

Photo: © AMMA

# 1 | Global trends Time is running out



There can no longer be any doubt – the Earth’s climate is changing and this is just the beginning. Everyone is going to feel the consequences. Action is crucial, if the world’s future is to be secured.

**It has taken** a long time – too long – for the world to face the facts: the Earth is getting warmer and human beings are mainly to blame. Not all the world’s inhabitants are ready to accept that everyone can take action to limit the damage. But even the most hardened sceptics are starting to waver in their convictions. The climate has been thrown completely out of kilter and each day brings fresh proof: more frequent and more violent cyclones in the Caribbean, floods in Africa, the gradual sinking of islands in the Pacific, heatwaves in Europe, the melting of glaciers, etc.

Scientists first raised the alarm more than 20 years ago. The first report of IPCC dates back to 1990. Based on an analysis of studies carried out by researchers worldwide, the IPCC regularly assesses the situation and charts the likely evolutions of climate. With each new report, its conclusions have become more sombre, backed up by increasingly damning research. The 4<sup>th</sup> report, published in late 2007, is chillingly clear: “Warming of the climate system is now unequivocal [...] 11 of the last 12 years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperatures (since 1850)”.

## A small degree with a big impact

Even more significant are the long-term trends. In just one century, the Earth’s average temperature has risen by 0.74°C. That figure may seem small, but its consequences are massive. The regions of the Northern hemisphere have seen the greatest temperature rises; they

now have fewer very cold days in winter and more very hot days in summer. Since 1993, sea levels have risen by an annual average of 3.1 mm. Since the industrial age and the 1900s, it has definitely rained more in North and South America, Northern Europe and Central Asia, and less in South-East Asia, the Mediterranean basin and the Sahel. Intense tropical cyclones have become more frequent in the North Atlantic. But while these facts are now established and the figures official, the precise causes are harder to determine. Today, the only certain truth is that human activity is the main cause for these upsets.

A quick explanation of how weather patterns work will make it easier to understand what is happening. Each day, the sun emits rays of light onto the Earth’s surface. The Earth absorbs part of their heat, reflects another share into the atmosphere and sends out a third share in the form of infra-red rays. These rays are cushioned by the clouds and water vapour, which stabilises the Earth’s temperature. The problem we are facing today is that the

## Some acronyms

### ACP (countries)

African, Caribbean and Pacific States that are signatories of the Cotonou accords

### IPCC

Intergovernmental Panel on Climate Change

### UNDP

United Nations Development Programme

### UNEP

United Nations Environment Programme

## Glossary

### Adaptation

Adjustment in natural or human systems to a new or changing environment

### Afforestation

Planting of new forests on lands that historically have not contained forests

### Carbon sink

A reservoir that can absorb CO<sub>2</sub> from the atmosphere. Forests are the most common form of sink, as well as soils, peat, permafrost and oceans

### Chlorofluorocarbons (CFCs)

Greenhouse gases covered under the 1987 Montreal Protocol and used for refrigeration, air conditioning,

packaging, insulation, solvents, or aerosol propellants

### Emissions trading

A market-based approach to achieving environmental objectives that allows those reducing greenhouse gas emissions below what is required to use or trade the excess reductions to offset emissions at another source inside or outside the country

### Extreme weather event

A weather event that is rare within its statistical reference distribution at a particular place

### Greenhouse gases

Gaseous constituents of the atmosphere, both natural and man-made, that absorb and emit

radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth’s surface, the atmosphere and clouds. Water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), and ozone (O<sub>3</sub>) are the primary greenhouse gases in the Earth’s atmosphere.

### Mitigation

An intervention to reduce the sources or enhance the sinks of greenhouse gases

### Storm surge

The temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions

Source: IPCC - [www.ipcc.ch/pdf/glossary/tar-ipcc-terms-en.pdf](http://www.ipcc.ch/pdf/glossary/tar-ipcc-terms-en.pdf)

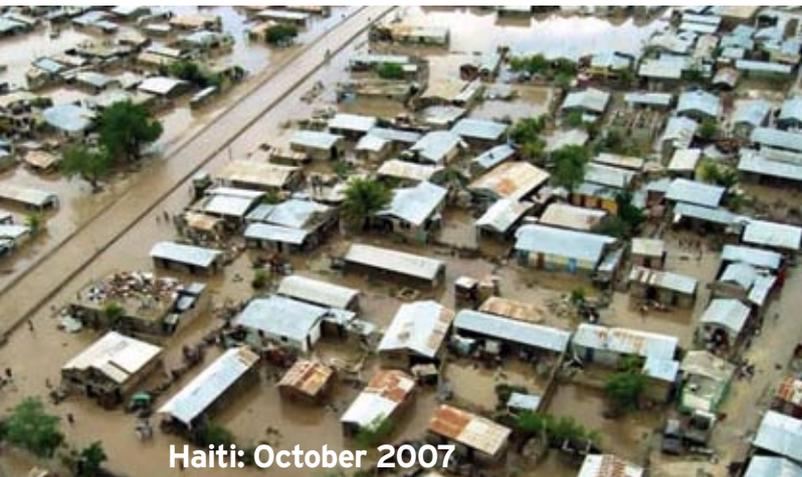
concentration of greenhouse gases (GHGs) produced by human activity has increased significantly. These GHGs trap a greater quantity of rays which are reflected on to the Earth and cause it to heat up – this is the infamous greenhouse effect, a phenomenon first explained in 1824!

**A vicious circle**

The main GHG is carbon dioxide or CO<sub>2</sub>, which accounts for almost 70% of human-induced GHGs. Six billion t are produced by burning fossil fuels, principally petroleum, for industry and transport. Western countries are responsible for the largest volumes of emissions, with the USA leading the field. But the emerging countries of China and India are catching up fast.

Added to this are the 1.6 billion t produced by deforestation in countries of the South. A burning forest releases carbon, while growing trees capture it. Likewise, working the soil releases carbon stored there. The problem, as the latest research reveals, is that the more the planet heats up, the less the plants and seas are able to absorb CO<sub>2</sub>... and the more land surface temperatures increase.

Agricultural activity plays a significant role, mainly by producing methane (CH<sub>4</sub>), the second most important GHG, though it is hard to assess these emissions with any accuracy. Methane is mainly produced by anaerobic (without air) fermentation, especially in rice paddies and in flooded areas (marshes and ponds). Ruminating cattle emit nearly 100 million t of methane into the atmosphere each year. Though small, termites produce an annual 15 to 35 million t of methane! They achieve this surprising output by fermenting vegetable matter from tropical forests in their intestines with the help of bacteria which live there.



Haiti: October 2007

Photo: © Syfria International

However, the greatest threat to the planet is the melting of permafrost. As they defrost, these soils in the arctic regions could release billions of tonnes of CH<sub>4</sub> and CO<sub>2</sub> into the atmosphere.

Finally, dinitrogen oxide or nitrous oxide (N<sub>2</sub>O, 16% of GHG emissions) is produced by intensive agriculture (notably pesticide use), deforestation and chemical processes such as aerosols.

**Uneven impacts**

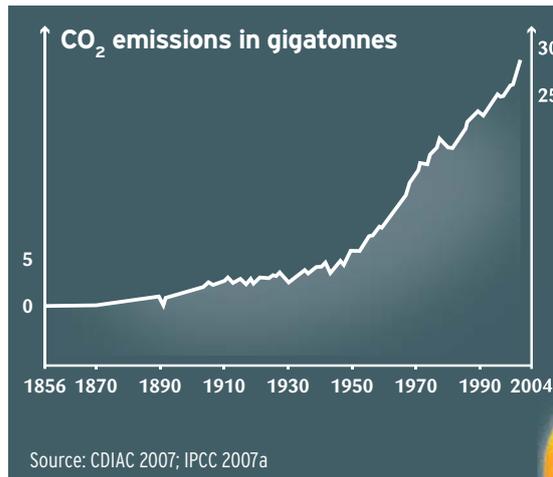
The EU and the USA account for more than half of global GHG emissions, sub-Saharan 1.59% and the small island States 0.37%. But GHGs know no borders and, as UNEP points out, 'ecological interdependence' is a fact: the impact of climate change on livelihoods and agriculture in countries of the South is inversely proportional to these nations' responsibility for the problem. The countries of the Northern hemisphere, which are currently seeing the most pronounced warming, are not necessarily experiencing hardship as a result. The increased temperatures extend the growing season of trees and plants. Species which once only grew in the south of these countries are now spreading towards the north. In France, maize, which is currently cultivated and irrigated in the south, could, due to lack of water and thanks to the milder temperatures, migrate to the northern plains over the next century. Cereal output is set to rise in North America, while that of fruit is already growing in France. Production of wheat, maize and pastureland is going to increase. On an overall scale therefore, the agriculture of these regions is going to benefit from the changes.

It is the dry tropical regions, already fragile due to population pressure, that will bear the brunt of climate variations. For here, unlike in temperate zones, the growing season becomes shorter when the temperature rises. Rice yields, for example, start declining at over 34°C. Even more worrying are changes in the length of the rainy season and rainfall intensity, since these factors have a direct impact on crops (see p. 7). Falling outputs in areas where communities rely almost exclusively on agriculture have a devastating effect. Africa is particularly susceptible, especially the least developed countries (LDC), which are already very vulnerable at the social and economic level. Climate change "will exacerbate deep inequalities within countries", forecasts UNEP in its 2007-08 report.

**Too little, too late**

The stakes are global, and the world is beginning to wake up to the fact. In 1997, 30 industrialised countries signed the Kyoto Protocol (see Box), which entered into force in 2005. They pledged to cut their emissions of six GHGs by 5.2% (compared with 1990 levels) by 2012. Countries of the South, including Brazil, China, India and Indonesia have also signed the Protocol, but have no set targets for reducing emissions so as not to hamper their development.

As an incentive to cut GHG emissions, principally CO<sub>2</sub>, through investment in clean technologies, European companies in particular now have emissions quotas. If they exceed their quota, they must pay a fine or buy emissions credits from other companies. They can also fund projects in developing countries to reduce or store GHGs as part of the Clean Development Mechanism



(CDM, see p. 20). Greater use of renewable energies, energy saving and behaviour changes – a whole new approach is taking hold, especially in European countries, in an effort to fulfil the pledges.

In December 2007, during the Bali (Indonesia) negotiations for the second phase of Kyoto after 2012, countries failed to agree on lower emission targets suggested by the IPCC. Yet it is crucial to cut emissions in order to limit temperature increases which, depending on various scenarios, are predicted to rise by 1.8 to 4°C between now and 2100 (see p. 5). It is already too late for the first half of this century.

**Urgent!**

There is an urgent need for local or regional climate change adaptation policies to limit the adverse effects, as well as for technology transfers and massive funding to help put these in place. The Least Developed Countries Fund and the Special Climate Change Fund, both managed by the Global Environment Facility (GEF), are available for countries that have launched a national plan of action defining urgent measures and priorities. But given the scale of the requirements, funding mechanisms are still being studied.

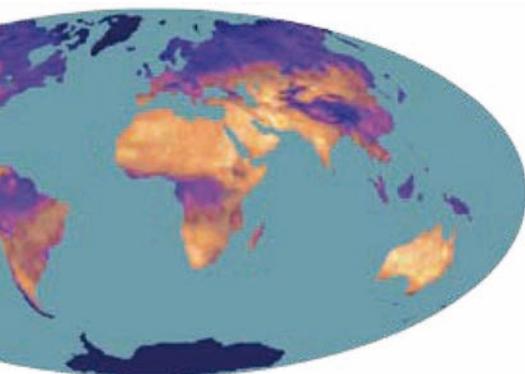
In the words of the Human Development Report 2007-08, whose title alone speaks volumes, *Fighting climate change: human solidarity in a divided world*, "Climate change demands urgent action now to address a threat to two constituencies with a weak political voice: the world's poor and future generations". The future looks decidedly stormy. ■



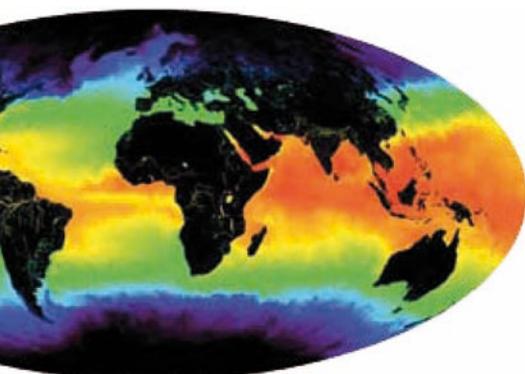


# Charting the future

Scientists agree that more extreme weather patterns are on the horizon. A range of forecasts predict increased drought in some parts of Africa and flooding in others. Rising sea levels and tropical cyclones threaten small island States. Nothing can stop the march of climate change, but there is still time to temper its effects.



