drame is preparing his PhD with the support of *'Institut de Recherche pour le Développement'* (IRD). IRD is collaborating with the Entomological Research Center of Cotonou (the Republic of Benin) to improve human health in Africa.
© Indigo/IRD

In the UNDP Technology Achievement Index, which measures technology creation, technology diffusion and human skills that goes with harnessing technology, Africa was rated poorly. Of five categories of countries, no African country is in the top two. Four are in the middle category, 5 in the bottom two tiers, described as «marginalized» technologically, and all the rest are in the bottom category, dubbed «below marginalized». This is an indication that Africa must improve its competitiveness not just by relying on its low labour costs, but also by improving innovation, research and development.

For the African continent, harnessing science and technology is the key to facilitating the transition to sustainable development. During 2005, NEPAD and the African Union Commission, in cooperation with UNESCO, laid out a Consolidated Plan of Action for Science and Technology Development in Africa. It articulates a commitment to collective actions to develop and use science and technology for economic and social transformation and for the integration of Africa into the global economy. It is based on three interconnected pillars: capacity building, knowledge production and technological innovation. Emphasis is placed on developing an African system of research and technological innovation through regional networks of centres of excellence for R&D and capacity building programmes. In this endeavour, enhancing capability to generate research while innovation is essential and building networks for sharing knowledge and best practices is critical.

African countries were active participants at the World Summit on Information Society (WSIS), which aimed to close the global digital divide. They have taken on board the key policy thrust of the WSIS which aims to: build an inclusive Information Society; put the potential of knowledge and Information & Communication Technologies (ICTs) at the service of development; promote use of information and knowledge for the achievement of internationally agreed development goals, including those contained in the Millennium Declaration; and address new challenges of the Information Society, at the national, regional and international levels.

In translating all these objectives into actionable programmes, African countries will have to implement several critical interventions: the promotion of ICTs for development; developing an information and communication infrastructure, the promotion of access to information and knowledge; capacity building; the promotion of cultural, identity, linguistic diversity and local content; and promoting the ethical dimensions of the information society, among others.

Policy Issues and Capacity Building

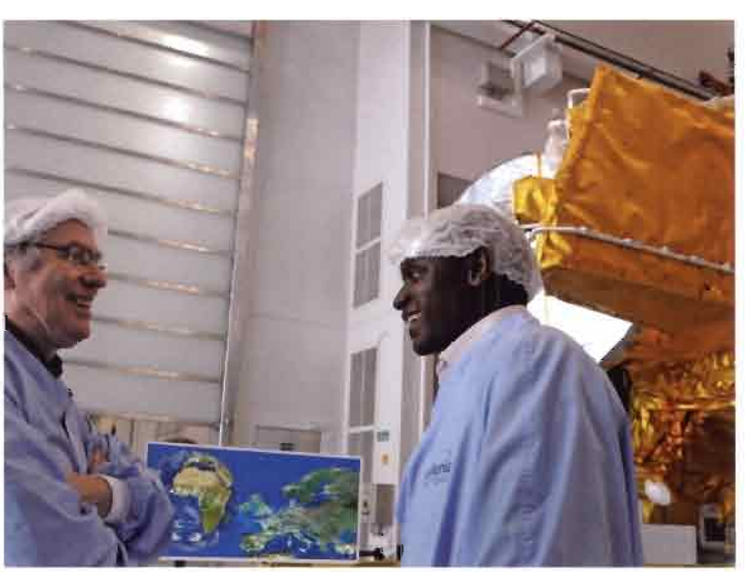
Strengthening of science and technology policy-making and development of relevant institutions is, clearly, a necessary condition for technology to play its important role in sustainable development of the African continent. Development institutions are weak in many African countries, particularly the smaller ones. Capacity building, especially human resources capacity and the development of an appropriate knowledge base is equally essential to sustainable development in the continent.

In terms of space science and technology, a handful of African countries ratified the 1967 Outer Space Treaty, the 1968 Rescue Agreement and the 1972 Liability Convention. Only Nigeria and South Africa have a National Space Policy and there exist only five space Agencies in the continent located in Nigeria, South Africa, Algeria, Morocco and Egypt.

