protos

water maakt vrij
l'eau, un droit naturel
agua por la vida
water powers people

Climate, Water and Development

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PREVIEW

We live in a rapidly changing world.
The climate is changing fast, as are the general views about that change and the consensus about the measures to be taken.
Something that seemed obvious yesterday is called into question today or set aside by new insights. What we put down on paper today may already be overtaken by tomorrow.

Yet we believe that it would be of value to draw up a "state of affairs" about the issues of climate change, focusing on the situation in the developing countries.

This brochure has been created with insights provided to the best of the ability of voluntary contributors, based on knowledge and discussions published up until the first half of 2008.

No doubt it is a story to be continued…

1/ INTRODUCTION

Can we continue to stand by and watch?

Global warming (or the enhanced greenhouse effect) is the phenomenon whereby we observe an increase in the Earth's average temperature. Since the beginning of the twentieth century, the Earth's average temperature has risen by approximately 0.74 °C. It is highly probable that this rise in temperature has been caused by human activities such as burning fossil fuels, deforestation and certain industrial and agricultural activities. As a result of these activities, the concentration of greenhouse gases in the Earth's atmosphere is increasing. Modelling indicates that between 1990 and 2100, the temperature may rise by anything between 1.4 °C and 6.4 °C. Temperature increases in excess of 2 °C would mean major changes for humans and the environment: a rise in sea levels, an increase in the number of periods of drought and heatwaves, extreme precipitation, a reduction in groundwater reserves, more frequent cyclones and other unpleasant extreme weather events. Global warming is also having a significant effect on the water cycle. These unwanted effects are being felt most strongly in the South.

The industrialised countries lie behind the problem. Yet, the developing countries are the hardest hit by the effects of climate change. That's because they have fewer financial and technological resources to adjust and prepare in time for the changes.
The North[1] in particular needs to work on making urgent commitments to combat change and introduce Mitigation Measures[2]. At the same time, the vulnerability of the South[3] needs to be countered by (pre)-Adaptation Measures[4]. In view of the fact that as a result of their combined greenhouse gas emissions the industrialised countries and emerging countries[5] are responsible for climate warming, a special effort should be expected from them to support the South in these measures.

1) *In this brochure, when we mention the North, we mean the wealthy industrialised countries.*
2) *Mitigation Measures mean the action taken to reduce greenhouse gas emissions. They relate to reducing gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and a number of fluorine compounds (HFCs, PFCs and SF6). Mitigation can be achieved by reducing greenhouse gas emissions, capturing and storing CO_2, preventing deforestation and replanting trees.*
3) *The South: all developing countries, including those situated in the Northern hemisphere.*
4) *Adaptation: adapting to the current and future effects of climate change.*
5) *Emerging countries generally refer to BRIC countries – Brazil, Russia, India and China. Mexico is also included sometimes.*

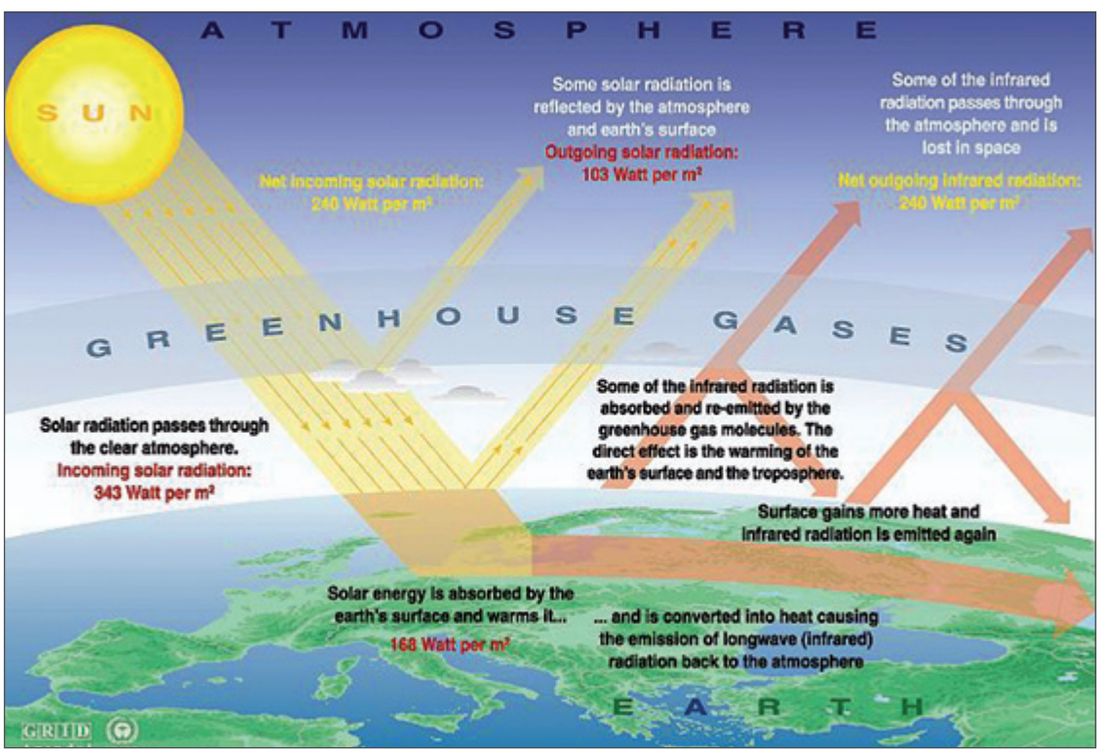
2/ CLIMATE CHANGE IN A NUTSHELL

Climate change

THE CAUSES OF GLOBAL WARMING

If we weren't surrounded by an atmosphere, the average temperature on Earth would be approximately 15 degrees below zero, rather than 15 degrees above, as is the case now. The atmosphere lets through sunlight, which warms up the Earth, but also does not allow that energy to escape again.
What happens is that some gas molecules absorb the planet's heat radiation temporarily. When they release that heat later, it goes in all directions – including back to the Earth. This means that part of the sun's energy remains trapped in the form of heat. But there is a balance between the heat coming in and the energy radiated out again: this is called the "natural greenhouse effect".

Since the beginning of the Industrial Revolution, activities by humans have become a very significant source of greenhouse gases. Industry that is based mainly on fossil fuels, highly intensive farming, large-scale deforestation and the production of numerous chemicals have all had an unexpected effect on the "natural greenhouse effect". These additional greenhouse gas emissions are preventing the Earth from radiating heat outwards. The following gases that humans emit into the atmosphere are effective at absorbing heat: carbon dioxide (CO_2); methane (CH_4), nitrous oxide or laughing gas (N_2O) and a number of fluorinated gases.

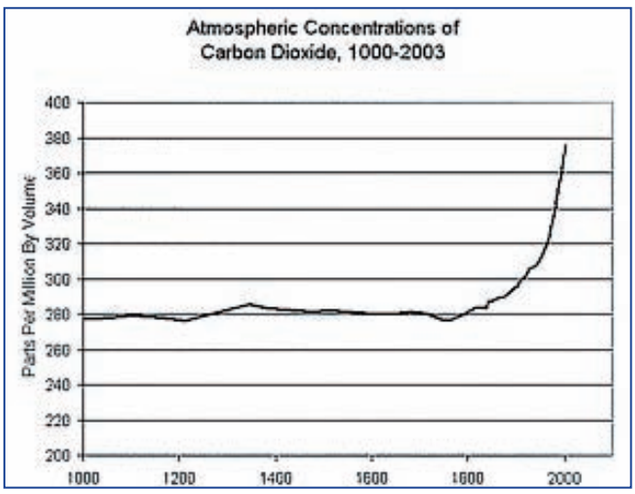


Greenhouse effect

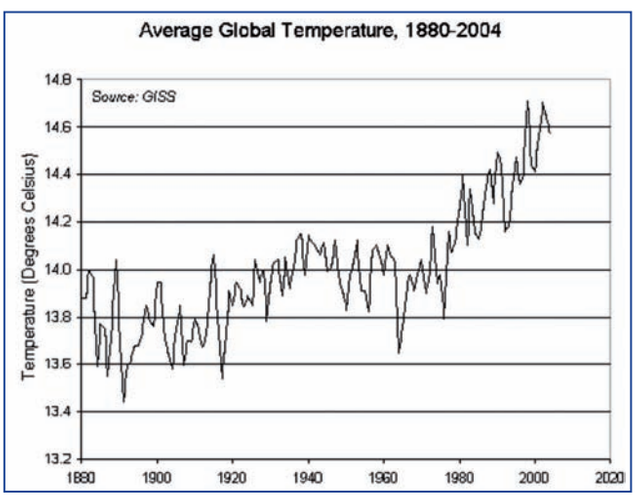
Between 2000 and 2005, an average of 25 Gt[6] of CO_2 were emitted each year, of which 8 Gt were absorbed in the oceans and 3 Gt stored by vegetation on land. In recent decades, the remainder has resulted in an annual increase in CO_2 of 1.9 ppm[7] in the atmosphere. This increase is in stark contrast with the annual rise observed prior to the Industrial Revolution, which was 0.0025 ppm. Even more unsettling is the fact that emissions continue to grow each year, whereas the Earth's ability to absorb those emissions is reducing. Part of the reason for this is that warmer oceans are less able to absorb CO_2.

The rise in the average temperature of the atmosphere is the most fundamental indication that the climate is changing.

In the past, there has always been a strong link between movements in temperature and concentrations of CO_2. The temperature on Earth has risen and fallen on many occasions. One essential difference with the past is that since mass human greenhouse gas emissions, the concentration of CO_2 has never risen so quickly and so high. Over the past 100 years the temperature has risen by 0.74 °C, which is much faster than in previous cyclical movements.



Timeline of CO_2 in past centuries



Temperature timeline since 1800

PREDICTIONS ON WARMING

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988. This United Nations organisation conducts a permanent assessment of the risks of climate change. The panel is made up of hundreds of experts from all over the world, from universities, research centres, corporations, environment organisations, and so on. The IPCC has produced 6 scenarios for the possible rise in the average temperature on Earth in the 21st century. The differences between these scenarios lie in variations in population growth, economic growth, energy usage and the measures taken to reduce climate change (mitigation).

The exact temperature for the various scenarios is uncertain, but it is highly likely that the rise in temperature will be between 2.3 and 4.5 °C. The IPCC has set the critical temperature increase limit at 2.0 °C by the end of this century (compared with the temperature since the beginning of the Industrial Revolution). If this value of 2.0 °C is exceeded, then the likelihood of the effects of climate change become too great, taking us more and more into uncharted territory. As the temperature continues to rise – which will happen if there is no serious policy on reducing CO_2 emissions – so does the likelihood of critical threshold values being exceeded. Exactly what would happen then is not known, but in any event the effects would be irreversible. Economic projections would then be purely speculative.