Highest temperatures at ground surface (2003-2005)



Highest temperatures at ocean surface (2001)



Source: NASA

In spite of rapid advances using geographical information systems (GIS) and simulation models, there is no clear picture of how climates will change. But there is now a wide consensus that changes in weather patterns are inevitable and that these will have significant impacts on agriculture, forestry and fisheries, as well as on infrastructures and lifestyles. Doomsday visions predict that as many as a fifth of the world's population will face starvation and millions will be forced by heat, drought and rising sea levels to abandon their land. Even the more measured forecasts envisage a future with entirely new climatic zones, which will put significant strains on agriculture, affecting how producers earn a living.

Most climate models predict shifting crop patterns that will generally benefit northern temperate areas and damage the tropical regions. The biggest impacts are forecast for Africa and the small island States of the Caribbean and the Pacific. The 4th assessment of IPCC, widely held as the most authoritative voice, has predicted that food production in Africa could halve by 2020. A study by Stanford University suggests that maize production could drop by 30% in the next 20 years. Production of other staples like millet and rice is projected to fall by at least 10%.

## Pests and diseases

According to the UK's Hadley Centre for Climate Change, temperature increases in parts of Africa could be double the global average increase. Given Africa's heavy dependence on agriculture, its high proportion of low-input, rainfed farming (95%) and existing stresses such as land degradation and population pressure, the impact there is likely to be the greatest. An increase of 5 to 8% of



Photo: © Europa

arid and semi-arid land in Africa is projected under a range of climate-change scenarios.

Some climate-induced changes are expected to be abrupt, while others will involve gradual shifts in temperature, vegetation cover and fish stocks. Secondary stresses triggered by climate change are likely to include the spread of pests and alien species, biodiversity losses and the increase of human and animal diseases. Depending on the rate of global greenhouse emissions, the IPCC predicts a rise of 1.1 to 6.4°C by the end of the 21<sup>st</sup> century. A 3°C rise in temperature would lead to famine for more than 150 million people, CTA's Brussels Briefings heard in February 2008. A similar temperature increase in Uganda would decimate coffee producing areas.

Climate change will affect livestock by changing the yield and nutritional quality of fodder,

## Rise in temperature and CO<sub>2</sub> in 2080

IPCC Scenarios	Relative to 1980–1999 average temperature (°C)	Relative to preindustrial temperature (°C)
<b>Constant year 2000 concentrations</b>	+ 0.6°C (0.3–0.9°)	+ 1.1°C
<b>B1 scenario</b>	+ 1.8°C (1.1–2.9°)	+ 2.3°C
<b>A1T scenario</b>	+ 2.4°C (1.4–3.8°)	+ 2.9°C
<b>B2 scenario</b>	+ 2.4°C (1.4–3.8°)	+ 2.9°C
<b>A1B scenario</b>	+ 2.8°C (1.7–4.4°)	+ 3.3°C
<b>A2 scenario</b>	+ 3.4°C (2.0–5.4°)	+ 3.9°C
<b>A1FI scenario</b>	+ 4.0°C (2.4–6.4°)	+ 4.5°C

**Scenario A1:** rapid economic and population growth combined with reliance on fossil fuels (**A1F1**), non-fossil energy (**A1T**) or a combination of both (**A1B**) • **Scenario A2:** lower economic growth, less globalisation and continued high population growth • **Scenarios B1 and B2:** some mitigation of emissions, through increased resource efficiency and technology improvement.

Source: IPCC, 2007

## From Rio to Bali

**1967:** first predictions of global warming

**1987:** adoption of the Montreal Protocol relating to substances which reduce the ozone layer

**1988:** creation of the Intergovernmental Panel on Climate Change (IPCC) charged with scientific monitoring of climate change

**1992:** the Earth Summit in **Rio** (Brazil) adopts a Framework Convention on Climate Change, ratified by 50 countries and entering into force in 1994

**1997:** adoption of the **Kyoto** Protocol (Japan) which commits industrialised countries to cutting greenhouse gas emissions by an average of 5.2% by 2012, compared with 1990 levels; flexible mechanisms are created to enable polluting countries to avoid targets by funding reductions in other countries.

**2007:** the 13<sup>th</sup> United Nations Climate Change Conference in **Bali** (Indonesia) reaches a last-minute agreement on a 'roadmap' aimed at producing a new treaty in 2009, in Copenhagen (Denmark). This treaty will replace the Kyoto Protocol in 2012. While the parties recognise that severe reductions in global emissions are needed, they do not take up the target of cuts of 25 to 40% in greenhouse gas emissions for industrialised countries between now and 2020, proposed by the EU and rejected by the USA.

Source: *La Documentation française*



increasing disease and disease-spreading pests, reducing water availability, and making it difficult to survive in extreme environments, say researchers at the International Livestock Research Institute.

**Fewer fish**

Sea-level rise is likely to exacerbate flooding, storm surge, erosion and other hazards, causing major problems for coastal communities, especially in the Caribbean and Pacific where more than 50%

of the population live within 1.5 km of the shore. The impact on freshwater is also likely to be grave. The Niger River Basin, which runs through nine countries, faces serious threats, according to the International Institute for Environment and Development. Studies in Tanzania show that fish production in Lake Tanganyika has dropped dramatically over the past decade, due to increased temperatures – further falls are forecast. The receding of Lake Chad's waters is expected to continue unabated.

Rising GHG emissions threaten at least 75% of key fishing grounds, as the ocean's natural

pumping systems come under threat, says UNEP. Increased carbon dioxide will raise the acid level in seas and oceans, which will further damage coral and plankton. At least a billion people will be forced from their homes between now and 2050 as climate refugees, predicts a study by the UK NGO Christian Aid.

A report issued by the Working Group on Climate Change and Development puts the overall cost of adapting to climate change at an annual US\$10 to 40 billion (£6.7 to 26.9 billion). And the longer the world delays, the more that bill is likely to rise. ■

# RESEARCH & INITIATIVES

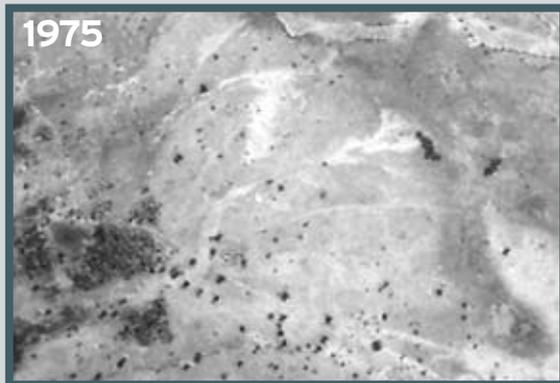
## INTERVIEW

# Threats and opportunities

Dr **Saleemul Huq**, Director of the International Institute for Environment and Development's Climate Change Programme (IIED)

There can be little doubt that small-scale producers in ACP regions are going to be the hardest hit by climate change. The recently released 4<sup>th</sup> assessment report of the IPCC has clearly stated that human-induced climate change is already occurring and that some parts of the world will be particularly vulnerable. These include all small island developing States, many of them in the Caribbean and Pacific, which will be affected by a sea level rise as well as higher intensity of hurricanes and typhoons. The report also identifies Africa, particularly sub-Saharan Africa, as extremely vulnerable due to the fact that these countries' economies are highly dependent on natural

*The province of Tahoua, in Niger, has become green again thanks to reforestation.*



Photos: © UNEP

resources and rainfed agriculture, and they generally have a low level of adaptive capacity.

However, if communities and governments take proactive steps to deal with climate change, they can do much to reduce the adverse impacts. Indeed, they may even be able to take advantage of new opportunities. Some of the options available include accessing international funding for mitigation of greenhouse gases by planting trees and vegetation, and tapping new funds for climate change adaptation. Rain-water harvesting technologies in low rainfall areas and shrimp aquaculture in coastal areas that are becoming more saline – these are just some of the opportunities that are being explored.

### Rewards for local communities

It is vital to recognise what is already being done by people and organisations, rather than thinking that governments should make such changes happen. NGOs and other civil society groups can play a major role in supporting action. Climate change resilience needs to be built systematically into new projects and policies. Whether it is the design of river basin management, new irrigation systems or urban planning, the impacts of climate change need to be at the forefront. Strengthening local land rights and encouraging investment in sustainable management will help farmers adapt to less rainfall. In many cases, this means improving technologies for soil management, like the extraordinary spread of simple terracing methods which have transformed the central plateau of Burkina Faso.

The important thing is to learn about what adaptation means, and how to strengthen local capacities to cope in ways which bring positive rewards to local people.

# The African monsoon under the lens

One of the major phenomena linked to global climate change in the 20<sup>th</sup> century was the drought in West Africa. To find out more, 800 scientists and technicians from 140 research laboratories in Africa, America and Europe studied the West African monsoon from 2001 to 2007 as part of the African Monsoon Multidisciplinary Analyses (AMMA) project.



Photo: Taburet © AMMA

*Technologies used for climate forecasting*

Oceanographic survey ships, satellites, stratospheric balloons, research aircraft... every conceivable tool has been used in a range of initiatives aimed at reaching a better understanding of this complex phenomenon, which is mainly caused by temperature differences between the ocean and warm continental land masses. The project is a key to improving climate models and developing clear forecasts for climate variations in the future.

AMMA will also enable scientists to determine the impact of these changes on the output and lives of the 300 million people who depend on this monsoon, whose influence on global climate patterns cannot be overstated.

[www.amma-international.org](http://www.amma-international.org)

## 2 | Crops

# Weathering the changes

In many ACP regions, climate-related disasters are already taking a heavy toll, causing massive damage to crops and infrastructure and forcing some people to flee their homes. But a range of options can help farmers protect their output from climate change.

**Juma** Njunge Macharia is a herbal medicine man from Murungaru, 100 km west of Nairobi, Kenya. His long experience and keen eye have been telling him for some time what climatologists now confirm. "When I was young the rainy season in the Kinangop area was known to start in mid-April, but it has shifted to June when it used to end," he says. Global data show that weather patterns are indeed changing, and natural disasters such as droughts, floods, and tropical storms are increasing in frequency and intensity.

In 2007, parts of Africa suffered severe drought while floods on much of the continent destroyed roads and buildings and wiped out millions of hectares of farmland. In March 2008, Cyclone Ivan struck Madagascar, destroying crops, livestock and buildings. Persistent drought in east and southern Swaziland has prompted some officials to suggest moving communities out of these areas. The Caribbean has been hit by a succession of extreme weather events, causing millions of dollars worth of damage. In Papua New Guinea (PNG), Cyclone Guba caused flash floods in late 2007, burying crops under mudslides. Meanwhile, in the northern islands of Kiribati, where coconut is the economic mainstay, production has plummeted due to drought.

### Shifting cropping patterns

Dramatic though the picture may be, the situation is far from hopeless. Most experts now agree that a blend of global and more localised strategies can do much to help producers weather the effects of climate change. Conservation agriculture, which involves minimal soil disturbance, can improve water use efficiency, carbon sequestration

and the capacity to withstand weather stresses. Raising productivity through improved irrigation will be key to ensuring food security as weather patterns shift. Producers may have to change the times they plant and the crops they grow; for example, sorghum may fare better than maize in the drier conditions forecast for parts of Africa. In South Africa, farmers are already delaying planting of maize to take account of changing rainfall patterns.

A US study in Mali found that farmers in the relatively cool, wet region of Sikasso, who grow maize and cotton, could benefit by turning to sorghum and millet, crops currently grown in Segou, in the hotter, drier north. The real challenge lies in finding an option for the farmers of Segou, as their climate becomes even warmer.

A number of climate-resilient crop varieties have already reached farmers' fields, and more are being developed (see Box). Photosynthesis slows down as the thermometer rises, and research shows that rice yields are declining by 10% for every degree Celsius increase in night-time temperature. One approach explored by the International Rice Research Institute (IRRI) involves modifying the plant to boost its photosynthetic capabilities.

Small-scale maize farmers of the Regional Agricultural Association Group, a community-based organisation in Western Kenya, have quintupled their yields in a year, using a drought-resistant variety of maize called Kakamega Synthetic-I released by the Kenya Agricultural Research Institute. A UNEP study in The Gambia shows that millet crop yields can be increased even in a climate-constrained world with harvests improved by 13% if new varieties are used. Scientists

## Pests and diseases

Research suggests that higher mean temperatures will increase pest developmental rates and fecundity, the frequency of outbreaks, and lead to expansion in the range of insect pests, diseases and weed species. Altered wind patterns are expected to change the spread of wind-borne pests and of bacteria and fungi that are crop disease agents. Higher winter temperature

increases the abundance of the striped stem borer and green leafhopper in rice systems.