As new discoveries in the field of science and technology, including space exploration will drive agriculture, medicine, income growth, and new inventions in the very near future in an unimaginable way, the African continent cannot afford to be left behind.

However, a formidable leadership in the continent is required to truly mobilize science and technology for sustainable development with all key stakeholders involvement in both policy formulation and implementation. This will ensure that policies are tailored primarily to meeting the specific needs of end-users and clients.

Dr. Mohamed Ibn Chambas



▲ Africa and Europe are working hand in hand to develop Space technology in the areas of Telecommunication, Internet access, Earth observation and Environment monitoring.
Thales Alenia Space. © Serge Henri

With love...

Africa's heart
Sometimes called the 'Venice of Africa', Ganvié (here photographed from a microlight aircraft) is located in the middle of lake Nokoué in the Republic of Benin. Originally based on farming, the village's main industries other than tourism are now fishing and fish farming. With a population of around 20 000 people, this site needs to be protected to remain one of the hearts of Africa.

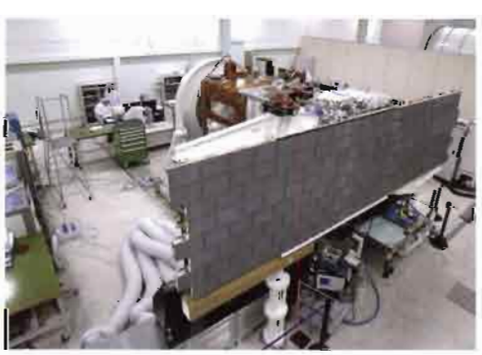
SPACE MISSIONS AND INSTRUMENTS

ALOS (Advanced Land Observing Satellite)
A JAXA (Japan Aerospace Exploration Agency) earth observation satellite carrying three instruments including a PALSAR radar (Phased Array type L-band Synthetic Aperture Radar).

AlSat
General name for the earth observation satellites of the Algerian space agency ASAL. The first, AlSat-1, was launched in 2002. Alsat-2A, equipped with a high-resolution multispectral camera, was launched in 2010. Alsat-2B is being integrated.

AMESD (African Monitoring Environment for Sustainable Development)
AMESD is a partnership between the African Union Commission (AUC) and the European Union (EU). AUC has been mandated by the five participating Regional Economic Communities (RECs): CEMAC, ECOWAS, IGAD, IOC and SADC and by the ACP Secretariat, to be in charge of programme implementation. The AMESD programme (initiated in October 2007) addresses the need for improved environmental monitoring focused on sustainable management of natural resources.

ARGOS
An international location and data collecting system that in France is under the responsibility of the CNES. ARGOS instruments are carried by low orbit (LEO) satellites such as MetOp, with continuous service assured since 1978. Among other things, ARGOS is used for the location of buoys, vessels and animals and for collecting environmental data.



Thales Alenia Space © Yoann Obrenovitch

COSMO-SkyMed
COSMO-SkyMed (COnstellation of small Satellites for the Mediterranean basin Observation) is a system of earth observation satellites set up by the Italian ministries of Research and Defence under the management of the Italian Space Agency. The system is for both civil and military use and is based on a constellation of four satellites equipped with a synthetic aperture radar (SAR) for full coverage of the Earth. e-GEOS, a joint venture between ASI (20%) and Telespazio (80%) sells COSMO-SkyMed data and products around the world.

© Jean-Michel Citeau

EgyptSat
General name for the earth observation satellites of the Egyptian agency National Authority for Remote Sensing and Space Sciences (NARSS). EgyptSat-1 was launched in 2007. It is fitted with two instruments, one infrared and one multispectral.

ENVISAT (ENVIronmental SAtellite)
An ESA earth observation satellite carrying the second generation of ERS instruments, and especially an advanced synthetic aperture radar operating day and night and in all weather and with resolution to 30 m (ASAR), an RA-2 microwaves radar altimeter and an imager/spectrometer operating in the visible and near-infrared spectra with resolution of 250 m (MERIS). It has been in low orbit since 1999.

ERS (European Remote Sensing Satellite)
An ESA earth observation programme using low orbit satellites. Two satellites were launched—ERS1 in 1991 and ERS2 in 1995, and each carries several instruments and in particular a synthetic aperture radar (SAR) and a microwaves altimeter radar.