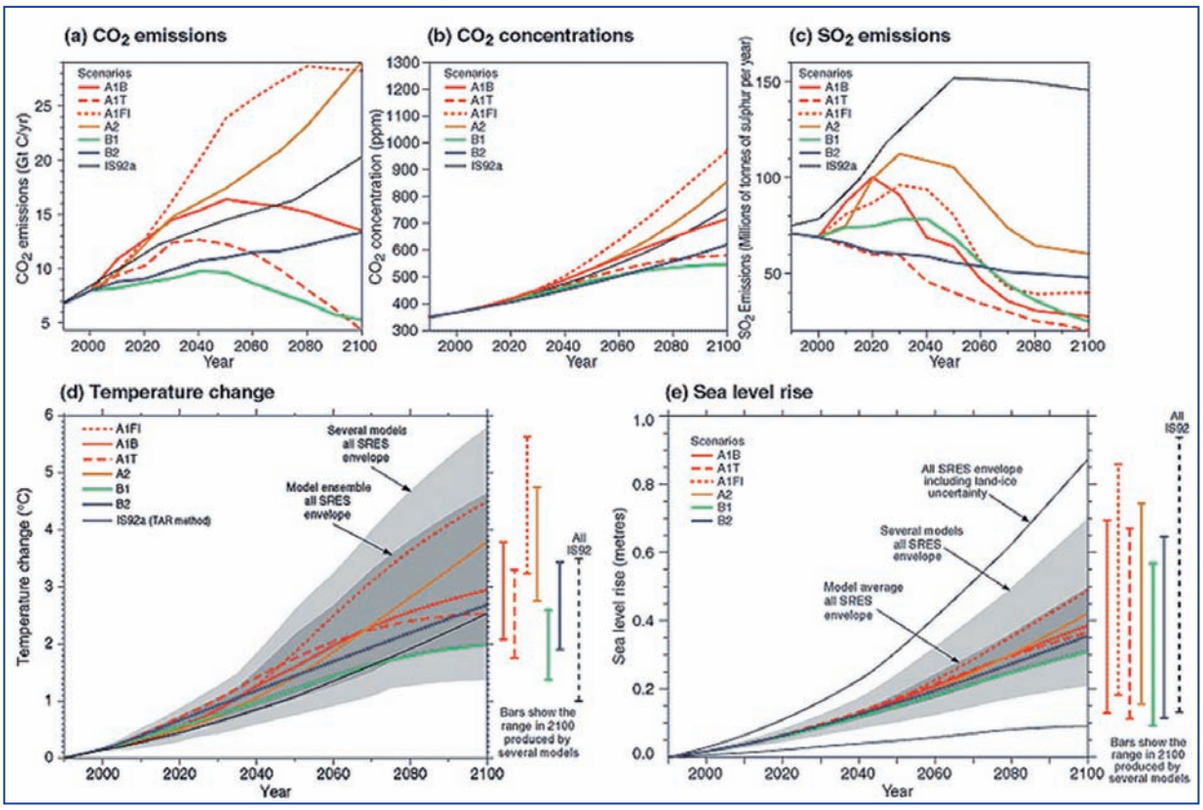
A rise of 2.0 °C corresponds with an increased CO_2 concentration of 450 ppm. However, in half of the scenarios, there is a greater likelihood of the rise in temperature being higher than 5.0 °C. A rise of 5.0 °C is equivalent to the increase in temperature that has taken place since the last Ice Age, approximately 13,000 years ago, when large parts of the United States, Europe and northern Asia were covered with ice.

6) Gt: gigaton or thousand million tons = billion tons = thousand billion kg.

7) ppm: parts per million = measurement used to express concentration: 1 part for every 1 million parts.

The following graphics show the various changes in temperature and sea levels, depending on each of the 6 scenarios.

The global climate of the 21st century



IPCC models for possible increases in CO_2 and temperature, CO_2 and SO_2 emissions and the rise in sea level

THE CONSEQUENCES OF CLIMATE CHANGE

The effects of climate change are already being felt all over the world. However, it is difficult to predict how quickly and how intensively the effects we are already feeling might increase.

Whereas the countries in the North and the emerging countries are mainly responsible for greenhouse gas emissions, the effects (such as more intense droughts, increased salinity of arable land, melting glaciers and floods) will be felt everywhere. In developing countries, people are the most vulnerable because they have fewer resources to adapt and take appropriate measures – and it is here that the consequences of climate change will be worst. In the North, action is being taken to accommodate the current negative effects (adaptation). In the South, though, where there is far less awareness and knowledge about climate change, and where they also have to cope with numerous other challenges in relation to development, any serious action is currently out of the question.

Below we detail 5 areas that are under pressure from climate change and where human activity is likely to be disrupted. Climate change will have a more significant and accelerated negative effect in 3 of these 5 areas as a result of unsustainable human practices: faster erosion of farming land, overconsumption of water in 'wealthy' regions, the disappearance of plant and animal species caused by residue from chemical derivatives, etc.

1. Farming production and food security

Warming will mean change with regard to precipitation (frequency and intensity) and the available water supplies for agriculture. In the countries around the Sahara in Africa in particular, as well as in Latin America and southern Asia, agriculture will be threatened by reduced water availability. The current erosion of farming land brought about by the clearing of trees on hillsides will only increase as a result of heavy rain.

Rising temperatures will also lead to more plagues of insects and the increased salinity of arable land, which will cause farming production to decline. People will have to work harder to obtain water (carrying water over longer distances, pumping it from deeper underground, etc.) and the cost of making water available for agriculture will rise.

It is estimated that by 2080, the effects of climate change will mean that approximately 600 million people will be facing additional food shortages.

2. Water supplies

It is also estimated that by 2080, 1.8 billion people may be in difficulty as a result of water shortages.

In addition to increased water consumption as a result of an increasing population and more frequent droughts, the melting of the glaciers will threaten supplies of drinking waters in many places around the world. Melting glaciers will have the most severe consequences in Asia, the Himalayas and in the countries in the Andes in Latin America.

3. Rising sea levels and exposure to natural disasters

An increasingly warm Earth will mean a rise in sea levels caused by melting glaciers, the melting icecap in Antarctica and the natural physical expansion of water as temperatures rise. A rise in temperature of between 3 and 4 degrees may result in an additional 330 million people being exposed to flooding on a temporary or permanent basis. Some islands will be partly or totally erased from the map, such as the Maldives, because the majority of the island group rises less than 1 metre above the water level.

Warmer oceans will also lead to more frequent and more intense storms. Over a billion people live in urban areas located on vulnerable hillsides or at low-lying levels on the coast and along rivers, meaning that their day-to-day lives will be disrupted to a greater or lesser extent.

4. Ecosystems and biodiversity

Current climate change is already having a negative effect on countless ecosystems. For example, half of all coral reefs are affected by rising temperatures in our oceans. The acidification of the oceans will also affect marine ecosystems, with consequences that are not yet known. The available space for plants and animals in areas where there are glaciers and at the polar icecaps is becoming smaller all the time and in most places is even disappearing altogether. On the remainder of the planet, a large number of plant and animal species will be able to adapt to the consequences. However, for others, the speed of change will be too great and ultimately they will disappear. It is estimated that approximately 20 to 30 per cent of the animal species that live on land will disappear.

5. Human health

It is still difficult to assess how great the effects of increasing temperatures will be on human health. The higher death rate recorded during the hot European summer of 2006 possibly provides an indication. However, the effect of poor air quality is becoming more clear all the time: fine dust and carbon particles are being blamed increasingly as causes of health problems and death. Epidemics of various kinds will also become more frequent and severe. For example, it is estimated that between 220 and 400 million people more will be exposed to malaria.

HOW CLIMATE CHANGE IS THREATENING THE MILLENNIUM DEVELOPMENT GOALS

In September 2000, all 189 member states of the United Nations signed the Millennium Declaration. Through this declaration, they undertook to meet a number of practical and measurable goals linked to a timetable, by 2015, in the fight against poverty, hunger, illiteracy, infectious disease and the further degradation of the environment. These were the Millennium Development Goals (MDGs).

However, climate change is creating another obstacle, along with all of the other difficulties and limited political will to achieve these targets. Climate change is having a clear effect on just about all of the targets:

MDG1
Eradicate extreme poverty and hunger

- Threats to forests, fish stocks, grazing and arable land, and hence food supplies
- Damage to dwellings, more difficult access to water supplies, negative effects on health, all of which mean additional costs
- Efforts to manage and make the most of stocks will increase, possibly leading to conflict, undermining the security of households and, by extension, leading to migration

MDG2
Achieve universal basic education

- More children and in particular more girls will be needed to leave school to earn extra money, or go looking for water or produce food
- Malnutrition and disease will lead to greater truancy from school
- Storms and floods may destroy roads, bridges and school buildings, resulting in higher absenteeism rates from school

MDG3
Promote gender equality and empower women

- Women in the South are more dependent on the environment than are men, thereby making them more vulnerable to change
- Women are responsible for collecting food, water and firewood and will need to spend more time on these activities

MDG4
Reduce child mortality, and

MDG5
Improve maternal health

- The quality and quantity of drinking water will decline and food shortages will lead to malnutrition
- Poor air quality will result in more respiratory diseases in children

MDG6
Combat HIV/AIDS, malaria and other diseases

- Numerous diseases will spread to other areas (particularly malaria), making pregnant women, young children and the elderly the most vulnerable

MDG7
Ensure environmental sustainability: Protect the environment, provide everyone with clean drinking water and have fewer people living in slums

- Climate change will adversely affect the quality and productivity of ecosystems, resulting in some of them being irreversibly damaged
- Biological diversity will diminish

MDG8
Develop a global partnership for development

- Climate change is a global challenge, requiring global cooperation between the North and South. In view of the fact that the South is expected to be more severely affected than the North, the South will be even more dependent on assistance from the North.

Climate change in a historical perspective

Modern humans, Homo Sapiens, originated in the high plateaus of Ethiopia about 200,000 years ago. On the geological timescale, that is "the day before yesterday" ...
In fact, humans have only been on Earth for a very short time. Humans are at the tail end of a long process of evolution of life on Earth – something that has been going on for about 3 billion years in all. However, no other "species of animal" has succeeded in such a short space of time in having such a profound effect on the planet – to such an extent that humans are actually placing their own continued existence under threat.
The Pleistocene age, which lasted for about 2 million years, was characterised by significant fluctuations in temperature across the entire planet, including a series of Ice Ages.
The temperature fell so much that glaciers and icecaps covered a large part of Europe, Asia and North America. The last great Ice Age, Würm, ended about 13,000 years ago and marked the end of the Pleistocene epoch. The development of humans then advanced and because we were able to adapt to different climate conditions, modern humans were able to migrate to new areas on Earth. The first humans were hunter-gatherers.
As the Earth warmed up, both the landscape and sources of food changed, too. Northern Europe gradually became a region of thick forests and mixed woods.
The inhabitants used the rivers to travel inland through the thick mantle of forests from the coastal areas. Little by little, people began becoming established in various areas.
These settlements and the warmer climate had major consequences for the development of the human race. Once the many animals from the tundra started to die out as a result of over-hunting (reindeer, mammoths, wild oxen, wild boar, etc.), food became harder to come by. Humans learnt to grow crops and domesticate animals. This brought the beginning, in about 10,000 BC, of the Neolithic Age or the era of farming. People started to bend what the Earth provided to their will.

How our consumption habits place the Earth under pressure

Our consumption habits are definitive for the quantity of raw materials that we use and for the pollution that we cause. Our consumption has consequences for other places in the world, too. To express the precise impact caused by our consumption habits, we talk about our "ecological footprint", "carbon footprint" and "water footprint".
By comparing these footprints across different countries, we are able to obtain a picture of who the major "consumers" and "polluters" are.

ECOLOGICAL FOOTPRINT

The ecological footprint measures human consumption of natural resources.
That consumption is compared with nature's ability to renew those resources. The ecological footprint is expressed in hectares of the Earth's surface.

The footprint (of a country, city or person) is the total area required:

- to produce the food and staples that that country, city or person consumes;
- to process the waste (mainly carbon emissions) generated by the energy consumption of the country, city or person;
- for the infrastructure of the country, city or person.

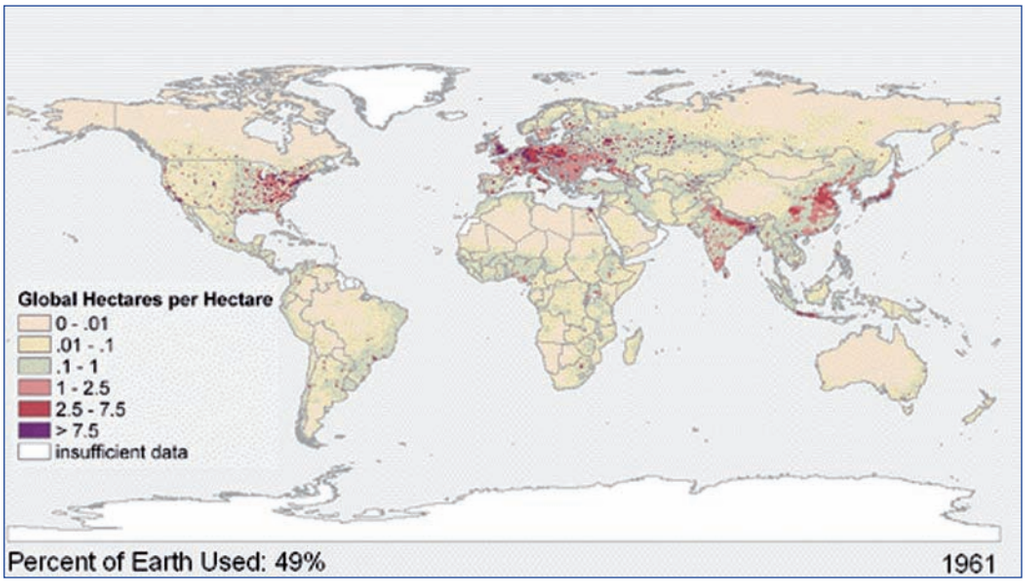
Only 1/4 of the Earth's surface is organically productive (forests, areas where there is fresh-water, coastal areas, pasture land, etc.).
The icecaps, deserts and deep sea produce little or are difficult to access to exploit the resources. In total, humans need 11.3 billion hectares – which is approximately 1.8 hectares of the Earth's surface per person – to feed and clothe themselves, live, keep warm, etc.