Numbers of parasitoids — insects such as wasps and flies that lay their eggs on or inside caterpillars — fall when rainfall is variable, studies reveal. Parasitoids are an important means of natural pest control for many tropical crops.

Climate change also has repercussions for

human and livestock health, by shifting the distribution of certain disease vectors. The World Health Organisation established a clear link between heavy rainfalls over much of eastern Africa earlier this year and major outbreaks of malaria. Dengue, a mosquito-borne virus that causes serious illness, is reaching epidemic levels in the Caribbean.

at the International Potato Center (CIP) are researching resistant cultivars to help farmers in PNG and parts of Africa prepare for increased incidences of late potato blight, a disease which is likely to spread in the warmer, wetter conditions forecast for some potato-growing regions.

**Traditional knowledge**

Traditional technologies also have a role to play in combating climate change. Farmers often select crop combinations that will survive harsh conditions, such as maize-beans, cowpea-sorghum and millet-groundnut. John Morton, of the Natural Resources Institute in the UK, believes that “possession of a store of indigenous knowledge should not be underestimated,” when it comes to

small-scale farmers’ ability to weather climate change.

In Malawi, increased incidences of flash floods have convinced some communities to revive the ancient but long abandoned practice of making bunds to halt soil erosion and run-off. Other villages prone to drought have introduced coping systems, setting aside part of the maize crop to use as a safety net for communities in times of need. ■



*In both arid and humid areas, farmers are looking for adaptation strategies for crop growing.*



# Agricultural insurance

The costs associated with crop damaging weather events double each decade, according to some estimates. Agricultural insurance is one response, though this sector is dominated by the North. Developing countries account for just 13% of global crop insurance premiums, partly because many small-scale producers cannot afford them.

A new tool known as weather index or coupon insurance may be a more practical option. It uses a meteorological measurement as the trigger for indemnity payments. The classic insurance policy is replaced by a coupon, and when a weather event is verified — a certain minimum temperature, amount of rainfall or wind speed — the farmer receives a pre-established figure as compensation.

Many believe this system offers a solution to some of the barriers to classic insurance for

small-scale farmers and fishers. These include the high cost of administering individual insurance policies and the expense of loss assessments on single farms. “Index insurance offers a more viable approach to agricultural insurance for most farmers,” said Peter Hazell, visiting professor at Imperial College, London.

Improving the way in which insurance is delivered remains a major challenge. Some of the more successful initiatives use NGOs or producer organisations as a channel. In the Windward Islands, about 6,000 smallholder banana growers have taken out insurance against windstorms, the major peril. The insurer, WINCROP, is owned by the Banana Growers’ Associations, ensuring reliability and affordable premiums for a range of weather-related events, including major hurricanes. In Mauritius, the Mauritius Sugar Insurance Fund (MSIF) provides automatic coverage against cyclones for all sugar growers. The fact that coverage is mandatory means premiums are lower due to economies of scale.

## [ REPORT ] Kenya: opposite extremes

Tea farmers in Kenya’s Rift Valley Province saw their crops devastated by torrential rains and a series of freak hailstorms. The downpours, which local farmers say were more intense than any they have previously seen, left a trail of destruction on tea plantations in Kericho, Bomet, Transmara and Gucha districts in late 2007, as well as on subsistence crops including bananas, maize and vegetables. In February 2008, more exceptionally heavy rainfall was accompanied by hailstones — a sight most Rift Valley residents had never witnessed in their lives. “The hailstorms left the ground covered with about 2 inches of ice and shredded the leaves on trees and tea bushes,” said Godfrey Meli, who works on the Nandi hill tea plantation. As a result of the storms, all tea factories in the affected districts

Photo: © Syfia International

Photo: © Syfia International



## INTERVIEW

# Irrigation challenges

**Luís Santos Pereira,**

Professor at the Agronomic Institute of the Technical University of Lisbon, Portugal, and a leading irrigation expert

Although temperature rises and rainfall decreases are predicted worldwide, climate models are unclear as to whether or not net radiation will increase or decrease. This makes it difficult to predict whether demand for water from crops and vegetation will rise or fall. Increases in CO<sub>2</sub> may also have an impact on water demand.

Rainfall decreases are predicted in most areas where irrigation is presently used. These changes may occur seasonally or throughout the year, but they will mean less water available for crops and natural vegetation. Moreover, storms are expected to increase in both frequency and intensity, resulting in less water infiltrating into the soil and aquifers. In areas where storms become more frequent and rainfall decreases, some rainfed crops may become marginal or no longer viable. In addition, dry spells are predicted to become longer and more frequent.

For all these reasons, irrigation is likely to become much more important than at present, but water resources may not be able to meet the extra demand. Therefore, farmers may have to adapt by switching to different crop varieties with shorter

cycles and better resistance to water stress. Another option will be to adopt water conservation practices that favour infiltration and soil water storage, and combat evaporation from the soil. Improved irrigation technologies and water saving practices will become essential.

A wide array of technologies exists, either for improving the performance of irrigation systems — surface, sprinkler or micro-irrigation — or for adapting irrigation scheduling to save water. There are also a number of tried and tested water conservation methods, such as terracing, surface tillage, soil mulching and direct seeding.

However, adopting improved technologies requires investment and knowledge transfer to farmers. This may not be a problem for large farms, but it is difficult for small-scale

producers with very limited capital and poor access to information. Deficit irrigation (where the crop is exposed to a certain level of water stress during a particular period or throughout the whole growing season) requires know-how and may result in yield reduction.

This shift from maximising production per unit area to maximising production per unit of water consumed (or water productivity) will pose difficulties for small-scale farmers who have limited land and often no other source of income. Their survival could well become one of the first challenges for climate change and will require new technical, economic, social and cultural approaches to irrigation in many parts of the world.

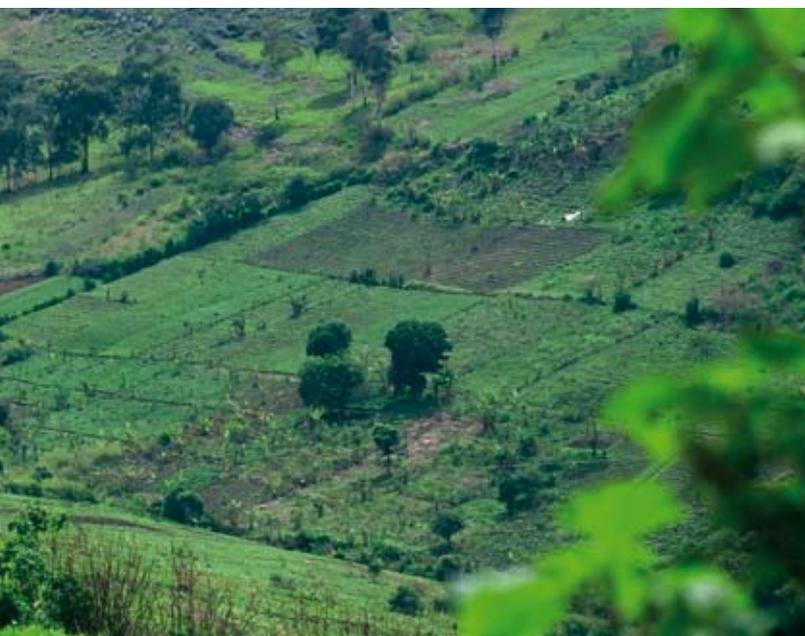


Photo: © Syfia International



Photo: © A. Khalif

*Some parts of Kenya were flooded in 2007 and 2008 while others were hit by drought.*

were forced to suspend production and some tea pickers were made redundant as the crisis hit. Said tea farmer, Franklin Bett, "We are pruning tea bushes to avoid further losses. We pray that the frost does not attack again because our output will drop even further."

Meanwhile, communities living along Kenya's River Tana face the opposite problem — the lack of water threatens this once flourishing crop-producing area. The river, which has its source in Mount Kenya, crosses seven districts before flowing into the Indian Ocean. In recent times, the waters have receded and some of the farmers with land adjoining the riverbanks have been left high and dry. Already, many producers have left, and more are planning to follow. Abae Kalasigha, chairman of the Tana River District's small-scale farmers association, said 20 settlements had closed

down to date. "Farmers are leaving and moving into urban centres in search of labour and better living standards," he said.

In spite of visits from NGOs and agriculture ministry officials, many farmers attribute the changes not to climate change but to a curse from ancestors who are unhappy due to lack of appeasement. One farmer, Alice Lopo, says that schools have closed down as people move to towns. "The river has dried up, leaving people no alternative but to move out of the settlements or practise nomadism." Another farmer, Halima Ali, says she has switched from growing maize to sorghum, as this can grow in hotter weather, with less water.



Photo: © Syfia International

All the farmers who have stayed behind say they realise that things will never be the same as they once were. For years, Albert Bouda has grown vegetables in fields washed by water from the River Tana. But now, he says, "We have to dig wells to get enough water for our crops." He adds, "The temperatures are higher, water evaporation from the ground is so fast, and there is a spread of agricultural pests on our crops".

**Abjata Khalif**

## Burundi: "God is punishing us"

[ REPORTS ]

## Malawi: bad water made good

In mid-April 2008, violent rain and hailstorms lashed down on a hill in the Kirundo region, in the far north of Burundi. Several hectares of maize, sorghum, rice, haricot beans, sweet potato and bananas were wiped out. Anatole Misago describes what happened: "In the previous days, it had been raining normally, and we were expecting a very good harvest. But on 17 April, there was a real hurricane. I'd never seen anything like it in my life." Just 15 km away, the scene was one of total desolation. "There has been virtually no rain since March. Our crops are beginning to turn yellow, soon they will wither altogether. How is it that the dry season starts in April?", asks Esperance Iczanye.

In the past few years, the seasons have become less clearly defined in almost all regions of the country. The rains sometimes arrive a month late or finish early. "The rain began in February. After 3 weeks, we planted. But the rain quickly gave way

to sun, which shone throughout almost the whole of March. When the rain returned 2 weeks ago, it was as if it was trying to uproot our already emaciated crops", recalls one woman farmer.

Helpless to change things, the farmers carry on growing their crops using the calendar that they have always known. "We have to plough and sow, even though we don't know what the weather will be like and in spite of the high cost of seeds. We would be sorry if we didn't sow and the weather turned out to be better than expected and our neighbours produced good harvests. You have to try your luck." These farmers are convinced that the vagaries of the climate are a sign of divine anger. "It can't be that the sun and the rain are taking it in turns to strike us," explains one of them. "Perhaps it is that there are many sinners in our midst and God is trying to punish us."

**Désiré Nshimirimana**

Rural communities in Malawi are turning climate change to their advantage, harnessing flood waters for irrigation and fish farming. "Whereas previously we relied on rainfed agriculture, we are now using harvested rainwater for both fish farming and irrigation," said Molesi Waumira, in Zomba District. Waumira says he and other farmers are using food scraps and farm waste as nutrients for small fishponds stocked with local species such as tilapia. The ponds also provide water for crops and sediment for fertiliser. The fisheries department and NGO World Vision



Photo: © Wells for Zoë

International are playing a leading role in developing innovative rainwater harvesting techniques as climate change adaptation strategies.

In the Dzimphutsi area of the southern region's Chikwawa District, another scheme is helping farmers to see floodwater in a different light. Changing rainfall patterns exacerbated by deforestation have caused increasingly frequent flash floods in this area, deluged by water from further up the valley.

"We used to consider floods as a curse in this area. However, now we use the same flood waters for irrigation and fish farming, so it is a blessing in disguise," said cotton farmer Spy Alufisha. The Dzimphutsi project, launched by the Southern Africa Development Community and the Malawi government, focuses on helping communities affected by climate change and flash floods in particular. The idea is to show how even 'problem water' can be managed and channelled to improve economic and social welfare without compromising the environment.

**Charles Mkoka**



**Burundi 2008**

Photo: © Syfia International

## INTERVIEW

### Managing risks in the Caribbean

**Steve Maximay,**  
a plant pathologist consultant  
based in Trinidad

Caribbean agriculture has always been characterised by risk, whether related to yields, markets or other factors. But whilst weather was often the single greatest determinant of risk, climate rarely entered the discussion. Today, every facet of Caribbean agriculture is being impacted by climate change. Fish stocks have been depleted as a result of reduced coral ecosystem-dependent spawning. Farm animals

are suffering from suspected heat-related stress. There are reports of changes in the flavour of Jamaican Blue Mountain coffee as a result of temperature and humidity variations. Less water is available for agricultural use and higher tidal variations are causing salinisation in aquifers.