GMES (Global Monitoring for Environment and Security)
GMES will provide accurate, timely and easily accessible information to improve management of the environment, understand and mitigate the effects of climate change and ensure civil security. It is headed by the European Commission (EC) in partnership with the European Space Agency (ESA) and the European Environment Agency (EEA).The Sentinel-1 satellites will provide all-weather, day and night radar imagery for land and ocean services.
The Sentinel-3 satellites will provide high-accuracy optical, radar and altimetry data for marine and land services.

GPS (Global Positioning System)
A satellite navigation system chosen by the USA in 1973. Fully operational since 1992, it consists of 24 orbiting Navstar satellites. Any user (land vehicle, ship, aircraft or spacecraft) can obtain an instantaneous position fix using four of them. Europe is developing its own system called GALILEO.

IKONOS
An earth observation satellite operated by the American company GeoEye. The satellite Ikonos 2 carries an optical instrument with spatial resolution to less than one metre.

IRIDIUM
Iridium Communications Inc. is the only mobile voice and data satellite communications network that spans the entire globe. Iridium enables connections between people, organizations and assets to and from anywhere, in real time.
The company has a major development programme underway for its next-generation network—Iridium NEXT.

IRS (Indian Remote Sensing Satellite)
The Indian space agency ISRO's programme for the remote sensing of land resources. The first satellite, IRS-1A, was put into orbit in 1988. With 10 satellites in orbit, IRS is the largest constellation of low Earth orbit observation satellites and provides data with various spatial resolutions and spectral bands.

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JASON
A spatial oceanographic altimetry programme that succeeded the experimental joint CNES/NASA programme, Topex-Poseidon, launched in 1992. Jason-1 (2001) and Jason-2 (2008) have the same 1300 km orbit and supply data for climatic and oceanic study and observations. Jason-3 should be launched in 2014. These satellites carry high-precision microwaves altimeters of the POSEIDON family.

LANDSAT
The generic name for US civil satellites for the observation of land resources and managed jointly by the NASA and the US Geological Survey. The first satellite was launched in 1972 . LANDSAT 7 was launched in 1999 and is equipped with a multispectral sensor (Enhanced Thematic Mapper Plus - ETM+). The Landsat Data Continuity Mission (LDCM) is currently the name of the next Landsat satellite mission.

Meteosat
Name of the operational geostationary weather satellites programme developed with ESA and EUMETSAT. The first satellite was launched in 1977. The first Meteosat Second Generation (MSG) satellite was operational in 2004 while the second was launched in 2005. Two further MSG satellites should guarantee continuity of service through to around 2021. Data are available via the EUMETCast dissemination system at the PUMA and AMESD stations installed in most countries in Africa. The Meteosat Third Generation (MTG) satellite programme is on the way, which will consist of two parallel in orbit positioned satellites, the MTG-I imaging and MTG-S infrared and ultraviolet sounder.

MetOp (Meteorological Operational satellite programme)
MetOp-A is the first polar orbiting (at 800 km) satellite from the MetOp programme managed by ESA and EUMETSAT in cooperation with the National Oceanic and Atmospheric Administration (NOAA).Data are progressively available at the PUMA and AMESD stations via the EUMETCast dissemination system.


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MODIS (Moderate Resolution Imaging Spectroradiometer)
MODIS is a key instrument aboard the Terra and Aqua Low Earth Orbit (LEO) satellites of the NASA administration, acquiring data in 36 spectral bands, or groups of wavelengths.

NigeriaSat
General name for the earth observation satellites of the Nigerian National Space Research and Development Agency (NASRDA). NigeriaSat-1 was launched in 2001. NigeriaSat-2 and NigeriaSat-NX, equipped with multispectral imagers, were launched in 2011.

PLEIADES
Pléiades (a programme initiated by the CNES) consists of two 'small satellites' with spatial resolution of 0,7 m at the nadir and a 20 km field of view. Their agility provides daily access at all points of the globe and cover capacity that is essential for better scales than those possible with the SPOT family of satellites.


© Telespazio

PUMA (Preparation for the use of Meteosat Second Generation satellite in Africa)
The PUMA programme, funded by the European Commission (EC), assisted 53 African countries and 4 regional meteorological centres with computers, satellite receivers, training and application support for receiving meteorological data. Thales Alenia Space manufactured and implemented these stations between 2004 and 2005.