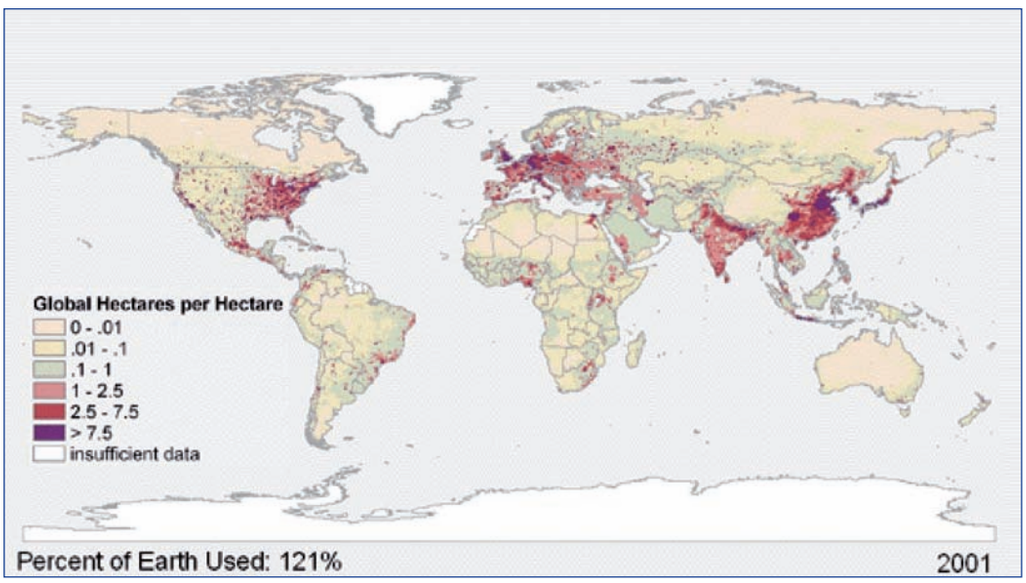
By converting consumption into the area of land needed for the production of that consumption, it is possible to compare the environmental impact of various types of consumption behaviour or lifestyles, or to make comparisons between different countries, population groups and individuals.

Trends in the ecological footprint – Period 1961-2001

In 1961, only 49 % of the Earth, or barely half of the planet, was being used. Forty years later, in 2001, that figure had multiplied by a factor of 2.5, meaning that 121 % of the Earth's capacity was being used. This means that we are using more "fertile Earth" than is available. By 2003, the global footprint had risen to 2.23 hectares of the Earth's surface per person. Hence we would actually need 1.26 planets to maintain our current lifestyle.
But at this level of usage/consumption of natural resources, the Earth's regenerative capacity (biocapacity) is compromised, taking us into an unsustainable pattern of consumption.
The average footprint of Belgians is approximately 6.7 hectares, whereas the average Indian has to make do with 0.8 hectares. If everyone on Earth were to live like us, we would need three additional planets to meet our needs. The average person in the US uses as much as 9.6 hectares. And if the developing countries were to adopt the same consumption habits as the US, we would need another five globes to accommodate us. Which aren't there, of course...

The figures below show the "intensity" of the footprint back in 1961 and the situation in 2001, expressed in the number of hectares of land required to support consumption in a particular area. The darker the colours, the higher the level of consumption.
The "footprint intensity" may be high because there is a high population density (such as in India or China), a high level of consumption (such as in the east of the US) or a combination of both (such as in Europe).





Source: Global Footprint Network & SAGE

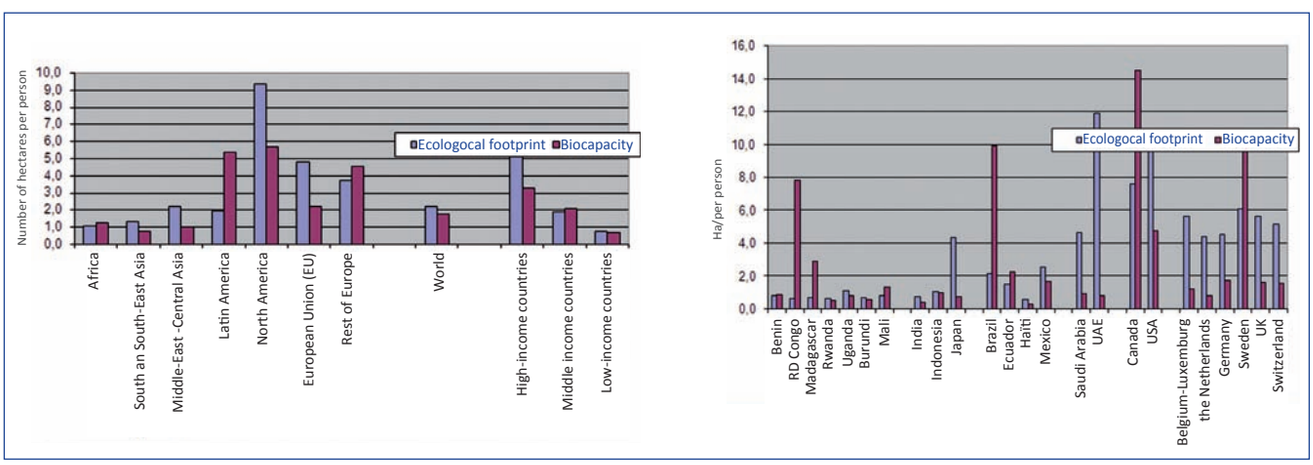
Footprint intensity in 1961 and 2001

Regional footprints and ecological debt

Overconsumption by the wealthy nations in the North creates inequality compared with the poorer South and slows down the development of those countries.

The figure below shows the ecological footprint and biocapacity for various regions of the world. If the footprint is bigger than the biocapacity (as is the case in most wealthy countries), this is called an "ecological deficit". If that is the case, we need to call on other countries to help accommodate this lifestyle. Another name for this is "ecological debt". This term refers to the debt that the wealthy countries owe to the poorer countries for using up their valuable raw materials and "their share of the Earth". If it is the other way round, this is called "ecological surplus" and is used to put the "surplus land" into production to generate consumer goods for those countries with shortages.

Acknowledging ecological debt puts the North-South relationship in a different perspective. In ethical terms, the ecological debt shows the collective responsibility of the industrial nations. This means that a change of lifestyle in the North is more than necessary. Copying the North's development model will not offer the South a solution for a sustainable world in the long term. Acknowledgment of its ecological debt invokes the North's responsibility and is entirely in line with the "polluter pays" principle. Sustainable development must reconcile economy and ecology with one another and should make the principle of collective accountability work towards achieving a fair distribution among the generations and between North and South.



Ecological footprint and biocapacity (2003)

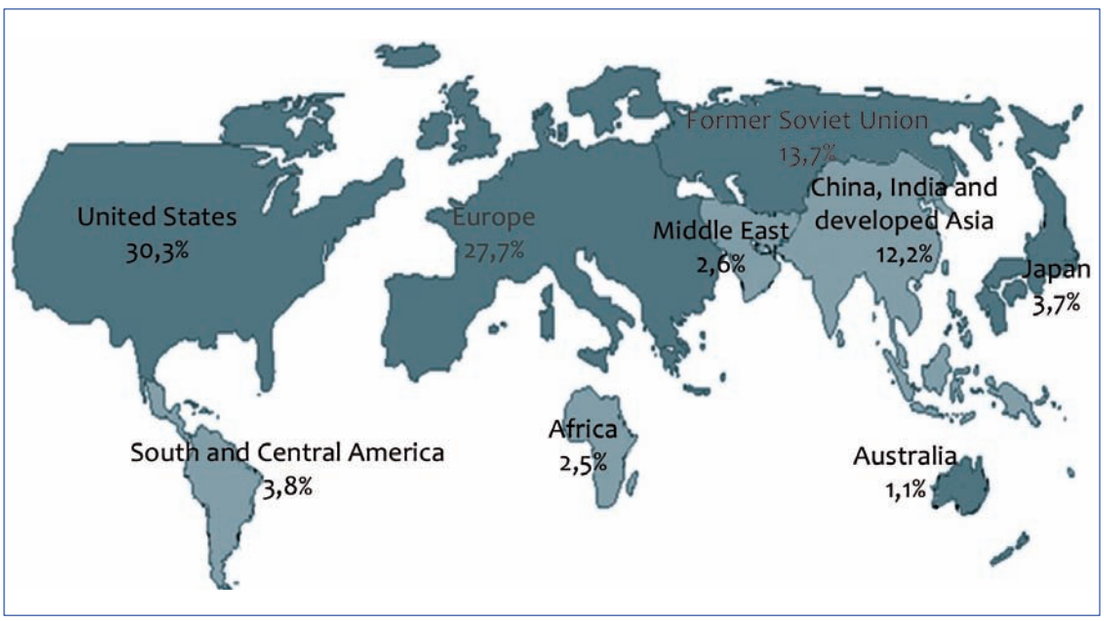
CARBON FOOTPRINT

When we use fossil fuels for things such as transport, producing electricity and heating, carbon dioxide is always emitted. This greenhouse gas is closely related to climate change and too high a level of carbon emissions contributes to global warming.

Trees, plants and algae are natural 'cleaners': they extract CO_2 from the air in order to grow and then supply our air with oxygen. If the Earth's capacity is too low to capture carbon dioxides in trees, plants and algae in the oceans, this greenhouse gas accumulates in the atmosphere.

Carbon footprint

Part of our ecological footprint is caused by the emission of carbon dioxide. The "carbon footprint" tells us how much land (biocapacity) is required to capture our carbon emissions. The carbon footprint weighs heavily in the overall ecological footprint. Since 1961, the carbon footprint has risen by a factor of at least 9 and now contributes to over half of the total footprint that we impose on our ecosystem. This means that we urgently need to reduce our carbon footprint and hence absorb our "ecological deficit". Half of the carbon footprint is caused by transport. Nationally, regionally or locally, the production and consumption of food can in itself mean a significant reduction in emissions.

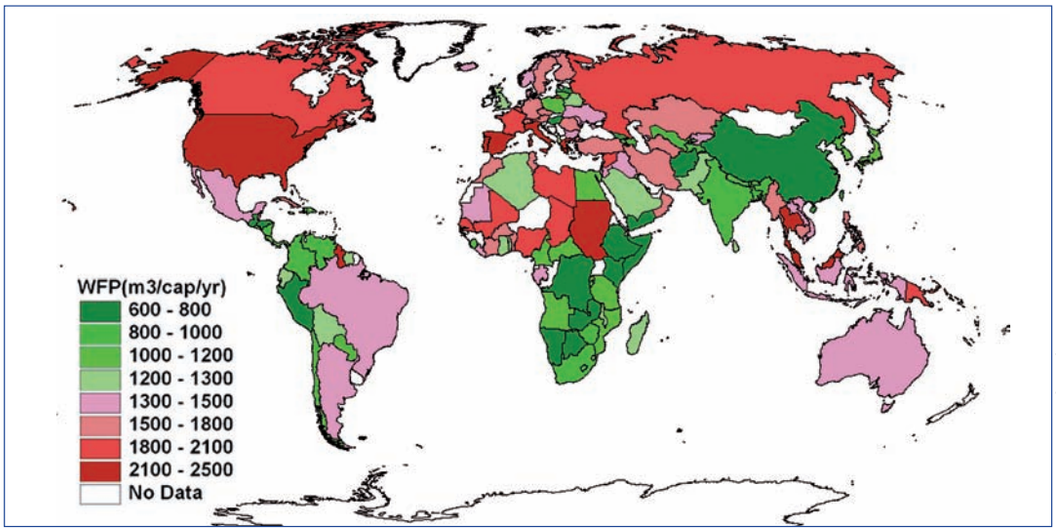


Source: World Resource Institute, www.wri.org

The countries' surfaces are in relation to emissions of CO_2 from burning fossil fuels '1900-1999'
industrialised countries versus developing countries

Regional differences in the carbon footprint

In 2004, the average emission of carbon dioxide in Belgium was 9.7 tons per person per year.
At the time, Qatar was ranked top with 69.2 tons per person per year.
A few other examples: US 20.4 tons, Botswana 2.37 tons, Nigeria 0.83 tons, Benin 0.29 tons, Uganda 0.07 tons and, in last place, Chad with 0.01 tons per person per year.
By way of reference: one growing tree captures an approximate average of 20 kg CO_2 per year.



source: www.waterfootprint.org

The water footprint per person per year

The water footprint is the quantity of water required to produce all of the goods and services (both produced domestically and imported) that a country consumes, expressed in a quantity of water per person per year. The water footprint of a country or population group tells us about the quantity of water required to sustain a certain lifestyle and hence to maintain a certain pattern of consumption. The water footprint can be divided into the use of "national" water (the domestic water footprint) and the use of water outside national borders (the external footprint).
This water usage includes water for agriculture (both rainwater and irrigation water), industry and households.