Risk management is intrinsically linked to adaptation. Extreme climate events such as hurricanes pose serious risks to Caribbean farmers and though there have been sporadic attempts at commodity-linked insurance, these have been largely uninspiring. One approach that I believe holds promise is helping producers with the timely use of proven mitigation strategies. With this in mind, I have

developed a mitigation strategy based on Hazard Analysis and Critical Mitigation Points (HACMP). It uses the critical point principle common to Hazard Analysis and Critical Control Points (HACCP), the worldwide food safety protocol. The critical point is a step which, if controlled, will eliminate a hazard or reduce it to an acceptable level.

This system helps farmers assess the level of risk, according to the three sides of the so-called risk triangle: hazard, vulnerability and exposure. In the Caribbean we cannot reduce the hazard, so we must decrease our exposure either by completing the product cycle outside the season when the hazard is most likely to occur or by physically protecting the product

(e.g. channelled watercourses to protect crops from floodwaters). The other option is to reduce vulnerability and that requires using tougher plants and animals. Research on hardier plant varieties is going on at the University of the West Indies and the Caribbean Agricultural Research and Development Institute, to ensure that they can survive in more saline or dry conditions.

Climate change presents opportunities as well as threats. Consumers are willing to pay more for products that are certified as eco-friendly. In much of the Caribbean, the tourism product is getting greener. Hoteliers and agriculturalists are already coming together to explore some of the opportunities.



## INTERVIEW

## “Better observation produces more accurate forecasts”

Arona Diédhiou, project leader for Interdisciplinary and Participatory Research on the West African Ecosystems, Climate and Societies (RIPIECSA)

### Why does West Africa have so many research projects for climate change?

It is the region that has experienced the most dramatic rainfall shortage in the whole world over the past 30 years, but (though we do not know why) in more recent years the situation appears to have returned to normal. However, although the quantity of rainfall now appears to be satisfactory, we are observing more frequent extreme weather events — dry periods during the rainy season, floods with serious consequences for agriculture and health (malaria, cholera, bilharzia, etc.).

For the next 50 years, forecasts for the region vary widely from one model to another. Some predict a return to wetter conditions, while others foresee a return of drought. It makes it difficult for politicians to take action when no one knows how things are going to evolve.

### How does the RIPIECSA project deal with such complex phenomena?

The project has taken an original approach by tackling problems in a multi-disciplinary fashion — climatic and social studies — and by carrying out participatory research, linking researchers, communities and decision-makers. NGOs, producer organisations, cooperatives and local communities all play an active role. However, the findings of these research initiatives will have to be accepted by the people who live in these extremely fragile areas. And above all, it is crucial that the results be adopted by decision-makers so they can include them in their policies and planning strategies.

The main objective is to make a precise analysis of these climatic phenomena so as to reduce the uncertainties that currently surround forecasts. And above all, there needs to be a change in scale, for weather events do not occur uniformly throughout the region. We have to be able to draw up scenarios at the local level so as to develop adaptation strategies that are useful to the people who live there.

### What are the priorities in this research?

The most pressing need is to strengthen the observation network in specific regions, for we lack historical data that can tell us what has changed and how. This is the focus of the first 25 projects selected. They are implemented by local services in conjunction with AGRHYMET. The subsequent phase aims to strengthen the human dimension in projects. An analysis of the interaction between humans and the environment is very important, because growing population pressure in particular has an impact on climate change.

Photo: © Terre Nourricière



### What can be done to help farmers in the short term?

The first thing is to set up alert systems to help communities foresee weather events. The project supports seasonal forecasting. It is now possible to know in advance if the rainy season will be wet or dry, and therefore enable farmers to adapt their growing techniques and their seeds.

Better observation produces clearer understanding and more accurate forecasts — that is how I would sum up the project.

## Weather alert

In Mali as in other parts of West Africa, the farmers are bewildered. The rainy seasons are no longer the way they once were when producers used them to get the best out of their crops. These days, the rains sometimes stop suddenly for several weeks, fall in torrents or carry on for much longer than normal.

Four years ago, GTPA, an agro-meteorological working group, was set up to help farmers. It groups 10 different services, including weather forecasts, agriculture, livestock and an early warning system (SAP). Throughout the rainy season, it broadcasts a radio bulletin every 10 days, which provides information about the weather and advice for farmers. The rain forecasts are based on data from national and regional weather services as well as from field trips carried out every 10 days. There are still gaps in the country's

This information, broadcast by national and community radios, is closely followed in rural areas, where it is highly valued. On the basis of the rains forecast, listeners know that they must begin planting this or that variety or start harvesting quickly. The launch of this service has greatly improved farmers' ability to adapt to the increasingly erratic climatic conditions.

The GTPA service relies heavily on the long experience of SAP, which is a member. Created in 1986 during some of the worst droughts, SAP has a network of almost 2,000 volunteers throughout Mali, who continually collect data on crop growing, forest, livestock and health issues so as to evaluate the food situation in the various regions. Each month, local councillors, agricultural authorities, farmers and herders fill out detailed questionnaires

weather coverage, but information supplied by livestock keepers and farmers themselves help to make the service more accurate. Local branches of services involved in GTPA play an active role.

The bulletins are also based on satellite monitoring which gives some advance warning of when rains are likely to begin or end. By working together with the AGRHYMET centre in Niger, GTPA is able to indicate to producers whether the winter will be wet or dry.

*Measuring rainfall (here in Mali) helps forecasting.*

on, for example, the price of cereals, the movement of herds and problems encountered with crops. These questionnaires are sent back to the regional level, where they are analysed. A national bulletin is produced from their findings and distributed to the government, embassies and international organisations.



Photo: © Syfia International

## Zero tillage traps CO<sub>2</sub>

Zero tillage, or conservation agriculture, protects and restores soils while capturing carbon (see *Spore* 112). Extensive trials carried out in Brazil show that soils cultivated using this method trap CO<sub>2</sub> rather than releasing it into the atmosphere. The absence of tillage – which avoids disturbing the layers of soil – combined with the rotation of crops and permanent ground cover limits the oxidation of organic matter in the soil,

a major source of CO<sub>2</sub> in tropical environments.

Zero tillage was pioneered in the USA and Brazil, where 22 million ha are cultivated in this way. It is now taking hold in parts of Central Asia and Africa. It is practised on 3,000 ha in Madagascar. During the past 5 years, pilot projects for conservation agriculture have been launched in Southern and East Africa. Farmers who practise it obtain higher yields and can benefit from 'carbon credits'.

## Climate-proofing crops

Climate change is forcing crop scientists to rethink priorities and focus on stress-tolerant rather than just high-yielding varieties. Researchers at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

are working to develop pearl millet, sorghum, chickpea, pigeon pea and groundnut to grow in a warmer world. To date, they have produced varieties tolerant to heat, high soil temperatures, low and variable rainfall, and diseases. At the International Rice Research Institute (IRRI), scientists are making important advances in producing varieties that can withstand drought and salinity. A team co-led by IRRI scientists made a breakthrough in 2006 with the discovery of a gene that allows rice to survive up to 2 weeks' flooding.

Kenya's Ministry of Agriculture recently launched high-yielding drought and disease-resistant varieties of maize, sugarcane and wheat. The seeds, developed by the Kenya Agricultural Research Institute (KARI), are marketed by seed companies in Kenya, Congo, Sudan, Tanzania and Uganda.

Scientists at the International Maize and Wheat Improvement Center (CIMMYT) and the International Center for Tropical Agriculture (CIAT) have developed a hand-held sensor using light and infra-red radiation, which can tell farmers whether plants need more fertiliser or not – less fertiliser use means less nitrogen released into the atmosphere.

Despite reservations, a growing body of experts believes genetic modification holds the key to developing climate-resilient crops. Trials on drought-tolerant maize developed by Monsanto are carried out in South Africa and studies on drought-tolerant soya beans and cotton are in the pipeline.

Climate change also poses a threat to biodiversity, and researchers fear many useful

## AIDA: recording and promoting innovations

Almost 45% of land in Africa is dry or arid, receiving just 300 to 800 mm of rainfall per year. Much of it is subject to irreversible desertification. Climate change is to blame, exacerbated by population pressure and inadequate or inappropriate agricultural development policies.

The aim of Agricultural Innovation in Dryland Africa (AIDA), an EU-funded project, is to seek out, analyse and publicise innovations introduced in rural areas and guide agricultural development policies in regions facing acute and recurrent food shortages. The project, which brings together African research institutes and universities (Kenya, Malawi, Niger and Uganda) and European institutes, including CTA, is headed by CIRAD in France. It offers training to African students in compiling case studies and success stories, provides a database of experiences in this field and helps to influence agricultural development policies through communication initiatives involving various international authorities.

[www.open-si.com](http://www.open-si.com)



Photo: © CIMMYT

*Maize plants exposed to drought: only the most resilient will be selected.*

wild species could disappear. "Climate change is leading to significant losses of genetic resources," said Kwesi Atta-Krah, deputy director-general of Bioversity International.

Lack of information can be a barrier to better climate change adaptation. "Many more farmers could benefit from existing drought-tolerant maize varieties, if they knew about the varieties and if quality seed were made available," said Wilfred Mwangi of the Drought Tolerant Maize for Africa project. In Nigeria, five radio stations are airing broadcasts to inform smallholder farmers of climate change adaptation measures. In 2007, Developing Countries Farm Radio Network and CTA launched a competition, inviting African radio stations to submit original scripts on how farmers cope with climate change. More than 80 radio stations sent in entries.



Photo: © CIMMYT

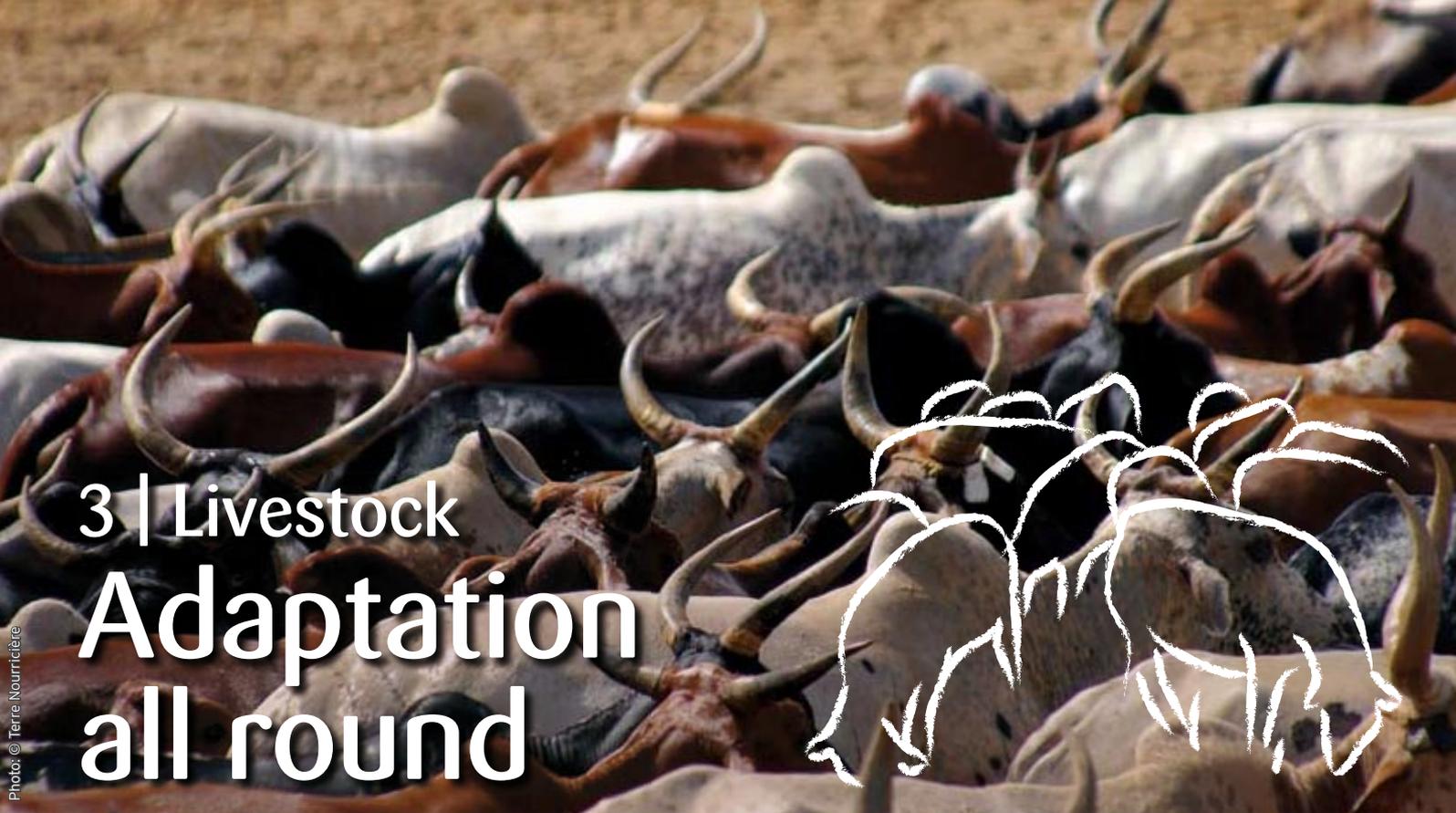


Photo: © Terre Nourrice

# 3 | Livestock Adaptation all round

Although livestock keeping is partly responsible for the greenhouse effect, it will be less affected than agriculture by climate change, except in arid areas. The challenge is to limit its impact on the environment while satisfying the growing demand for its products (meat, milk and eggs).