QuickBird
An earth observation satellite operated by the American company DigitalGlobe. It carries an optical instrument with spatial resolution to less than one metre.

RASCOM (Regional African Satellite Communications Organisation)
RASCOM is an intergovernmental commercially run organization, bringing together 45 African countries. RASCOM's main objectives are to design, implement, operate and maintain the African telecommunications satellite system. The Rascom-QAF 1R is in operation.

SARAL (Satellite with ARgos & Altika)
The CNES and ISRO (the Indian space agency) are handling the SARAL satellite project jointly. The CNES provides the MCU SARAL payload that contains an ARGOS instrument and a new generation Ka-band altimeter: Alti-Ka. The SARAL mission is for study of oceans and the continuity of the ARGOS system.

SMOS (Soil Moisture and Ocean Salinity)
The SMOS mission is an ESA, CNES and CDTI joint observation programme providing soil moisture and ocean salinity maps. The data used is from the microwaves radiometer carried by the SMOS satellite launched at the end of 2009.

SPOT (Satellite Pour l'Observation de la Terre)
A civil earth observation programme launched in 1978. It operates with low Earth orbit satellites carrying high-resolution optical and infrared instruments. Five satellites have been launched. Data are distributed by the SPOT Image company.

SumbandilaSat
South African microsatellite put in orbit in 2009. Its high-resolution imager gives data mainly used for agriculture, mapping of infrastructure and land use, population measurement and the monitoring of reservoir levels.

TIGER
Following the 2002 Johannesburg World Summit on Sustainable Development, the European Space Agency launched the TIGER Initiative—focusing on the use of space technology for water resource management in Africa and providing concrete actions to match the Resolutions.

VEGETATION
The VEGETATION instrument consists of an imager system functioning in the visible spectrum at 1 km spatial resolution. The two VEGETATION instruments are passengers of satellites SPOT4 and SPOT5. Service continuity is provided by PROBA V and Sentinel 3. The distribution of VEGETATION data is handled by VITO (Mol, Belgium).


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Sustainable Development in Africa & *Satellites*

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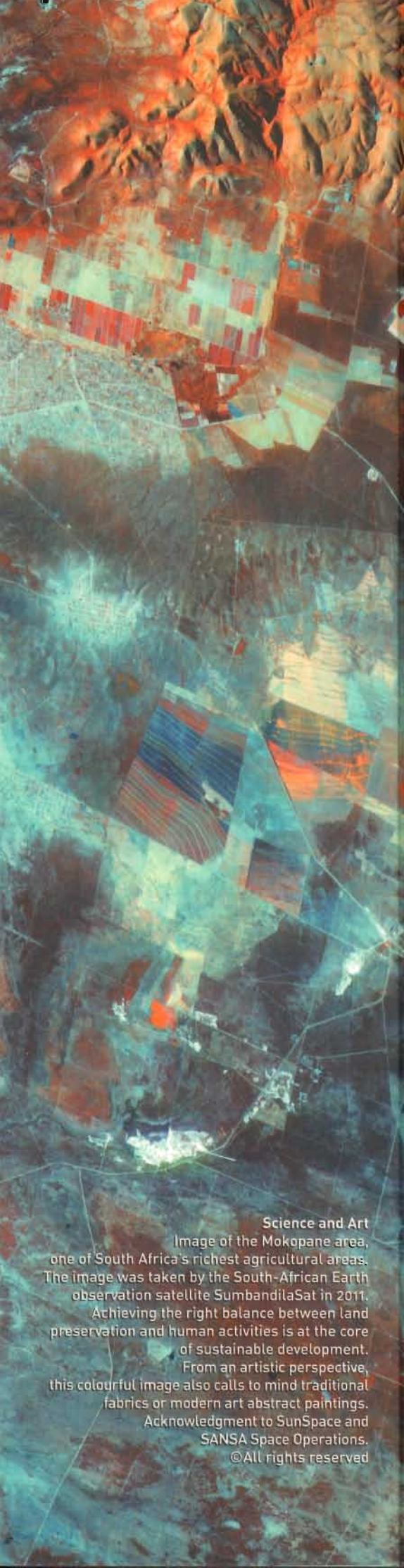