The global water footprint is approximately 1,240 m^3 per person per year, which is the equivalent of about half of an Olympic swimming pool.
The production of agricultural crops (domestic and external production) is the largest user and contributes to 70 % of the total global water footprint.

The four factors that determine the water footprint of a country are: the population density, consumption habits (e.g. high versus low consumption of meat), the climate (growing conditions and water requirements for crops) and farming practices (the efficiency of water usage).

Water consumption by some countries

Eight countries (India, China, US, Russian Federation, Indonesia, Nigeria, Brazil and Pakistan) represent 50 % of total global water consumption. These countries are also home to more than half of the world's population. As such India, China and the US are the biggest users of water, with 13 %, 12 % and 9 % respectively.

There is also a big difference between the various countries in terms of the composition of the water footprint. For example, the consumption of industrial goods in the US contributes 32 % to the national water footprint, whereas in India that figure is only 2 %. The water footprint per person also varies sharply. In the US, the average water footprint is 2,480 m^3 per person per year, while in India the average is 700 m^3.
The figure provides a picture of the water footprint per person per year in various countries.

Virtual water

The concept of virtual water can best be described as the total quantity of water required for the production of goods or services. To determine the actual amount of water to produce, for instance, a cup of coffee, you first have to take into account the total volume of water needed to grow, dry, roast, pack and transport the coffee beans. In the specific case of a cup of coffee, the quantity of virtual water required is 140 litres. This is more than the daily domestic drinking water usage of the average Belgian (110 litres in 2007).

The concept of virtual water can be an interesting tool for tackling the prevailing water shortage in certain parts of the world in a supranational manner. Taken between various countries and regions in Africa, virtual water can be used as a concept to result in more efficient water usage (and food production). The concept of virtual water can help African nations to calculate their comparative benefit in the area of energy and food production for each country.
In East and Central Africa, hydroelectricity is potentially the most important source of power. Based on a comparative calculation of the quantity of water needed to produce, for example, 1 KWh of electricity or 1 kg of rice, a country or region may "specialise" in a particular product and hence reduce the pressure on the water sources in those regions where there is the highest level of water shortages.
For example, Uganda can use the water from the Nile to produce sufficient electricity for the whole of East Africa. The rest of the region can use its sources of water for other purposes, such as food production or for drinking water supplies.

"External" water consumption shifts the production of certain goods to other regions and countries. It is a way of "importing water" ("virtual water") to supplement a country's own shortage of water. For example, Jordan imports 5 to 7 billion m³ of water each year, whereas only 1 billion m³ of water comes from its own (scarce) water supplies.

Consumption unit	Water consumption
1 cup of coffee	140 litres
1 glass of beer	75 litres (mainly as a result of the production of the grain required to brew the beer)
1 glass of milk	200 litres
1 kg beef	15.500 litres
1 slice of bread	40 litres
1 kg coconut	2.500 litres
1 kg corn	900 litres
1 kg cheese	5.000 litres
1 kg rice	3.400 litres
1 kg beet sugar	1.500 litres

Water footprint for a number of products

The water footprint can be reduced in the following ways:

1 Separating out economic growth and rising water consumption, for example by using advanced water-saving techniques enabling the same harvest to be achieved using less water, by reusing (waste)water, etc.;

2 Switching to consumption habits that use less water, such as eating less meat;

3 Choosing the right crops for a particular climate and selecting more drought-resistant crops.

Read more about this in the PROTOS brochure entitled "L'eau et l'agriculture dans une perspective internationale" (available in Dutch and in French).

It is clear that all of these footprints are tools for trying to quantify the real problem: What is the capacity of our planet Earth if natural resources (such as soil, air and water) are no longer used sustainably and we endanger what's alive now and in the future?

International conventions on climate change

NEED FOR AN INTERNATIONAL POLICY FRAMEWORK

In October 2006 Nicolas Stern, former vice president of the World Bank, published a report about the economic consequences of climate change. The message was that keeping climate change under control (and hence global warming) would cost the world economy less than repairing the damage caused by climate change.

Reducing greenhouse gas emissions would cost our world economy approximately 1 % of Gross National Product (GNP) each year. "Doing nothing" is likely to cost at least 5 % of GNP and could even be as high as 20 % in the worst case scenario (as a result of storms, floods, heatwaves, etc.).

To absorb the economic, ecological and social consequences, a clear international commitment is required, doubtless with different responsibilities and based on the capabilities of each country. However, an international policy framework and international commitments are difficult to achieve, because a number of the major players (particularly the US) place obstacles in the way.

The first effects of climate change are already making themselves felt. Where the North is able to invest in "adaptation" measures to counter the effects of climate change, the South cannot. International help is already needed now to tackle the early effects of the problems.

INTERNATIONAL CONVENTIONS

The IPCC or Intergovernmental Panel on Climate Change is generally considered to be the benchmark body in relation to monitoring the risks associated with climate change.
Since it was established in 1988, the IPCC has published a series of reports that are used as reference works by policymakers, scientists, students and other specialists. These reports, which come out every 4 to 5 years, have a major influence on the environmental policy of many governments. The latest report was published in various parts in 2007, followed by "The Technical Paper On Climate Change And Water" (April 2008).

Environment summit - Rio de Janeiro - 1992

At the environment summit held in Rio de Janeiro in 1992, the majority of countries signed the UNFCCC climate treaty (UN Framework Convention on Climate Change). The aim of the treaty (also called the "convention") is to reduce greenhouse gas emissions and hence prevent the unwanted effects of climate change. This Conference formed the foundation for a sort of world plan for the 21st century, "Agenda 21", aimed at finding a balance between economic progress and ecology. It also focused growing attention on poverty and inequality.
The climate treaty came into effect on 21st March 1994. Since then, virtually all United Nations states have signed and ratified the treaty.

Kyoto Protocol - 1997

In the 1997 Kyoto Protocol (within the framework of the UNFCCC climate treaty), industrialised nations agreed to reduce emissions of 6 greenhouse gases by an average of 5.2 % compared with 1990 levels. The Protocol requires the various countries to aim for different reduction percentages based on their economic situation and current emissions. Those industrialised countries aiming for this reduction percentage are called "Annex I countries" within the Protocol. On 16th February 2005, the Protocol came into effect despite the fact that the US, which is one of the main producers of greenhouse gas emissions, has still not ratified the Protocol.

In addition to reducing emissions in their own country and/or capturing emissions in forests and other ecosystems, the Annex I countries can also convert part of their reduction into measures abroad if that appears to be more cost-efficient.

There are two options here:

a. Joint Implementation (JI):

Annex I countries can invest in projects to reduce emissions in other Annex I countries. These projects can be counted in with their own Kyoto targets and for this they receive Emission Reduction Units (ERU). 1 ERU is the equivalent of reducing 1 ton of carbon dioxide.

b. Clean Development Mechanism (CDM):

Annex I countries can invest in projects to reduce emissions in developing countries (non-Annex I countries). This can mean significant cost-savings for Annex I countries and in this case Certified Emission Reductions (CERs) are allocated.
However, the Kyoto Protocol only allows CDMs on condition that they are in addition to the measures taken in the Annex I country.

In addition to these 'flexible mechanisms', countries can also purchase the emission entitlements of other countries in order to avoid any reduction shortfall in their own country.
This measure is applied when one country emits more than is allowed in the Kyoto Protocol, whereas another country that has already reached its target can reduce still further and hence can sell this 'surplus'. This is called the process of emissions trading. Work is currently being carried out on European emissions trading in the wake of the experience from past years. There are similar initiatives in other parts of the world. Both CDMs and emissions trading are discussed below in detail.

UN CLIMATE CHANGE CONFERENCE IN BALI

A UN climate conference was held in Bali from 3rd to 14th December 2007.
Representatives from 180 countries and observers from intergovernmental and non-governmental organisations attended the conference for follow-up discussions on the 1997 Kyoto Protocol. Kyoto governs the reduction in greenhouse gases until 2012. Most of the targets have not yet been met. During the conference in Bali, the IPCC's summary report was used as the base for negotiations.
However, the final statement did not contain any firm targets backed by figures, mainly due to the refusal of the US to talk about reducing emissions of the greenhouse gas CO_2.

UN climate change conferences are yearly conferences held in the UNFCCC. They serve as the formal meetings of the COP (Conferences of the Parties). See: http://unfccc.int

CLEAN DEVELOPMENT MECHANISM (CDM)

At the present time (2008) we are about 10 years after the adoption of the Kyoto Protocol and some 800 CDM projects – and a few billion EUR of credits – have been registered. Hence it can be said that CDMs have been successful in terms of developing a new market in emission reduction credits (ERCs).

Nonetheless, CDM has also received much criticism from various quarters. The Kyoto Protocol created the CDM process in order to achieve sustainable development and to enable Annex I countries to meet their targets on reducing emissions.
However, we need to take a closer look at this second point: reducing emissions as cheaply as possible. What tends to get forgotten are the effects in the developing countries themselves, both on the environment and in terms of development. At the moment, there is no tool in place for monitoring whether the "sustainability" target is actually being achieved.

In addition to non-sustainable projects, in some cases credits are being allocated to projects that have been carried out anyway. However, Annex I countries are still receiving credits for them, which again allows them to keep emitting as much or even more in their own country.
More controls and monitoring, for example in establishing a uniform certification system and objective criteria, might offer a solution to this problem.

At the present time, only a small percentage of CDM projects are being carried out in Africa, whereas the majority of investment is being made in emerging economies or emerging countries such as India, China and Brazil. This is where the biggest reductions are to be achieved. A balanced distribution of CDMs across the various continents is more than necessary to guarantee both reductions in emissions and sustainable development all over the world.

THE CO_2 MARKET

Emissions trading

International emissions trading allows industrial countries to trade emissions reductions between themselves. In so doing, emission entitlements are traded with 1 emission right equivalent to the entitlement to emit 1 ton of carbon dioxide.
Via the "cap and trade" system for the period 2005-2007, a maximum allowable quantity ("cap") was imposed on all EU countries. Each country then drew up allocation plans under which these quantities of emissions were distributed among various companies. Countries whose emissions remain below the Kyoto targets can sell these emissions to countries that are not achieving their target. There can also be international emissions trading between companies. In addition, the credits obtained via JI and CDM can also be brought into the system and traded. Anyone unable to achieve their emissions reduction targets, even with the use of emissions trading, Joint Implementation and Clean Development Mechanism, is fined. For the period 2005-2007, this fine was € 40 per extra ton of carbon dioxide, whereas the price to buy credits was estimated at approximately € 10 per ton (with the price determined on supply and demand).

Although CO_2 emissions trading is one of the main tools in the European approach (all of the major energy-intensive European companies have to participate in the system), a number of highly critical observations can be made. The permitted maximum emissions are still set too low and CO_2 emissions trading is used as the most cost-effective (= the cheapest for the time being) solution of meeting the targets set, instead of fundamental action being taken to reduce CO_2 emissions. However, the price for credits is expected to keep rising.