**Livestock's** global responsibility for climate change is now an established fact. In 2007, FAO's Deputy Director-General Alexander Müller estimated that this sector caused 37% of methane emissions and 9% of carbon dioxide (CO<sub>2</sub>) output and that it also used 8% of the world's water. The belching and flatulence of ruminants release vast quantities of methane into the atmosphere. In areas where livestock keeping is more intensive and industrial, cultivation of feed crops uses chemical fertiliser, the manufacture of which produces CO<sub>2</sub>. At the other end of the production chain, packaging, refrigeration and transport of the meat to the consumer also churns out greenhouse gases.

Global demand for animal products is increasing with growing urbanisation and rising meat consumption, especially in emerging countries. This trend is expected to lead to a rise in the number of livestock reared worldwide, a factor which threatens to exacerbate climatic imbalances. Livestock already uses 30% of land for grazing or fodder cultivation, according to a report from FAO. New pastureland is often created by burning forests, especially in Latin America.

In the particularly fragile arid areas of some developing countries, transhumant livestock are both victims of climate change and contributors to it, since they accentuate its impact. As they pass, animals degrade plant cover and nibble at young trees. In the Sahel,

herds that leave for the more humid zones in the dry season have completely destroyed shrubs and grasses in some places. Drought coupled with overcrowding reduces the amount of grazing available, forcing herders to take their animals ever further afield and encroach on agricultural land. "After several years with no rain", observes Jean-Charles Clanet, a geographer at France's development research institute, IRD, "the water points have dried up. On land that was once rich, there is often nothing left but stones."

### Changing routes

According to a recent World Bank study, "Farmers in Africa are likely to move slowly toward livestock (especially goats and sheep). Managing livestock in Africa is likely to be more profitable than growing crops under future climate conditions."

In arid zones, the increasingly dry conditions linked to rising temperatures threaten the survival of animals. For these regions, experts are weighing up solutions aimed at restricting the passage of herds in certain areas, thereby reducing conflicts with farmers. For example, German researchers have started marking the trails at the request of authorities in western Niger. Water reserves there are strictly monitored and grazing areas are regulated. Elsewhere, climate change may modify the distribution and nutritional quality of forage plants, factors that will influence milk and meat production.

## Herders' testimony

**Adamou Djibo, 49 years-old with seven children, is a Peul cattle breeder in the pastoral zone of Ekrefane, 400 km northwest of Niamey, Niger**

"I was 15 when I started taking the herd off to graze. Raising cattle is not like it used to be. Twenty years ago, we moved around without any great problems. Everything went as it was

supposed to. Throughout this area, there was plenty of grazing for the animals. But today the herd is suffering badly from lack of grass. New diseases are appearing. It is very hot during the dry season. Our cows often die when giving birth; frequently, the calves are premature. None of this ever used to happen. The vet in our area has told us that these new diseases are caused by climate change. But I don't understand anything about that."

**Interview  
by Souleymane Saddy Maâzou**



Photo: © Syfia International



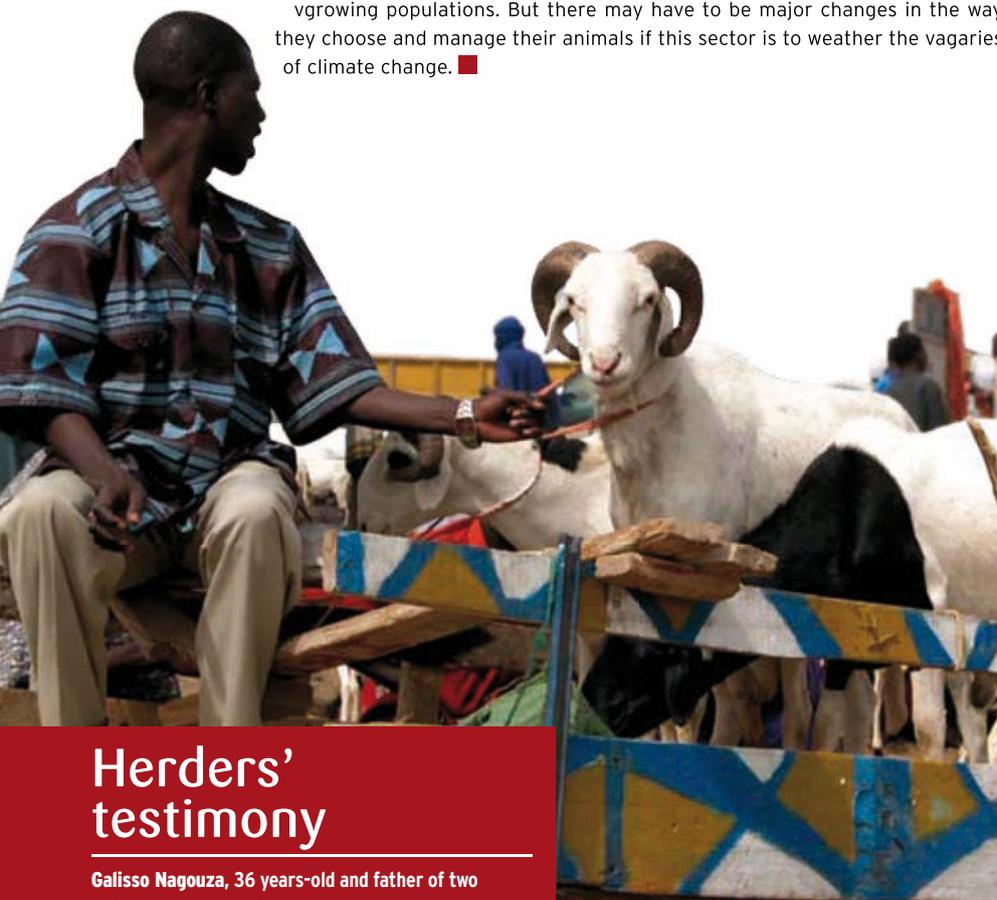
### 3 | Livestock

Research results show that the most striking change caused by climate fluctuations will be the type of livestock species farmed. If the climate becomes hotter and drier, goats and sheep will take precedence over cattle and chickens, which are very sensitive to the heat. The humid zones will in turn become more suited to poultry and large livestock, notably dairy cows, especially in high altitudes. But if rainfall increases in these areas, goats and chickens will become more attractive options. "With climate change, livestock ownership will increase across Africa, except in the deserts", concludes the World Bank study. In 2007, the UNEP suggested doubling the number of small ruminants in Africa and Asia. Already in Ghana, goat rearing is gaining ground.

There is also an urgent need to use more improved local breeds, which are better adapted than imported breeds to the climate and to its variations. During a recent drought, Ugandan herders who had kept their Ankole cows were able to take them to watering points further away, while herders who had replaced them with imported breeds lost everything.

In places with poor grazing where feed crops can be cultivated, keeping animals in stalls is advised, so as to limit their impact on the environment. Efforts are under way to improve fodder crops and other feed and make them more digestible so as to reduce flatulence in ruminants. At the same time, researchers are trying to improve the management of animal waste (manure and slurry) to reduce methane emissions, notably through more efficient conversion into biogas.

vgrowing populations. But there may have to be major changes in the way they choose and manage their animals if this sector is to weather the vagaries of climate change. ■



## Herders' testimony

**Galisso Nagouza, 36 years-old and father of two children, is the son of a well established Peul livestock keeper in Nord Tahoua, 600 km from Niamey, Niger**

"Some of my brothers are sceptical about climate change. But I've been to school and I know a bit about it. People here are too fatalistic. Before, everyone knew when the dry season would come and when there would be the rainy season. But now, that has all changed. Our livestock have to walk long distances to get water. When I was a child, we used to find water without having to travel dozens of kilometres as we have to these days.

I remember: there were times when our animals stayed in the fields for months at a stretch after harvest, eating the millet and sorghum stalks that were left. Now, that is just a distant memory.

The fields no longer produce much due to lack of rain. It is very hot and grass is getting scarcer. In a few years' time, many livestock keepers like me won't know what to do any more. That worries me because our livestock are a part of us."

SM

## [ REPORT ] Uganda: shrinking pastures

For years, Uganda has been known as the pearl of Africa, due to its natural vegetation and fresh waters. But global warming, exacerbated by deforestation and charcoal production, has reduced rainfall in many parts of the country, leading to drought. Uganda's Cattle Corridor, which stretches from western and central Uganda to mid northern and eastern regions, has seen a dramatic shift from semi-arid to arid conditions. These changes have had a significant impact on livestock productivity.

Gaudesius Opio, a farmer and agricultural engineer from Soroti District, says he believes climate change is responsible for the prolonged drought. Since the devastating floods that destroyed



Photo: © Syfia International

## Burkina Faso: the last of the big herds

[ REPORT ]

History has caught up with Yaya Guariko. "When I settled here in 1985, there were more animals, more water and more grass than there are today", recalls this herder from Hamdallaye in Burkina Faso. Guariko has seen pasture land disappear before. Raised in Burkina Faso's prime livestock region in the north, he watched the land succumb to desertification during the years of acute drought, before he moved close to Ouagadougou to carry on the time-honoured tradition of life as a Peul herder. "A decade or so ago, we took our animals to graze close by. Now, we have to go almost 20 km to find even poor quality grass and the long

trek tires the animals out", observes the herder, who blames lower rainfall levels. Dr Moumouni Ouédraogo, a specialist in environmental sciences at the Ministry for Animal Resources, confirms the bleak picture: "With every new drought, the herders move further away to new areas. Today the problem is particularly acute because all the available space has been taken over by new villages."

It is a constant worry. From November to June, nothing grows and almost all the water points run dry. In Hamdallaye, there is only one solution — intensify livestock keeping. Small herds of



lives and property in his region in September 2007 at the time of this interview, in April, not a drop of rain has fallen. "It has never happened like this. There is no grass or drinking water. Animals are dying." Opio adds that herders from all the neighbouring villages now take their livestock to the wetlands for grazing but this poses problems of a different kind. "Our young animals are attacked by snakes and crocodiles," he observes. Competition for the wetlands is also triggering conflicts among herders and crop farmers.

The long drought and subsequent reduction in pasture has led to a fall in both livestock quantities and quality, causing malnutrition in communities that rely heavily on the cattle economy. Opio is one of many farmers who have seen a sharp drop in productivity. "I used to get one litre of milk a day from a cow, but now I can hardly get half a litre," he says.

A 2007 food assessment carried out by Uganda's Ministry of Agriculture, Animal Industry and Fisheries shows that approximately 980,000 households from 19 districts in the Cattle Corridor have been seriously affected. Coping mechanisms adopted by

livestock farmers include 'paddocking' and planting drought-resistant pastures such as *Panicum maximum*. 'Paddocking' involves dividing land into small plots and fencing each one separately. When the grass is exhausted, the animals are transferred to another paddock.

Akello Stella, a livestock farmer in Lira district, says she and other herders have resorted to rearing small-sized indigenous livestock. "We have realised that our local short-horned cattle are somehow more manageable. Heifers of other breeds were getting sick while others died." Mukama Robert, programme officer for Fida International, a food security project in northern Uganda, says more and more farmers are

turning away from higher-yielding exotic breeds. "Local breeds are being maintained because they are more resistant to weather changes. Unfortunately, their turnover is low," he said.