Science and Art
Image of the Mokopane area, one of South Africa's richest agricultural areas. The image was taken by the South-African Earth observation satellite SumbandilaSat in 2011. Achieving the right balance between land preservation and human activities is at the core of sustainable development. From an artistic perspective, this colourful image also calls to mind traditional fabrics or modern art abstract paintings.
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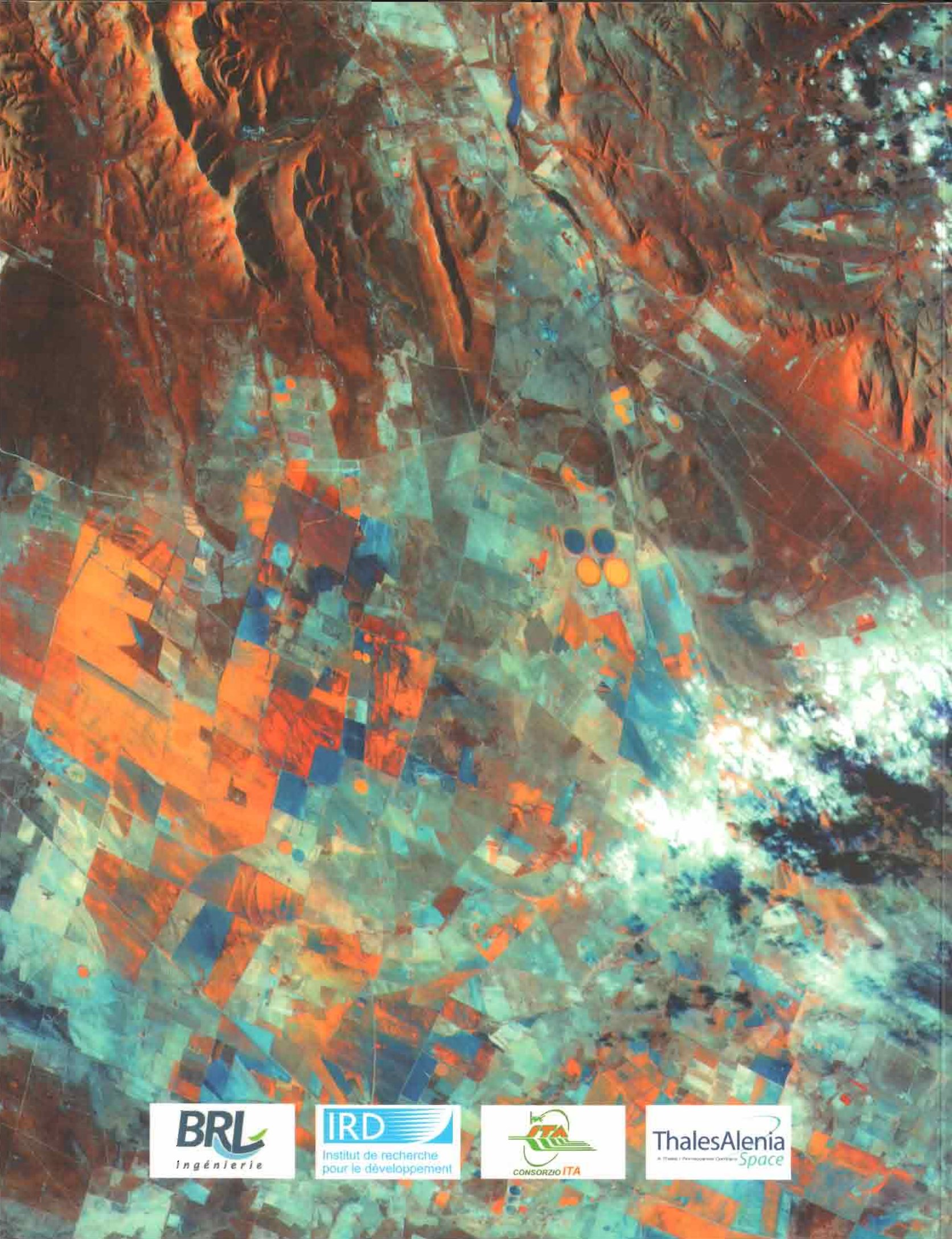
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