An ecological tax or environment levy

By imposing an environment tax, it is possible to charge polluters a price for the quantity of pollution and damage that they cause to the environment. There are already a number of experiments and lines of thought about this idea, albeit on a limited scale: e.g. about packaging materials, an environment tax for cars instead of road tax. That way, a CO_2 tax could be linked to all consumer goods so that goods causing a high level of pollution would cost more than environmentally friendly goods. This would also apply to polluting production processes, thereby encouraging industry to switch to processes that are less harmful for the environment.

Tropical rainforests and their effect on the climate problem

Avoided deforestation and REDD: Reduced Emissions from Deforestation and Degradation.

The large-scale deforestation in the tropics in recent years, principally to create greater areas for agricultural planting, has contributed to approximately 25 % of the increase in greenhouse gases. Putting an end to these clearance practices could mean a significant reduction in CO_2 emissions.

However, at the current time there is no possibility of linking CDM projects to countering emissions caused by deforestation. This means there is also no possibility of allocating credits for "avoided deforestation". In any event, how do you measure the level of reduction prevented by not clearing forests? And who will monitor to ensure that the forest is still there in say, 10 years' time? How can you prove that it's a case of "avoided deforestation" and not "just" a forest?

There is also the risk, if there is no international agreement and if there is a lack of international participation by all countries, that the deforestation process will simply move to other countries ("*leakage*"). If this were the case, some countries would be rewarded for "not clearing forests", while deforestation would simply continue in another country that has plenty of forest.
Also, the whole CO_2 market could be seriously disrupted if forests were put into the *Clean Development Mechanism*.

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Flooded land - Benin

3/ CURRENT WATER PROBLEMS AND INCREASED VULNERABILITY IN THE SOUTH AS A RESULT OF CLIMATE CHANGE

Water plays an important part in our daily lives. We build towns and cities close to water. We wash with water, we play in water, we cook with water, we drink water and we work with water. A large proportion of the goods that keep our economy running are transported over water and water is needed to grow plants, rear animals and produce more goods. The human body is made up of 70 % water. We grow for our first nine months in water. Two-thirds of the surface of our planet is covered in water. Water is our culture, our life. Water stands for emotion, feelings, the subconscious. To sum up, water is everywhere in our daily lives. And yet, or perhaps precisely because this is the case, we barely pay any attention to it.

Each individual approaches, uses, manages and 'worships' water in his or her own way, depending on the culture, resources and availability of the water in the area where they live, according to cultural traditions, local customs and social values. Water is not only an absolute necessity for life, it is also a challenge for the economy and for politics, meaning that we need to take responsibility for nature and the universe.

Life as we know it today would not exist without freshwater. Water provides lubrication for living cells, which are the real building blocks of life.
Water circulates through living organisms, it dissolves salts and sugars, carrying nutrients, vitamins and hormones to our organs, it facilitates the chemical reactions that drive our vital functions, and it removes waste. When we drink water, it's as though we are giving our insides a wash. Water fulfils similar functions for the natural world and all ecosystems, just as it does for individual organisms.

In this section, we situate the water cycle and the available water in the world, the historical connection between water, climate and development, as well as the current issue of water in the South where there are many dangers. We look at the extent to which climate change will have an effect on the problem of water (especially in the South). Finally, we will describe a number of countries where PROTOS operates and we examine the water sector and the effects of climate change. In a subsequent section, we look further into how PROTOS projects in relation to water and water management act to counter the vulnerability that these countries are experiencing as a result of climate change.

The water cycle – Water in the world

The question of whether there will still be enough water to feed the ecosystem while at the same time meet the ever-growing needs of people is not a straightforward one to answer. *Below is an anecdote to illustrate the problem.*

World experts on water met at the second World Water Forum in The Hague in 2000.
Much of the discussion was based around predictions for future water needs in three important subsectors: (1) drinking water supplies and sanitation[8] (2) food production and (3) protecting nature.
Models had shown that by 2025, irrigated agriculture – which already used 70 % of all freshwater and is responsible for some 30 % of world food production – would need at least 17 % more water to feed the estimated 8 billion people on the planet.
The man, who was responsible for the subsector dealing with irrigation and food security, supported this prediction using graphs and tables. He then turned to the people responsible for nature conservation and asked them how much water the world should put aside for nature. These people looked at each other somewhat surprised and alarmed, feeling themselves pushed and pulled between the two other subsectors and all the figures. They also hadn't made the necessary calculations.
But then someone piped up: "Nature doesn't compete for water usage: the natural ecosystems are themselves the source of water!"
A justified comment, of course. The Earth's capacity to keep more and more people alive is entirely dependent on protecting nature and keeping in equilibrium with the water cycle.
The water cycle is the combination of physical, chemical and biological processes that continuously recycle water and ensure that there is a constant supply of freshwater to sustain life on Earth.

THE WATER CYCLE

When you drank a cup of coffee this morning and enjoyed a glass of cool mineral water at lunchtime, did it occur to you that the water molecules (H_2O) needed to produce your drink may already have been through the water cycle countless thousands of times before? They have undoubtedly already been drunk and excreted before by another animal or human, been absorbed by and evaporated from plants and trees, used to wash and to cook. After being used, that water returned via the drains, creeks, rivers and streams back into the ocean, or was evaporated by the heat of the sun, only to form clouds again and rain on the mainland somewhere, ready to go through the cycle again.

Water doesn't disappear just like that: in principle, the volume of freshwater that passes through the water cycle remains pretty constant. And that's the way it has been for at least the past 13,000 years under relatively stable weather conditions. Scientists believe that water has been present on Earth in liquid form for about 3 billion years. Yet when the Earth came into being after the "big bang", it was still a mass of molten lava, hidden under a veil of vapours and gases.
Only after millions of years of cooling down did a crust form on the Earth's surface, as various chemical elements created stable bonds and the H_2O vapours condensed with the falling temperatures into liquid water: the first precipitation on Earth, the start of the cycle of water and life.

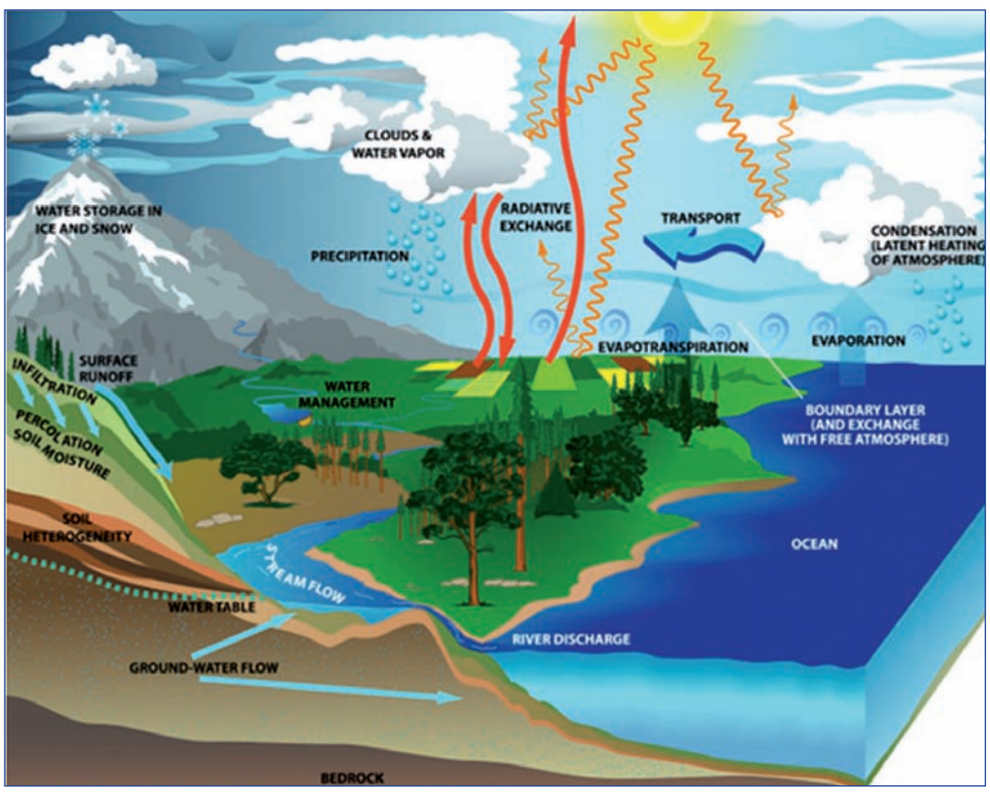
The constant supply of solar energy causes water to evaporate from the oceans and the land, carrying it to other parts of the world. Because more water evaporates over the ocean than falls there as precipitation, there is a net supply of freshwater from the oceans to the continents.

8) In this brochure, the term "sanitation" means infrastructure such as latrines, WCs, sewers, wastewater purification, and education about the relationship between (waste)water, hygiene and health.

Each year 577,000 km³ of water evaporates from the oceans. Of that figure, 20 % falls as precipitation over the land, with the majority evaporating immediately again. Approximately 42,700 km³ of water flows back to the ocean via rivers and underwater streams.
Some 15,000 km³ is constantly present in the air as water vapour and the atmosphere recycles it about 33 times a year. This means that the average time that a water molecule remains in the atmosphere is about 11 days.

The average annual rainfall across all continents is 746 mm, with 480 mm disappearing as evapotranspiration[9]. The difference determines the net quantity of water that reaches our rivers, lakes and groundwater deposits.
The annual water balance differs sharply from continent to continent.

Water circulates round the world, carrying nutrients and building materials to the ecosystems, creating chemical communication between (parts of) the ecosystems and carrying waste matter away so that it can continue to function in the best possible form. Water is required for photosynthesis in plants and all forms of life need this pure matter.



Source: http://nccwep.org

The water cycle

9) Evapotranspiration is the total of evaporation and transpiration by plants. Evaporation is responsible for the movement of water to the atmosphere from the soil, tree canopy and surface water. Transpiration is reponsible for the escape of water (water vapour) from plants via the stomata in the leaves.

TOTAL WATER SUPPLIES ON EARTH

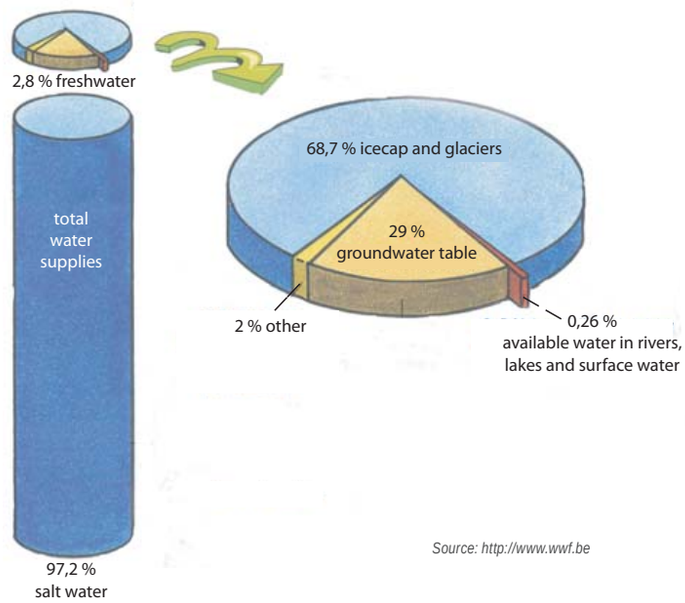
Seen as the current volume

Water is so everyday and so omnipresent that we pay little attention to the limits of this "free" commodity. The world's total water supplies are estimated at 1,386 million km³. An impressive figure.

However, total water supplies consist 97.2 % of saltwater and only 2.8 % of freshwater. Of this freshwater, 68.7 % is in the form of snow and ice at the poles and in mountainous regions.

Easily accessible supplies of freshwater are located in lakes, rivers and in the uppermost layers of groundwater. This represents 0.26 % of the total volume water or approximately 3.6 million km³.

It is still a gigantic volume, of course: a huge reservoir 154 km wide, 154 km long and 154 km high.