**Angella Nabwowe**



Photo: © A. Nabwowe



Photo: © Syfia International



Photo: © Syfia International

*Livestock keepers (here in Burkina Faso) have to travel further and further to feed and water their animals.*

around 20 cattle have replaced the bigger ones of former times. The animals no longer wander in search of rich grassland that now only exists in the memories of the elders. The cattle are kept in pens. Feeding has also changed. Today it largely consists of cereal bran (millet, maize or rice), oilseed cake and fodder specially cultivated for livestock. "At present, I have a herd of less than 30 cattle, which I can manage better. Aside from oilseed cake, which I buy, I produce hay ready for the dry season", explains Guariko. Wealthier livestock farmers use cross-breeding to produce animals with greater resistance to heat and higher milk yields (a daily average of 4 l compared with 1 l for the local breed). Animals bred this way adapt more easily to being kept in stalls.

In desperation, some herders send their flocks to the east of the country. Others leave the land of their forefathers to settle in coastal countries

such as Benin, Ghana and Togo. "With no more grasslands, nomadic herders, who were used to grazing their cattle in northern Togo, Côte d'Ivoire, Benin and Ghana, have decided to settle in those countries. That represents considerable lost earnings for the national economy", says Dr Ouédraogo. The herders would much rather stay in Burkina Faso, but they feel cornered and abandoned. "The government should help us. If it doesn't, in a few years' time there will be no meat nor milk left in Burkina, for all the livestock will have moved to neighbouring countries", predicts Hamadou Cissé, who owns more than 100 cattle.

**Thierry Rolland Ouédraogo and Nourou-Dhine Salouka**



Photo: © Syfia International

## Herders' testimony

Hamadou Salah, 45 years-old and father of six children, is a Tuareg camel herder at Toukounous, more than 300 km from Niamey, Niger

"I inherited livestock keeping from my grandparents and I have been doing it since I was a child. In those days, there was grass just behind our huts. But over the years, everything has changed. There is no more grass for our animals. The little rain that falls in this area has become even less frequent. Even when we move to new pastures, grass is increasingly hard to find. This change in the weather has had an effect on our livelihoods. Twenty years ago, we had more than 100 camels; today, there are just 20 left. We have sold almost all of them to the butchers. I very much regret this state of affairs, since for us, livestock is like gold."

S M

## INTERVIEW

## “We need action”

**Prof Abdoulaye S Gouro**, Director-General of Center for Research and Development of Animal Husbandry in the Sub humid Zone (CIRDES)

**What concrete steps are being taken to adapt livestock keeping to climate change in West Africa?**

**Prof A S Gouro:** To my knowledge, nothing concrete is being done, either to help herders or political decision-makers. No one has said to them: “Look out, in 20 years, due to climate change, this is what livestock keeping is going to be like. Take action!” And that is where the problem lies.

**What should be done?**

First, greater attention should be paid to the issue to see what is really happening. We need to find out if climate change has caused any precise geographical shift in disease. And if that turns out to be the case, we need to know exactly where the disease is now located. It is no good

climate change, that will be a big waste of money.

All this is extremely important for political decision-makers. If we can forecast what our livestock is going to look like in 10 to 15 years, the decision-makers can take the necessary measures. But they need real-time information at the right moment (...)

As far as national action plans are concerned, our countries are putting forward a number of institutional measures. These are proposals, not solutions for the herders or political decision-makers. We need action.

**What is your prognosis if nothing is done?**

If nothing is done, as far as food supplies go, we will become increasingly dependent on western

countries for animal products. And within the region, the dependency of one country on another will also increase, as will the cost of foodstuffs. There is a risk of a wholesale change in agricultural practice, with people producing just to survive

instead of to live in a sustainable manner. Science must come up with some sustainable solutions.

**But you are not predicting that livestock keeping will disappear altogether?**

Oh no! I would not go so far as to say that there will be no animal species left on our continent, or in our sub-region. Maybe a new form of livestock keeping will emerge. But imagine if there were fewer livestock. The output of our animals is already low. That is why we keep so many of them. A cow only produces a litre of milk per day. If we had fewer animals, think of the consequences!

**Interview**

**by Souleymane Ouattara**

## A sickening climate for animals

Climate change has already had a clear impact on animal disease. Concerned about the problem, the World Organisation for Animal Health (OIE) recently launched a special working group which held its first meeting in July.

One of the issues that researchers are currently investigating is whether or not viruses responsible for animal diseases can change vectors (the organisms they use to spread) so as to migrate into areas where the climate is favourable but where their traditional vectors do not yet exist. Scientists also need to monitor the evolution of traditional vectors' habitats so as to prevent the spread of diseases for which they are carriers.

The most striking example of the effect of climate on animal disease is that of Rift Valley Fever. The resurgence of this disease in East Africa is directly related to increased rainfall in the region, say OIE officials. The disease, which reappeared in Kenya in late 2006, has spread throughout the region, especially in Sudan and Tanzania. The virus is passed on to livestock by mosquitoes, which proliferate with the rains, especially when there is flooding. It affects cattle, sheep, goats and camels, as well as wild ruminants and various small rodents. Animals infected with the disease have a high death rate. Humans



*Contact with wild animals (here gnus) encourages the spread of diseases.*

are also very sensitive to the virus. The disease poses a threat to the traditionally vibrant livestock export trade from the Horn of Africa to countries of the Middle East.

Conversely, in regions where the climate is becoming drier, there could be fewer watering holes in pastoral areas, a factor that would increase interaction between domestic livestock and wild animals. Wild animals are frequently a source of diseases that can be transmitted to domestic animals. Increased contact between cattle and gnus, for example, could trigger outbreaks of malignant catarrhal fever. All gnus are carriers of this disease, which is fatal to livestock.



Photo: © Syfia International

doing things by chance; we need to identify the real problems, the real consequences, and above all predict what will happen if the trend continues. There also needs to be a great deal more communication so that people are informed and can adopt good practices.

At the technical level, we need to establish precisely what type of livestock keeping will be suited to the new conditions. Which animals should be kept in which areas? Which diseases should we be fighting against? Which diseases have disappeared? If we don't have this kind of information and continue, for example, to fight diseases whose vectors are no longer present in this area due to

Photo: © Syfia International

Photo: © Terre Nourricière

## 4 | Forests

# A double-edged sword

Tropical forests are highly vulnerable to changes brought about by lower rainfall and higher temperatures, but they can also play a key role in mitigating climate change. Political hurdles are limiting the use of instruments to encourage sustainable community management.

**Forests** are unusual in that they are a potential prime cause of climate change – through deforestation – but can also play a key role in mitigating its impacts. According to the UN Environment Programme (UNEP), between 20 and 25% of all CO<sub>2</sub> emissions are caused by burning forests to clear the land for farming. Poor forest management policies, including unrestricted logging, excessive harvesting of firewood and road construction contribute to the problem. The world is losing about 200 km<sup>2</sup> of forest a day, according to FAO, with forests in Africa being felled at twice the global average.

Research into the impacts of climate change on forest ecosystems lag behind, though initiatives such as the Tropical Forests and Climate Change Adaptation project are trying to redress the imbalance. Some climate models indicate that towards 2050, temperatures in tropical forest areas will increase by up to 2°C from their 1970 levels. Combined with predicted rainfall changes and secondary factors such as increased fire and pest outbreaks, these could produce severe consequences.

Direct impacts are likely to include lower volumes of forest goods and services, among them timber, fuel wood, and valuable non-timber

products such as fruits, fungi, honey and natural medicines. Forests are also crucial for safeguarding other ecosystems – they regulate water cycles, protect biodiversity and provide physical buffers against desertification, drought, land degradation and flash floods. The ripple effect could be incalculable.

### Sustainable management

A number of initiatives are under way in ACP countries to combat illegal logging. Many countries now have national schemes, though these have had mixed results. The industry itself is showing an understanding of the need to change its ways. In February 2008, senior executives of some 15 of the leading tropical forestry companies announced their commitment to sustainable management. Good governance is crucial, and legally protecting forests by designating protected areas, indigenous reserves, non-timber reserves and community reserves has proved effective in maintaining forest cover in some countries.

As well as suffering the effects of climate change, forests have huge potential for offsetting it. Trees have the capacity to trap vast amounts of carbon which would otherwise escape into the atmosphere

## A community effort

Papua New Guinea (PNG) has been the target of much criticism for its handling of one of the world's largest tropical forests. Massive logging and land clearance have put the island's forestry sector in the international spotlight. Each year, 50,000-60,000 ha of forests are cleared, including 50% for agriculture, 25-30% for industrial logging, and the rest for infrastructure. Most of the logging in PNG is carried out by Malaysian firms who pay landowners very little. Fire is often used for land-clearing and at times – especially during dry El Niño years – they burn out of control. But there are pockets of good management, and the

island is home to what some say is one of the best examples of community forest enterprise anywhere in the world.

Globally, community control over forest areas has doubled in the past 15 years as community cooperatives, associations and non-profit companies succeed in coupling commercial success with a fair distribution of social and environmental benefits. In PNG, 29 community companies have joined forces under the umbrella company Forcert, and linked up with seven central marketing units spanning four islands. The community producers handle logging and transport to the

marketing units, which dry, process and export the wood. Forcert handles marketing, technical support services and management of certification under the Forest Stewardship Council (FSC) label. Timber sales go mainly to Australia, with both FSC and Fair trade certification. "Whether for timber, other forest products or emerging environmental service markets, strong democratic community forest enterprises are an excellent model through which to channel resources or avoid deforestation and poverty reduction," said Duncan Macqueen of the International Institute for Environment and Development (IIED).

as CO<sub>2</sub>, one of the worst GHG offenders. A growing awareness of the role of forests in protecting against climate change has sparked a number of tree planting initiatives. In Nigeria, the government has launched tree planting in three zones. In Malawi, pupils from primary schools in the districts of Msanje and Salima have formed clubs to replant trees on bare land. The Kabara community in Lau, Fiji, has planted 2,600 Vesi trees (*Intsia bijuga*) as part of a reforestation effort.

### Shut out of the market

Providing incentives to conserve the forests that we already have could be just as important. Carbon payments can be an effective stimulus in reducing forest degradation, as they offer local communities a chance to help cut global carbon emissions, while increasing prospects for their own livelihoods. However, at present, the rules are stacked against the forestry sector. Under the Kyoto Protocol's Clean Development Mechanism (CDM), carbon offset schemes are limited to afforestation and reforestation. Credits can therefore be earned for planting new trees but protection of existing forests does not qualify. Some forestry

experts say that farmers' cooperatives, or even rural carbon banks, could arrange to certify a community's carbon sequestration, apply for carbon payments, and distribute funds back to farmers. Heavily forested countries charge that the failure to extend CDM financing to the preservation of old-growth forests is unjust. In September 2007, Brazil, Cameroon, Costa Rica, DR Congo, Gabon, Indonesia, Malaysia and Papua New Guinea, which together contain 80% of the world's remaining tropical forests, formed the Forestry Eight to challenge the exclusion.

Many agree that forestry has been neglected in the climate change debate. To date, of the almost 1,000 CDM projects undergoing or granted approval, only three are from the forestry sector. ■

## Carbon sinks

Estimates of the total amount of carbon stored in the forests vary greatly. One calculation, based on research by the IPCC, puts the total at about 1,000 billion t. Africa contains about 15% of the world's remaining forests. The vast forests of DR Congo alone are estimated to contain as much as 8% of all the carbon stored in the Earth's vegetation.



Photo: © Terre Nouricière



## INTERVIEW

### “Avoided deforestation”

**Alain Karsenty**, of the forestry resource and public policy department at the French Agricultural Research Centre for International Development (CIRAD).

#### What role do forests play in climate change?

Forests play a very important role, for they absorb and conserve carbon or CO<sub>2</sub>, the main gas responsible for the greenhouse effect and hence climate change. The CDM which was set up as part of the Kyoto Protocol

to cut greenhouse gases (GHG) offers incentives for reforestation in countries of the South. These latter are offered carbon credits in exchange.

Unfortunately, in practice the CDM does not work for forests. For a variety of reasons, the industries of wealthy countries, which are obliged to cut their CO<sub>2</sub> emissions either by directly reducing them or by purchasing carbon credits, do not buy credits from forests. As a result, out of 1,023 projects registered under the CDM over the past 10 years, only one involved reforestation. Yet deforestation accounts for the equivalent of 15 to 20% of global GHG emissions. So we cannot allow this state of affairs to continue.