Source: http://www.wwf.be

Seen as the volume recycled each year

Each year, the water cycle provides continental precipitation of approximately 119,000 km³. The majority of this evaporates again fairly quickly. The renewed and available output of the water cycle that runs off into the oceans is 42,700 km³ per year.

However, we cannot consume all of this accessible water without giving it some thought. It would be foolish to pump all of the rivers dry and destroy all forms of life in and around the river, with all of the adverse effects that this would have on the ecosystem. Plus, of course, we need these rivers ourselves for recreation, fishing, shipping, generating energy through hydroelectric plants, industry, etc.

Overall, it is accepted that 2/3 of the renewable volume of water is needed each year to sustain natural, vital ecosystems.

That's why water management has to be geared to the quantitative and qualitative recycling capacity of the water through the water cycle (the renewable water supply). This is the case for each continent and even for each region.

- In terms of quantity, usage needs to be geared to the flow of the rivers and the natural supplementing of the groundwater layers. This happens via the water cycle.
- In terms of quality, we need to strike a sustainable balance between the natural cleansing capacity of the water, where necessary supplemented by human intervention, and the burden that is placed on the water.

This will be dealt with in a later section.

UNEQUAL DISTRIBUTION OF WATER STOCKS

The amount of precipitation that falls on the continent each year and does not evaporate again immediately, is approximately 42,700 km^3. The biggest available volumes of water are found in Asia, with 13,500 km^3 per year, and in South America (Amazon basin) with 12,000 km^3 per year. Europe and Oceania on the other hand are endowed with the smallest water stocks (2,900 and 2,400 km^3 per year respectively), but they are also the smallest continents. North America, with 7,890 km^3 and Africa, with 4,050 km^3 per year are somewhere in between[10].
The regional differences in Africa are particularly great: North Africa has only 2 % of the available freshwater, while the Congo basin alone holds more than a third of all Africa's freshwater.
The regional availability of water, coupled with the population numbers in a particular area indicate whether or not there is sufficient freshwater per capita in that area.

According to a recent report[11] one-fifth of the world's population (1.2 billion people) live in areas where there is a physical shortage of water, which means that insufficient freshwater is available to meet the needs of households, agriculture, industry and the environment. A further 500 million people are bordering on water stress.
It is expected that by 2025, two-thirds of the population will live in areas with serious water shortages (between 1,000 and 2,000 m^3 per capita per year of available water) or in areas where there are catastrophic water shortages (less than 1,000 m^3 per capita per year of available water).

Details of water availability from every angle are provided in the PROTOS brochure entitled "La filière de l'eau", November 2006.

THE ISSUE OF WATER USAGE FOR AGRICULTURE

Agriculture is responsible for 70 % of freshwater consumption worldwide. Industry uses approximately 20 % and about 10 % goes to drinking water and hygiene purposes.

This means that as the biggest user of freshwater, farming is at the centre of the challenge surrounding overall water management. Whereas the average person only needs between two and five litres of drinking water a day, calculations show that our daily diet requires around 3,000 litres of freshwater a day on average. The diets of people in the wealthier countries point to an even higher water consumption. Eating a hamburger requires more than 10,000 litres of water when everything needed to produce one is taken into account (grass and grain production for the cattle, processing the meat, transport, etc.).
See the concept of virtual water on p. 13.

Irrigation has existed for thousands of years. The first major civilisations and cities came into being in ancient times by populations concentrating in fertile valleys and delta regions (Nile, Tigris & Euphrates, Ganges, Yellow River).

Over the past 2 or 3 decades the scale of human influence on the natural ecosystems and groundwater reserves through activities such as farming has been enormous. More and more water is being taken for irrigation, including during the dry season. Water table levels are falling as a result of overexploitation in China, India, Iran, Mexico, the Middle East, North Africa, Saudi Arabia, Spain and the United States. Some countries, such as Libya and Tunisia are tapping into deep fossil groundwater layers that are not being replenished, or hardly.

The water used for irrigation is taken mainly from surface water. In 1950, there were approximately 5,000 large dams (with walls higher than 15 metres). Today, that figure is 45,000 worldwide. This means that in the past 50 years, an average of 2 dams have come into service every day! Some watercourses and rivers, including the Amu Dar'ya, Colorado, Ganges, Indus, Rio Grande and the Yellow River only flow all the way to their estuaries in the sea during certain periods of the year. The Aral Sea and Lake Chad have shrunk in area in just a few decades, caused mainly by

10) I. Shiklomanov, Hydrological institute of Saint Petersburg: Global population profile 2002.
11) David Molden (2007), Water for Food, Water for Life.
A comprehensive assessment of Water Management in Agriculture. IWMI, Earthscan Publications.

irrigation for cotton-growing (Aral), but also as a result of the climate becoming drier (Chad). The Aral Sea is a textbook example of unsustainable water management, or how not to do it. Some measures have been taken since to restore the sea partly, but the damage done to the environment by pesticide residue (used in growing cotton) in the sandy soil is virtually irreparable.

It is clear that the challenge of providing the rising population with enough food cannot just find a solution by drilling wells for new water supplies and tapping into surface water to meet the needs of irrigated crops.

The advent of biofuels, initially hailed as being "climate-neutral" and one of the best sustainable alternatives to fossil fuels, has placed enormous additional pressure on the world's food market in a short space of time and is certain to consume additional large volumes of water in the future. This development raises many ethical questions and is currently also under discussion.

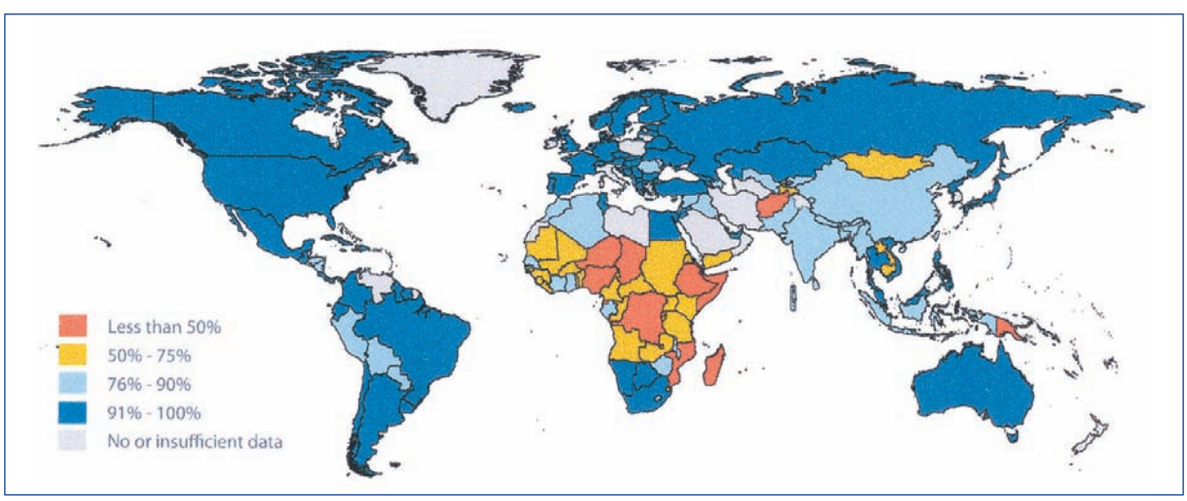
THE PROBLEMS OF PROVIDING DRINKING WATER AND SANITATION IN THE SOUTH

Drinking water and hygiene are responsible for only a moderate proportion of the world's water consumption. Access to safe drinking water is a priority, because its importance for human health and life is enormous.
Worldwide, 0.9 billion people have no access to drinking water, while over 2.5 billion lack sanitary amenities (WHO/Unicef figures for 2006)[12].

In the wealthy North, we have unrestricted access to water, 24 hours a day, in the kitchen, bathroom and toilet. We don't have to walk between our home and a watering point, as do about a quarter to half of the people in the South. A family of 5 in rural areas in the South needs at least 120 litres (24 litres per person) for its own basic needs: drinking, water to cook with, for washing, for cleaning, for washing clothes and for personal hygiene. However, this need means that someone from that family has to carry around 120 kg of water, often over significant distances, using buckets or jerrycans. At the drinking water distribution point there is often a long line of people waiting for water that often costs them more than we pay for it (calculated in percentage terms of the available family budget). In the South, up to 10 % and even more of the family budget is often spent on water.

The map of the world shows the average national level of water supplies for 2006. You can see just how many countries in Africa still have very poor access to drinking water. "Water supplies" according to these statistics means "based on national drinking water standards".

Countries in sub-Saharan face the greatest challenges in drinking water



Drinking water coverage, 2006

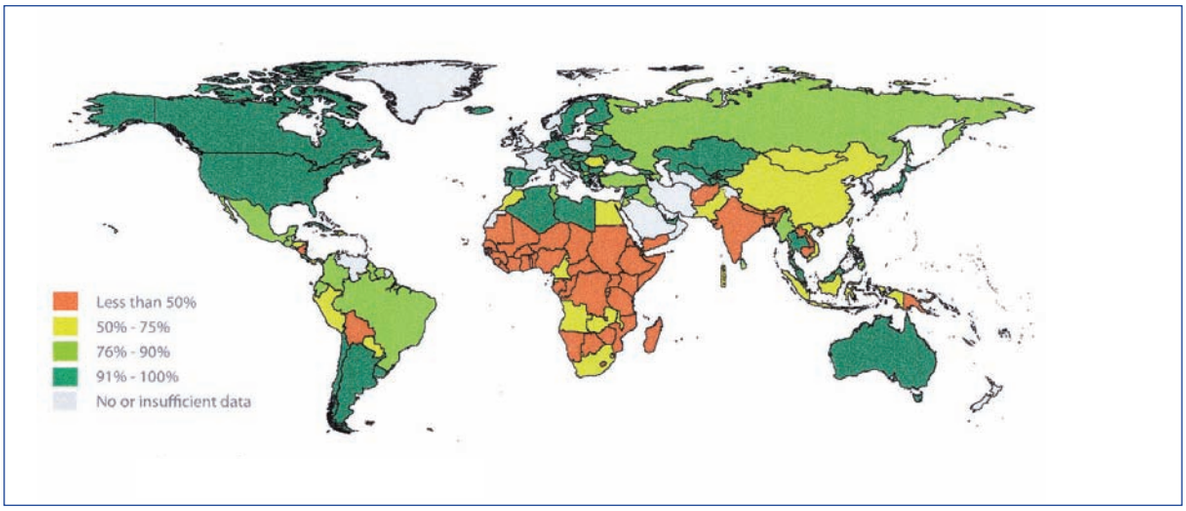
12) WHO/Unicef Joint Monitoring Programme MDG assessment 2008: Progress on drinking water and sanitation: special focus on sanitation. More recent figures are available at http://www.wssinfo.org/introduction/

The aim of these standards is, in the years ahead, to give all inhabitants access to a watering point that is a maximum of 30 minutes on foot, there and back from their home (i.e. within a radius of 1 km from the dwelling).

The number of families in African or Asian countries who have access to the drinking water network in their home is usually limited to 10 to 20 % of the population.

The official figures on access to elementary sanitary amenities are even more dramatic, as the map illustrates. Even a growing economic superpower such as India still has a level of sanitation amenities under 50 %. In a number of African countries, such as Benin and DR Congo, the official figure is around 30 %, while in Niger and Burkina Faso, it falls below 15 %.

Sanitation coverage remains low in sub-Saharan Africa and Southern Africa



source: JMP OMS/Unicef 2008

Improved sanitation coverage, 2006

In (sub)tropical regions, the dry season combined with high temperatures can sometimes last for months, while a little later monsoon rains cause flooding again. High temperatures and the presence of (polluted) water are very favourable breeding grounds for all sorts of water-related diseases. Malaria, yellow fever, bilharzia, elephantiasis, onchocercosis (river blindness), diarrhoea, cholera, etc. are all associated with poor hygiene, insufficient sanitary amenities and drinking contaminated water.

In the developed North (Europe, Japan, North America, Russia), the treatment of wastewater has only been around for a few decades. Prior to that we simply discharged our soiled water into creeks and rivers – on its way to the sea.
The water ecosystems have a fairly good capacity for purifying dirty water – but too much is too much. In densely populated and highly industrialised areas, this purification capacity is far too small and humans have to give nature a helping hand by building (expensive) wastewater treatment plants. This problem of water purification now also occurs in the South, in parallel with the rapid growth of cities, as well as certain industrial and mining activities.

Deterioration of water problems due to climate change

EFFECT ON THE WATER CYCLE AND THE WEATHER

The climate and freshwater systems are linked with each other in a complex manner via the water cycle. A change in one system causes a change in the other. This means that climate change has an effect on both the quantity and quality of freshwater.
Storing more energy in the atmosphere means that more energy can be released via the wind. Higher temperatures generate more evaporation and hence more water in the atmosphere. Both of these facts produce a higher level of variability in the climate: more intense precipitation, more hurricanes in one location or in one particular period of the year, and more and longer droughts in other places or at other periods of the season. To sum up: the water cycle becomes stimulated and the pace of change speeds up.
Taken globally – i.e. at many locations – there will be more precipitation; whereas in other places, the level of precipitation will fall. It is also possible that certain seasons will see more precipitation, while others see less. This climate change results in changes to every facet of the freshwater system.

Countries with low incomes, situated in arid and semi-arid regions, are particularly vulnerable. There will be precipitation at a specific time of the year and the amount that falls will vary sharply from year to year. In areas where this happens, the lack of groundwater stocks will create greater vulnerability to the effects of climate change. Water infrastructure (dykes, pipelines) was designed in the past with an eye to stable climate conditions. Only recently have we begun taking account of the uncertainties of climate change in terms of managing our water supplies. Below are a number of examples of the effects of climate change that are already being clearly observed, or that are virtually certain to be on the way.

In the past decades, a number of lakes have shrunk alarmingly in size. In the case of Lake Chad, reduced precipitation is a major cause of the sea contracting since the 1960s. For many rivers and lakes that have shrunk as a result of increased or excessive water consumption, climate change will make the situation even worse, particularly if it results in a decline in the net quantity of water available (= precipitation minus evapotranspiration).

There were twice as many major flooding disasters in Belgium between 1996 and 2005 than there were during all the decades between 1950 and 1980.

Floods are the most frequently occurring form of natural disaster in Africa, Asia and Europe and affect more people worldwide (an average of 140 million per year) than all other natural disasters put together. In the past two decades, Bangladesh has been affected by three extremely severe floods. It is predicted that if the temperature rises by 2 °C, those areas subject to flooding will increase by 23 to 29 %. Approximately 20 % of the world's population who live in flood-prone areas will have to cope with an increased risk of flooding by 2080.

During the 21st century, there will be increasing numbers of people – mainly in Asia and Africa – who will be affected by floods caused by severe storms and hurricanes. A single hurricane cannot be linked as such to climate change, but the frequency and intensity of these weather events will increase. In 2005, hurricane Katrina resulted in 388 km² of swampland, dykes and islands being lost around the city of New Orleans in the Mississippi delta. The hurricane reduced the Chandeleur islands (located south-east of the city) to half of their previous land area.

Natural systems such as swampland form the first line of defence against storm floods in this densely populated region. Most of these have been lost, as well as major breeding grounds for birds and rich fisheries. Katrina also cost the lives of 1,800 people and economic losses amounted to over 100 billion dollars. Along the coastline of Louisiana and Mississippi, approximately 300,000 houses and more than 1,000 historic and cultural sites were destroyed. The loss of capacity to extract and refine oil caused a rise in oil prices. The fact that a hurricane such as Katrina ravaged the prosperous North opened many more eyes than a comparable typhoon in a country such as Bangladesh.

In general, we can say that extreme (weather) events will occur more during the 21st century, at increasing numbers of locations and/or will be more severe. This will involve heatwaves, heavy precipitation, droughts, more and heavier storms, hurricanes and cyclones, as well as a rise in sea levels.

To sum up briefly and powerfully, we can safely state that

the main cause of climate change is more energy being stored in the atmosphere. The effects of this will be manifested mainly in too much and then too little water.

EFFECT ON WATER STOCKS AND RIVER BASINS

Changes in population numbers, lifestyle, economy and technology have a major effect on water consumption. The growing demand for food is important in this regard, because irrigated farming worldwide consumes the most water. Then, in addition to this, there are the effects of climate change.

Droughts have a negative impact on water supplies for domestic, industrial and agricultural usage. Certain arid and semi-arid regions such as Australia, the west of the United States, the Horn of Africa and the Sahel are already having to deal with more intense and longer droughts. These areas will only become more vulnerable as a result of the increase in droughts that climate change will cause.

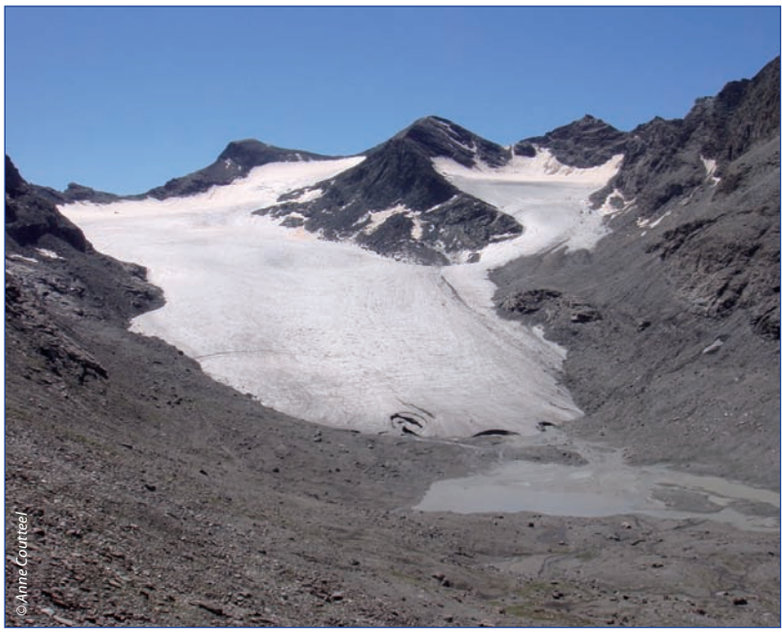
In catchment areas where rivers are fed by melting snow and glaciers, the higher temperatures over time will mean lower water levels in rivers and smaller water supplies during the summer and autumn. And precisely where demand for water is the greatest, supply is the lowest. Until 10 years ago, water flowed in the Draa in Morocco all year round, fed by melting snow from the Atlas Mountains. These days, the Draa dries up in summer and autumn.

Currently, more than a sixth of the world's population depends on melt water from glaciers and snow. In these areas, climate change will also have very severe consequences. Higher temperatures are making the glaciers melt more quickly. In the short term, this will mean higher water levels in the rivers, although the quantity of melt water will gradually decline in the decades ahead. An example of this are the South American water catchment areas along the Andes, where the glaciers are shrinking markedly. Many small glaciers in Bolivia, Ecuador and Peru will disappear altogether in the coming decades. Cities such as Nairobi are dependent for their drinking water on melt water from Mount Kilimanjaro. At the current rate at which the glaciers are melting on this giant mountain, there will be an urgent need in a few decades' time for other, more expensive solutions…

In regions where little snow falls, rivers are much more dependent on patterns of precipitation. Research shows that the seasonal fluctuations in water levels are increasing. This means higher water during peak periods of precipitation, but outside those times, the water levels will be lower than normal as a result of longer periods of drought.

Climate change will lead to water and food shortages, as well as migration and economic losses. These, in turn, may also lead to conflicts. The relationship between climate change and conflict is highly complex and not enough is known about it. It is clear that the risk of conflict can be better accommodated if there is greater capacity for adaptation. This latter issue is often a problem in developing countries.
Having an appropriate policy on development is therefore a priority. It is known that climate change may play a role in causing violent conflicts. But it is also a fact that it is very unlikely that climate change will be the only or main reason. It only becomes a risk when there is political instability at the same time and if there are ethnic tensions and water shortages.

Climate change and its consequences, such as water stress, can together lead to conflict. Taken historically, water is an important example of this. Through the years, water shortages have usually resulted in cooperation between states that share these scarce water supplies. Dialogue between states about water supplies can create trust and lead to collaboration in other areas. Examples of this are the negotiations between India and Pakistan and in the Lempa catchment area in Central America.



RISING SEA LEVELS: THREAT FOR LARGE CITIES, DELTAS AND FRESHWATER AQUIFERS

As the temperature rises, water expands and sea levels rise. The melting of glaciers on land also brings more water to the sea, causing levels to rise. At a later stage, the melting of the icecaps in Greenland and in Antarctica will add to the rise of the sealevel (the North Pole is made up of drift ice, so melting does not change the sea level). Less ice on the planet also means that less of the light and heat of the sun is reflected away, more seawater absorbs more heat, causing even greater rises in sea levels.

Flood deltas are highly vulnerable to rises in sea levels. The sea level is expected to rise on average by 14 to 44 cm this century (the worst model indicates a rise of 5 metres). But in many densely populated delta regions, rising sea levels pushed by the wind and tides may be temporarily far higher than the world average. Major cities such as Bangkok, New Orleans, Dhaka and Shanghai will become more susceptible to flooding.
The rise in sea levels represents a serious threat for the deltas, particularly when combined with the negative effects of the unchecked expansion of these cities and ever-expanding human activity (agriculture and industry around the cities).

Researchers have developed models which show that more than a million people in three mega-delta regions will be directly affected by the effects of climate change. These are the Ganges-Brahmaputra delta in Bangladesh, the Mekong delta in Vietnam and the Nile delta in Egypt.

Many people who live in delta areas are already having to deal with frequent flooding. These floods are caused both by seasonal peaks in the water levels in rivers, as well as by storm surges from the sea.

A quarter of the world's population lives in coastal regions where freshwater is already in short supply. These areas are also experiencing rapid growth in population. The fastest-growing cities in the world are virtually all located on the coast. Because so much water is being extracted from groundwater deposits, this water is becoming 'contaminated' by the ingress of saltwater.

This effect will only worsen as the sea level rises. Saline seawater is penetrating ever-further inland, particularly in river delta areas. Storms add further to the negative effect. This means that freshwater will become an increasingly rare commodity in flood deltas.

Small islands are particularly vulnerable when the sea level rises. Stocks of drinking water are also highly susceptible to variation in rainfall patterns. Small island states obtain most of their water from rainfall, because there is little or no freshwater or surface water available.
Tuvalu, a small island state in the Pacific Ocean, is already struggling to combat serious flooding from the sea, which is causing damage to houses and threatening supplies of drinking water. Some inhabitants have already left the island.

Problems with drinking water supplies resulting from climate change are most likely to occur in developing countries where there are densely populated, low-lying coastal areas, as well as in mega-cities situated on the coast, arid and semi-arid coastal areas and in small island states. In these locations, both natural and socio-economic factors only add to the risks.

Another major problem resulting from rising sea levels is the erosion of beaches. A 1 cm increase in the sea level causes greater erosion of the beach over a distance of 1 metre inland. Increasing and greater storm surges are speeding up this process. At the present time, 70 % of sandy beaches worldwide are already suffering from erosion.
Any further rise in the sea level will make this erosion even worse.

CLIMATE, WATER AND DEVELOPMENT: CHALLENGES FOR DEVELOPING COUNTRIES

It is clear that the effects of climate warming are having a major influence on water-related problems. The tropical regions are more sensitive in this regard and the developing countries are the most vulnerable. These are also the conclusions of the World Bank.
In the table below, the bank gives an overview of the various sectors or factors that are threatened by climate change (drought, floods, storms, the threat of rising sea levels and agriculture) and the countries that are exposed the most.

Drought	*Flood*	*Storm*	*Coastal 1 m*	*Coastal 5 m*	*Agriculture*
Malawi	Bangladesh	Philippines	All low-lying island States	All low-lying island States	Sudan
Ethiopia	China	Bangladesh	Vietnam	Netherlands	Senegal
Zimbabwe	India	Madagascar	Egypt	Japan	Zimbabwe
India	Cambodia	Vietnam	Tunesia	Bangladesh	Mali
Mozambique	Mozambique	Moldova	Indonesia	Philippines	Zambia
Niger	Laos	Mongolia	Mauretania	Egypt	Morocco
Mauretania	Pakistan	Haïti	China	Brazil	Niger
Eritrea	Sri Lanka	Samoa	Mexico	Venezuela	India
Sudan	Thailand	Tonga	Myanmar	Senegal	Malawi
Chad	Vietnam	China	Bangladesh	Fiji	Algeria
Kenya	Benin	Honduras	Senegal	Vietnam	Ethiopia
Iran	Rwanda	Fiji	Libya	Denmark	Pakistan
low income		*middle income*		*high income*	

Source: World Bank

The only three developed countries that appear in the list above[13] are the Netherlands, Denmark and Japan. In principle, these countries have the resources and knowledge to protect themselves against rising sea levels.