#### So what can be done to encourage forest countries to slow down the rate of deforestation and plant more trees?

In 2005, a new proposal was made by the Rainforest Coalition, a group of forest nations led by Indonesia and Papua New Guinea. This proposal, currently being debated for post-2012, is known as ‘avoided deforestation’. It involves paying direct compensation to developing countries that reduce deforestation, either compared with previous levels or compared with a projected scenario for the future. But some countries have deforested to such an extent in the past that their deforestation levels

will automatically fall in the future. Should they be ‘compensated’? And who can make clear predictions about deforestation? The concept could turn out to be impossible to implement.

#### So there is an impasse?

No, because there is now wide agreement that forests must be included in efforts to mitigate climate change. Many believe that in any case there should be an international fund. This would be financed by taxes created, for example, on carbon and would fund structural measures to address the fundamental causes of deforestation. These could focus on improved land security and better



## INTERVIEW

## Biodiversity alert

**Sylvie Andriambololona**, an expert in plant conservation and biodiversity, is coordinator of a Missouri Botanical Garden project.

**Does climate change pose a serious threat to plant biodiversity in Madagascar?**

Plant biodiversity in Madagascar is very rich and quite unique, with some 90% of species peculiar to the country. All 13,000 plant species found in the three forest types (humid, dry and thorny) have proved to be sensitive to climate change. The slightest variation seriously upsets the balance of the ecosystem, resulting in losses of habitat and plant populations. Climate change is already making itself felt in Madagascar, with temperature rises, infrequent and torrential rainfall, longer dry periods and increasingly violent cyclones.

Many plants can only reproduce and grow within a certain temperature range. They respond to precise doses of rain according to the seasons and risk being ousted by competition from other plants or failing to survive the changes.

**What biodiversity loss is already evident?**

At present, little data is available; so far, no studies have been carried out on this subject. However, we can discern a general trend. From the west and north, plant cover is moving eastwards

towards the coastal strip. The flowering and fruiting seasons are becoming less certain for many species. Increasingly, there are long delays for both, due to erratic rainfall. Mountain species are tending to seek refuge in higher altitudes, often as much as 200 m further upland. In the south and southwest, dry zones are shifting northwards.

**Interview by Mamy Andriatiana**

*In Côte d'Ivoire (far left) and Madagascar (left), trees have been sacrificed*



Photo: © Syfia International



Photo: © Syfia International

### [ REPORT ]

## DR Congo: trees are disappearing

*Women loaded with charcoal for sale at Bukavu, Sud-Kivu.*

farming techniques so as to slow down the encroachment of crop cultivation in forested areas, etc. Studies are also being conducted into how to implement what are known as 'payments for environmental services' (PES) to all stakeholders involved in managing forests — village communities, farmers and forest enterprises. These payments involve offering compensation for earnings lost due to forest conservation. To do this, we need to start mobilising funds immediately and prepare programmes that combine structural measures and PES. These details should be worked out very soon.

**Interview by Antoine Labey**

With an average of 19°C, the weather is usually cool all year round in Sud-Kivu. In this mountainous region in eastern DR Congo, the altitude ranges between about 350 and 2 000 m, rising as high as 3,400 m in the Kahuzi Biega National Park. Bayubasire Bikaya, who heads the Provincial Department for the Environment, Fisheries and Forestry, believes the shrinking of the forest "from 50 to 100 km around towns and large conurbations", and linked to the growing demand for charcoal, has contributed to local climate variations. "The temperature has risen by an average of half a degree and the thermometer sometimes reaches 28°C", observes Cyprien Birhingingwa, a geographer. The climate has also become drier. "Rainfall has dropped from 1,400 to 1,000 mm/year."

Local vegetation is suffering as a result. Already, several varieties of trees and shrubs have been affected by these sudden changes. "Cinchona (*Cinchona spens*) and Arabica coffee no longer

flourish as they did even 5 years ago. These are varieties that we have always cultivated on the hillsides", recalls Bulongo Lukendo, a member of the Natural Resources Network in Kivu. *Tetradenia riparia* or *Iboza riparia*, which has white flowers, perfumed leaves and curative properties for humans, livestock and plants, is also disappearing.

Gervais Igugu, a member of POPOF, a local association that works in the Kahuzi Biega National Park area, has also noticed that certain species are disappearing at lower altitudes. *Prunus africana*, a tree whose bark is used to make remedies for sterility, is increasingly hard to find. *Hagenia abyssinica*, whose leaves are used to treat headaches and stomach pains, has also become very scarce. But though the effects are all too clear, the reason for these dwindling resources has yet to be identified. Both climate change and overharvesting are thought to be to blame.

**Thaddée Hyawe Balundi**

# Madagascar: the forest is burning

[ REPORT 1 ]

For kilometres at a stretch, along the road that links Antananarivo to Toamasina in eastern Madagascar, flames lick at the slopes, lighting up the night sky. Just before the rainy

season, the farmers burn the forest without any let up. Here, slash and burn cultivation, or *tavy*, remains a common practice. "All you need is a scythe and there is no need for irrigation", explains one farmer. According to Jeanniq Randrianarisoa, manager of Conservation International, "At least 100,000 ha of forest are destroyed each year."

Such intensive deforestation accounts for 95% of Madagascar's CO<sub>2</sub> emissions and severely disrupts climate patterns. "A leaden sun, prolonged drought punctuated by torrential rain, suffocating air, increasingly intense cyclones." Pauline

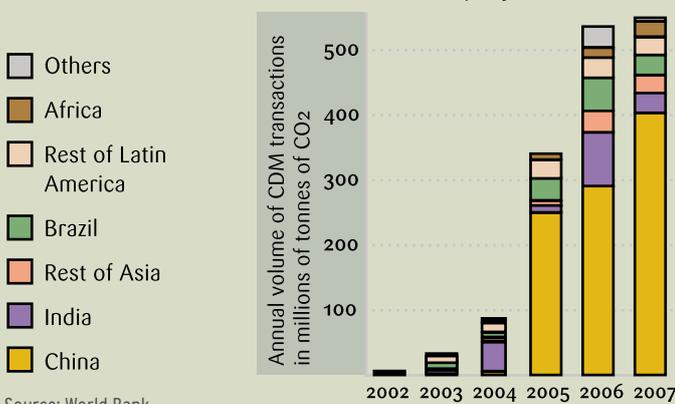
Marthe, a farmer from the Toamasina region, is well aware of these changes, which have had a serious impact on output. "I harvest 20 times less rice than I did 20 years ago," she complains. The climate is so variable that agricultural technical staff no longer recommend crop calendars to the farmers. "We are no longer in a position to say when the best time is for crop growing because of the uncertainty of the rains", says Gilbert Raharinosy, an official from Toamasina's regional agricultural department.

At the global level, however, the island prides itself on being a carbon sink: with 9 million ha of forest (15% of the surface area), it captures 35% more CO<sub>2</sub> than it emits.

**Mamy Andriatiana**

## RESEARCH & INITIATIVES

Global distribution of CDM projects



## Capturing carbon

While some ACP rural dwellers are cutting down trees for charcoal and timber, others are busy planting new ones and earning money. Carbon sequestration schemes, launched by the Kyoto Protocol's Clean Development Mechanism (CDM), allow industrialised countries to offset CO<sub>2</sub> emissions by investing in forestry projects in developing countries. In return, the communities receive payment, derive income and products from the newly planted trees and profit from the sustainable development benefits that all carbon offset projects must include.

In Uganda, the Plan Vivo Project is selling carbon credits to UK-based companies on behalf of local farmers. Under the Nhambita Community Carbon Project in Mozambique, each household will receive US\$242.60 (€158) per ha over the next 7 years. Some projects have a strong environmental component. In Uganda, the Forest Rehabilitation Project is helping to conserve Mount Elgon and

Kibale National Parks, which have suffered serious deforestation. The Western Kenya Integrated Ecosystem Management Project is using trees to improve erosion control and watershed management in the Lake Victoria Basin.

Globally, carbon sequestration projects are worth an estimated US\$300 million (€196 million), but Africa accounts for a tiny share with just 19 projects. One obstacle to widespread take-up has been the difficulty of calculating how much CO<sub>2</sub> small-scale farmers are removing from the atmosphere. Scientists have addressed the problem by using satellite imagery and infrared spectroscopy. Working with the Earth Institute at Columbia University and Michigan State University, the World Agroforestry Centre (ICRAF) has developed methods that integrate satellite data, field survey and rapid laboratory analyses. Highly accurate, the new technique greatly reduces the need for expensive on-the-ground verification.



Photo: © ICRAF

## Trees and crops

Studies show that planting trees between crops and around land plots can help prevent soil erosion, restore soil fertility and provide shade, thereby offsetting some of the effects of climate change. By planting certain fast-growing shrubs on fallow land, farmers help the soil retain more water. One modelling exercise showed that this system could maintain maize yields in dry years when traditional practices give very low yields. Agroforestry also contributes to climate change mitigation, since trees and shrubs absorb more carbon than other crops. The IPCC reports that agroforestry has the potential to sequester nearly 600 Mt CO<sub>2</sub> a year by 2040.

Growing numbers of ACP producers are integrating trees into farming systems, planting fodder trees for cattle, fruit and nut trees for food and other trees and shrubs that produce gums, resins and medicines.

Trees help maintain production during excessive or poor rainfall.

Their deep root system can explore a larger soil volume for water and nutrients during drought. In times of heavy rainfall, their high evapotranspiration rates help them pump excess water out of the soil.

The parkland or scattered tree system can buffer against climate variability. In the traditional farmed parklands of West Africa, dense shading by shea trees (*Vitellaria paradoxa*) and *néré* (*Parkia biglobosa*) can reduce millet yield by 50-80%. But economic yields from tree products outweigh crop losses. In semiarid Kenya, farmers have developed an intensive parkland system using the fast-growing *Melia volkensii* (Meliaceae), which produces high value timber in 5-10 years. Trials show that income from tree products exceeds the value of crop yield lost through competition by US\$10 (€6.5) or 42% during average years and US\$22 (€14.50) or 180% when 50% of the crop fails due to drought.



# 5 | Coasts and oceans

## A dangerous heatwave

The warming of the oceans upsets a fragile ecological balance whose first victims appear to be the fish. Climate change is beginning to take a heavy toll on coastal areas. 'Marine deserts' are becoming increasingly common.

The oceans cover 70% of the Earth's surface with an average depth of 3,800 m. This huge mass of water (3 billion billion m<sup>3</sup>) traps heat and slowly releases it, thereby regulating the outside temperature. The climate influences the marine ecosystem which in turn influences the climate. A deeper understanding of this environment has therefore become central to research on climate change.

Discussions on global warming and oceans inevitably lead to the subject of rising sea levels caused by the melting of the polar ice caps. Researchers now agree that this phenomenon is a real and significant problem, and calculate that, since the end of the 19<sup>th</sup> century, the average level of oceans has risen by about 12 cm. The warmer the Earth becomes, the faster the polar ice caps melt and the faster the ocean levels rise. These levels increased from less than 2 mm per year last century to a current rate of 2.5 mm and could reach an annual 3.5 mm by 2100. Depending on the various models, they could rise by 15 to 80 cm

between now and 2100. Each time a forecast is reviewed and refined, it is in an upward direction...

### Sinking islands

In 2005, the first communities to be evacuated from sinking islands were moved out from Vanuatu in the Pacific. A similar fate awaits islanders in the atolls of Tuvalu and the Maldives. The great deltas of the Ganges, the Nile and the Mississippi are at risk, as are the densely populated coastlines.

Coastal erosion is another problem. The West African coast has been particularly exposed for several decades; in Benin, some parts of the capital Cotonou had to be evacuated. The intrusion of salt water in the water table of coastal zones increases salinity in soils, resulting in fertility loss. Global warming can also transform the sea into a merciless agent of death, by intensifying cyclones and tornadoes. In this respect, the protective role of mangroves is becoming increasingly recognised – when well maintained,

## Guinea: less rice and fewer fish

As far as the eye can see, there are stubs of trees and rice fields. Hectares upon hectares of mangroves have vanished from Guinea's coastline. The elders no longer recognise their once wild and marshy region, which is now densely populated. Soumaila Bangoura, 35, cut down 240 ha of mangroves to grow rice, the staple diet of Guineans who consume more than 90 kg/year. He hopes to carve a further 25 ha out of this precious and fragile land. The coast is dotted with encampments, set up for salt harvesting, which devours huge quantities of fuel wood cut from mangrove trees, as does the fish smoking widely practised in the region.

"They tell us that it is not good to cut the mangroves. But what are people supposed to do if they want to cultivate land?" asks Mamoudou Soumah, a farmer. "We have less rainfall and the rains stop earlier than they used to. Our yields are much smaller". Other puzzled farmers note that they too harvest less and less rice, though they cannot explain why. Ahmed Faya Traoré, who heads the Climate Change in Guinea project, is well aware of the cause of this vicious circle. Rising sea

levels and coastal currents have also contributed to the shrinking of the mangroves and hence to the "impoverishing of soils for cultivation, caused by the intrusion of saltwater which has a direct and damaging effect on soil fertility". This leads farmers to clear yet more land, only to harvest poorer and poorer yields.

Through awareness-raising campaigns, NGOs have managed to persuade some coastal dwellers that it is in their interest to change their ways. Yayah Cissé is one of them. Like growing numbers of salt farmers, he uses a new technique to extract salt. He traps seawater on plastic sheeting stretched out in the sun so that the salt dries naturally, without the need to burn any wood.

Just like the farmers, the fishers look on helplessly as their catches decline with every year that passes. The days of plentiful fish are over. Morlaye Touré remembers how it used to be: "Before, we stayed near the coast and caught large numbers of big fish, but for at least

5 years now, we have had to go out much further in our small canoes if we want to get a good catch."

The tree stubs offer increasingly scant shelter to the fish for which the strange roots of the mangroves were once prime breeding grounds. "The more you cut them down, the fewer fish you have on the coasts", says Ahmed Faya Traoré. A cruel case of cause and effect.

**Alpha Camara**

*In Guinea, drying salt in the sun avoids burning wood*



Photos: © Syfia International



## 5 | Coasts and oceans

they cushion the force of waves and the wind and also help combat coastal erosion (see page 23).

More complex phenomena, equally alarming, are having a serious impact on aquatic life. So-called 'marine deserts' are spreading. These are areas of the ocean where

life has completely disappeared. The warming of the surface waters causes a slowdown in the mixing of these with the lower, colder layers that contain the nutrients essential to the growth of plankton. The gradual disappearance of plankton leads to a decline in the more evolved species which feed on it, beginning with fish. Marine deserts are currently developing in the North and South Atlantic and in the North and South Pacific, according to surveys carried out by the USA's National Oceanic and Atmospheric Administration. For the time being, the Indian Ocean appears relatively unscathed. Since 1998, these marine deserts have taken over some 6.6 million km<sup>2</sup>, twelvefold the surface area of France!

### Fish in troubled waters

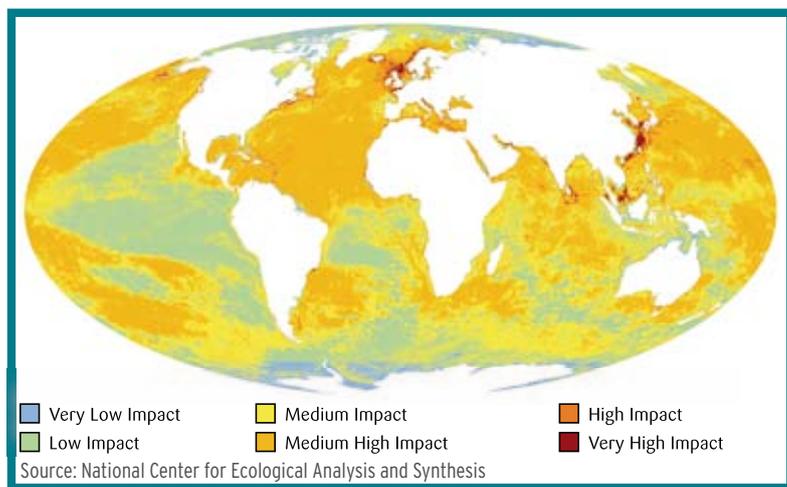
Added to this threat to fishery resources is the slowdown of the Earth's major ocean currents due to an overall rise in land surface temperatures. A report titled *In Dead Water*, published in early 2008

by UNEP, clearly shows that this slackening of pace will have a major impact on fish stocks. It could affect three-quarters of the world's most important fishing grounds, says the report, which observes that "millions of people including many in developing countries derive their livelihoods from fishing while around 2.6 billion people get their protein from seafood". A decline in circulation of the ocean's natural pumping system affects the 'washing and rinsing' mechanism of the continental shelf, which keeps the waters healthy by flushing out growing levels of wastes and pollution and brings nutrients to fisheries. Half of global fish catches and all small-scale fish catches are taken on this shallow continental shelf bordering the coasts.

Another alarming prediction: according to UNEP, "80 to 100% of the world's coral reefs may suffer annual bleaching events by 2080" and die as a result, a major risk given that these are a crucial source of food for the fish who live there (see page 23). The corals of the western Pacific, the Indian Ocean, the Persian Gulf and the Caribbean Sea are particularly at risk.

"We are gambling with our food supply", warns Christian Nelleman, who coordinated the UNEP report. ■

### Human impacts on marine ecosystems



# Papua New Guinea: sinking by degrees

[ REPORT 1 ]

Time is running out for the people of Carteret Island, an atoll that is part of the Autonomous Region of Bougainville off the coast of Papua New Guinea (PNG). "Food gardens and coconuts have been destroyed and children are going to

school hungry," said Ursula Rakova, who heads Telele Peisa, an NGO trying to help families on the sinking island. With sea levels rising inexorably, the islanders face the prospect of leaving their homes. There is simply nothing left to eat.

Climate experts have forecast that the island, which is home to 1,000 people, will have completely disappeared by 2015. Already, the encroaching water is making life very hard. "It is extremely difficult now for food crops to grow on the atolls. Salt water seeps through the land, making it impossible for food to grow. Breadfruit is seasonal and is not as plentiful as it was 30 years ago. Fruits are getting smaller in size," said Ursula, who is fighting to get the islanders relocated on the larger island of Bougainville 90 km away as climate change refugees. "Bananas struggle to grow in salt-inundated land."

For the time being, the island community is struggling to survive

on rice sent by the Autonomous Bougainville Government. But food aid can take days or even weeks to arrive on the island due to transport difficulties, and supplies are running out. The government of PNG has allocated K2 million (€450,000) to the Carteret Relocation Programme, but this is unlikely to be enough to help the islanders buy land and start new lives. The Catholic Church of Bougainville has donated land to build 10 homes, and the first families left the island in June 2008.

Juliana Samsi, a nurse who runs the local clinic, says that though the people of Carteret have always lived in harmony with the sea, they are now starting to be frightened. "We are so scared living on these atolls, anytime soon waves will come and just sweep over us all," she said.

Ursula echoes the community's feeling of helplessness. "Carteret islanders are victims of climate change and rising sea levels. The atolls are sinking and despite not knowing the sciences, people can see with their naked eyes the impact of the rising sea levels," she said. "The atolls are going down, and going down really fast."

Eric Tapakau



Photo: © E. Tapakau



## INTERVIEW

## Paradise lost

**Penina Moce**, 45, lives on Kabara, part of a small group of islands off Fiji's main island of Viti Levu.

To many, my island may not be an ideal place to live. We do not have any rivers or streams and therefore depend mainly on rain for our household needs. We do not have much land suitable for growing crops. But my people have survived like this for countless generations. In the 40 or so years I have lived on Kabara, I like many of those on my island have noticed changes, like the rapid erosion of coastal areas near our villages, longer periods of dry

hot weather, the increased frequency of storms and storm surges, changes in the seasonal patterns of our plants and animals and the bleaching of corals in our fishing grounds.

In one village, Naikelayaga, the beach has eroded 10 m back over the past decade, so that it now threatens the school. If we are constantly forced inland by the sea, it is unlikely we could relocate, as all four villages are surrounded by high limestone cliffs. The only option then would be to abandon our island, but I hope that day never comes.

Water shortage has always been a part of our lives, but in recent years we have noticed that our normal dry season seems to have extended and the weather is far drier. This not only affects how much water we

have for our daily needs, but also our gardens. The leaf and root crops like slimy cabbage, cassava, sweet potatoes, yams and bananas wither and the white bugs that thrive during this period infest and destroy what is left. During times like these we often resort to drinking coconuts, but when the dry season is prolonged the young coconuts fall off the tree before we can use them.

The seasons for trees in the forests to bear fruit and for fish to spawn have changed. Recently, we have noticed that these either happen earlier or later than usual. In the past, the fruiting of certain trees coincided with the spawning or breeding times of certain fish — now they are out of sync. Our fishing grounds have begun to change.

In the past, most of our corals were very colourful, but now everything appears white and the fish we harvest are fewer and smaller.

As we come from islands that are isolated, assistance from government is often very slow. However, the communities on my island have begun to take action, by planting more trees, protecting our reefs by banning all damaging activities to corals and implementing community water use restrictions. These are just small steps we have taken ourselves, but as I understand it, since climate change is a global problem, our efforts will still be useless if others do not take action as well.

## RESEARCH &amp; INITIATIVES

## Mangroves no time to waste

According to a study carried out in 2006 by the Climate Change in Guinea project, rising sea levels linked to global warming should result in stronger coastal currents, higher tides and sea encroachment of land. Guinea's coastal region, home to West Africa's largest and richest mangroves, will therefore bear the brunt of global climate change. The region's entire economy is now under threat. "The main victims of all these climate variations will be people living near the coast. As far as the economy is concerned, estimates are that more than 2 million people will suffer income losses", says the study.

In an effort to limit the foreseeable damage, Guinea has launched a national plan of action for climate change adaptation (PANA-CC), adopted in April 2008, which sets out priorities, among them measures for protecting the coastal areas. It outlines vigorous action for saving the mangroves and reforesting the region, planting teak and cashew.

At the same time, there is an urgent need to encourage the production of biogas and the use of butane gas as substitutes for the fuel wood which is the main source of energy for almost all households in Guinea. "In my opinion the government is being rather slow to establish a national policy for gas production. If this is not done, we will continue to suffer the effects of desertification", warns Ahmed Faya Traoré, who heads the Climate Change in Guinea project.

Faced with rising water levels, communities are being advised to build sea walls and plant trees along the coast in order to protect the rice fields that have taken the place of mangroves. Other recommendations include enforcing laws on coastal settlements and tackling pollution. For these adaptation measures to work, it is crucial that local people be provided with environmental education and prepared for possible catastrophes in the future.

## Transplanting coral in the Caribbean

For coral reefs in the Caribbean, 2005 was not a good year. Water surface temperatures of 30° C or more led to severe bleaching of 50-95% of coral colonies over a huge area, killing many of them. What if you could move the coral to more favourable places?

Various factors can put corals under stress, but elevated sea surface temperature appears to be one of the main threats. A study using data from 263 sites across the Caribbean found that hard coral now covers just 10% of reefs, down from 50% a few years ago. In 2005, the University of the West Indies and the Barbados Coastal Zone Management Unit collected data from 4,600 colonies of 29 species of hard corals. Bleaching ranged from 59% to 86% and affected 26 species. These observations support other reports from the region that a consistent water temperature of 30-31° C is the precipitating factor in bleaching.

But the ability of some species to resist bleaching in specific physical conditions may offer hope for conservation. The discovery of over 700 magnificent hard coral colonies led to a 3-week delay of an extension project at the Bridgetown port in Barbados, while the colonies were relocated.

Marine biologist Andre Miller was called in: "No one thought that there would have been so many large coral colonies, and since we were working against the clock we decided to initially focus on carefully severing and removing all viable hard corals."

While awaiting transplantation, the corals were kept in barrels of fresh salt water. A marine park was chosen as the new site. The corals were reattached with a non-toxic mix perfected by Miller and fellow divers, based on ordinary cement and various additives. Prepared on board the dive boat and taken underwater in plastic bags, the mix had to be the right consistency to bond the base to the substrate but not immediately dissolve in the water. Once secured, the corals were marked with coloured plastic tags and monitored regularly.

Within just a few months, it was difficult to differentiate between the original and transplanted colonies as natural calcification had started to fuse the base of each colony onto the substrate.

The technique, also used on Australia's Great Barrier Reef, offers the possibility of re-populating damaged reefs. Since species have differing

*Coral can be transplanted to prevent its bleaching and death.*



Photos: P. Laboute © IRD

responses to bleaching at various depths, transplanting could also be used to redistribute colonies to more favourable locations.

Miller and his highly trained team have worked on several coral transplant projects in Barbados, the Grenadines, Jamaica and St Lucia, and in all cases the survival exceeded 90%. Corals left in their original areas would already have been smothered. The future for coral transplantation as a management tool seems bright.

Andy Taitt