While the Millennium Development Goals (MDGs) were set in 2000, we can now see that achieving them is becoming increasingly difficult through the effects of climate change.
See the summary on p. 7.

An appropriate policy on development for developing countries is therefore a priority.

In a section below we will focus on the problems associated with water and development in a number of countries where PROTOS works.

13) In this table from the World Bank, the impact for a country defined by both absolute (estimate of the number of people affected) and relative effects (estimated damage as a part of GNP). "Coastal": 1 metre or 5 metres means a 1 metre (a scenario normally expected over 100 years) rise in sea level, or 5 metres (with the worst combination of factors for the next 100 years).

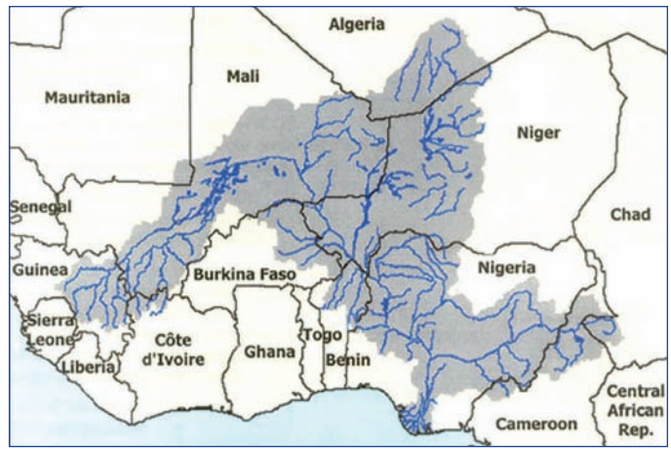
A number of examples of water and climate problems in regions where PROTOS operates

THE INNER NIGER DELTA IN MALI - WEST AFRICA

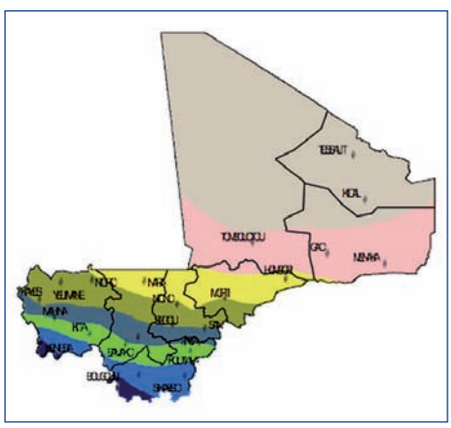
Context

West Africa is one of the poorest regions in the world. The average per capita income is € 270, compared with an average of € 560 for the whole continent. Recent years have seen a major exodus from the countryside to the city, yet despite this, more than 2/3 of the population still lives from subsistence farming.

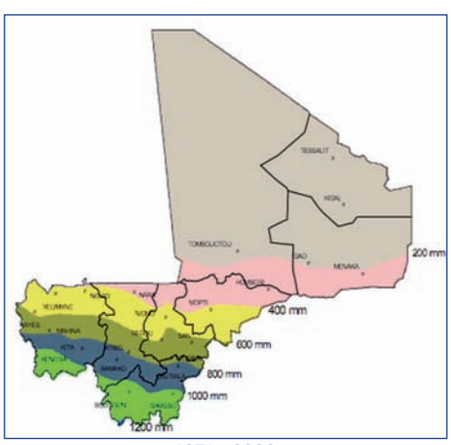
Mali is a Sahel country situated in the heart of West Africa. Extending over 1,241,238 km² (40 times bigger than Belgium), Mali is divided into 8 regions or provinces.
Mali has in excess of 13.5 million people, approximately 70 % of whom live in a rural environment.



The Niger river basin



1951 - 1970



1971 - 2000

Average annual rainfall (mm)

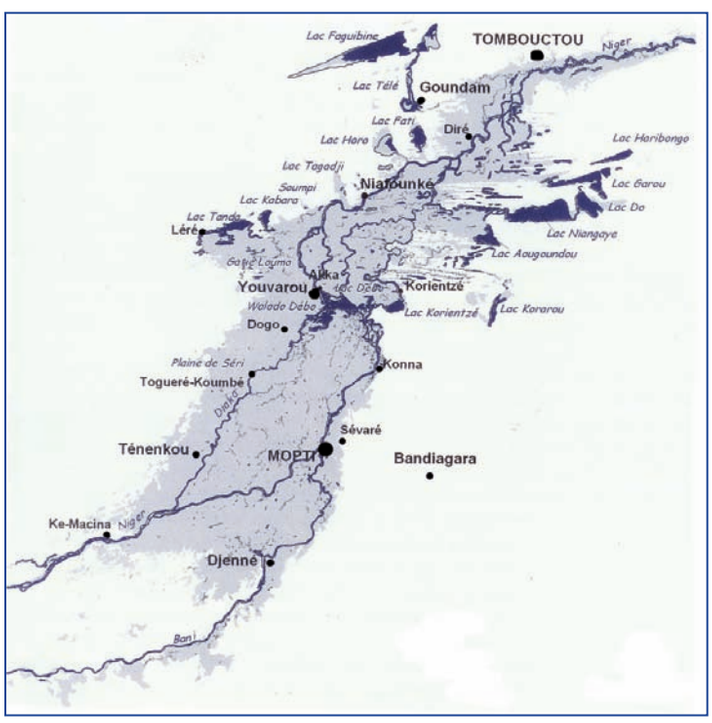
The climate is subtropical, warm with a rainy season and a (long) dry season. Average rainfall over the entire country is only 280 mm a year, although there are significant differences between the humid south of the country (1,200 mm per year) and the desert to the north of Timbuktu (<150 mm per year). The rain falls in heavy bursts over a few months and the potential evapotranspiration (evaporation into the air and through plants) is very high (up to 4,000 mm per year).

Starting in the 1970s, Mali experienced three decades of limited rainfall. Exceptional droughts occurred in 1973, 1985 and 1993. The succession of dry years ('80-'90 – "la Grande Sécheresse") had had particularly catastrophic effects because the lack of rain meant the water table could not be resupplied and the rivers ran dry.
Until 1970, Mopti received an average of 450 mm of rain per year, with extremes of 350 and 650 mm. Between 1970 and 2000, the average has been less than 380 mm per year, with extremes of 270 and 470 mm. In recent years, rainfall has become more intense again, although it appears to be less predictable, with fewer but heavier rainstorms, while the genuinely dry years have not returned.
The country is cut through by 2 major rivers, the Senegal (1,700 km) and the Niger (4,200 km).
As a result the country, despite the very hot and dry climate, has large supplies of surface water that penetrates inland. However, this availability of water is limited in area (in the vicinity of the rivers) and in time (the rainy season).

Water availability and water supplies

In theory, Mali has a great deal of water per inhabitant. The average quantity of renewable freshwater per capita per year is estimated at 10,000 m3. This is far above the threshold of 5,000 m3 that is used when speaking about an incipient shortage. However, the rainwater falls in barely 3 months and the (limited) rain that falls on the extensive desert area is in practical terms not available for the people. Of the surface water that flows into the south-east of Mali, a great deal is lost through evaporation, while a large proportion has to be reserved so that it can flow on into Niger, Senegal and Mauritania. This means that in most parts of Mali, there is water stress for over half of the year.

In Mali there is a low level of drinking water supplies. Only 60 % of the population has access to a drinking water point within a radius of 500 metres from where they live, with an average of 400 inhabitants using each point.
It is estimated that the number of people connected to drinking water pipes is 100,000 (<8 % of the population). Access to sanitation amenities that meet standards is 45 % (2006). In order to achieve the Millennium Development Goal on drinking water and sanitation, Mali requires a massive and sustained level of investment until 2015 estimated at 47 million dollars a year (*source: Le Livre Bleu, 2004*).



Inner Niger delta

The Niger is a river whose basin is shared by 9 countries. It is a genuine artery of life. As a result of water usage and high level of evaporation (mainly in the inner delta) and the fact that the river flows through the desert terrain in the north, under half of the annual flow of the river reaches the city of Niamey in Niger, a country that is even poorer than Mali. The Niger flows into the ocean through a huge delta in Nigeria, which is known for having the largest discovered oil reserves on the African continent.

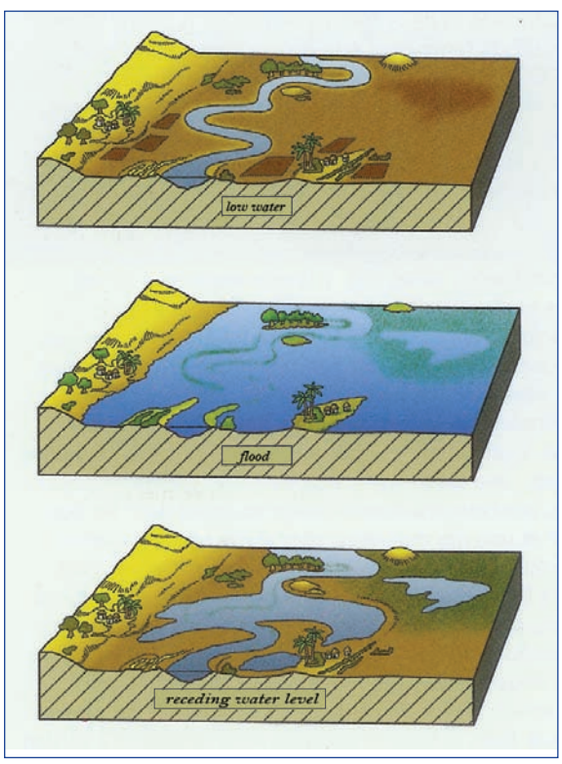
The Inner Delta covers an area as large as Belgium (3 million hectares), where the natural fall of the river is only about 10 metres over a distance of approximately 300 km. From August, the water rises suddenly with great speed, submerging hundreds of inlets, small lakes and large ponds. The population lives on natural or artificially raised islands in the middle of the water and on the banks of the inlets. From the end of November onwards, the water recedes again and between March and June, the green area teeming with fish and birds is transformed into a scorching, barren stretch of desert. Water is then only found in the river, a number of inlets and a few small lakes that gradually dry up.

Since the area was acknowledged in 2004 by the Ramsar convention[14], attention has again grown for researching and preserving this unique hydrological system and attempts have been undertaken to achieve a balanced and fair system of distributing water between the various water-dependent interest groups distributed across the whole of the river basin.

14) The Ramsar convention is an international agreement on wetlands of international significance, in particular as a habitat for waterbirds.

A number of dams have already been built on the headwaters of the river to produce electricity and for irrigation. As part of an overall development plan for the whole Niger river basin, there are now concrete plans in place to build even bigger dams upstream. These dams will reduce the natural flood level during the rainy season compared with previous measures. The result of this is that the major population group that has lived in and around the city of Mopti for over a thousand years on the natural floodplains (inner delta), is now threatened in its traditional activities of rearing livestock, farming and fishing by the "rhythm of the river". Will these people be able to adjust to the more limited availability of the floodwaters?

The overexploitation of water supplies is attributable on the one hand to lower rainfall and to the rapid growth in population on the other, plus changes to farming methods and ways of life. The huge fluctuations in rainfall levels and their increasing unpredictability (in absolute figures and distribution) have also led to more controlled forms of irrigation – which has an impact on the quantity of water available downstream.
At the same time, the local policymakers and people are given little information about the new dams and the impact they will have. This creates a major risk of local, national and even international conflicts. Various ethnic groups also use the water for other productive purposes (farming, livestock, fishing), which increases the risk for conflict still further.
It is certainly not excessive to state that sustainable water management is a "conditio sine qua non" for the progress of the country and its people.



Water level in the Inner Delta

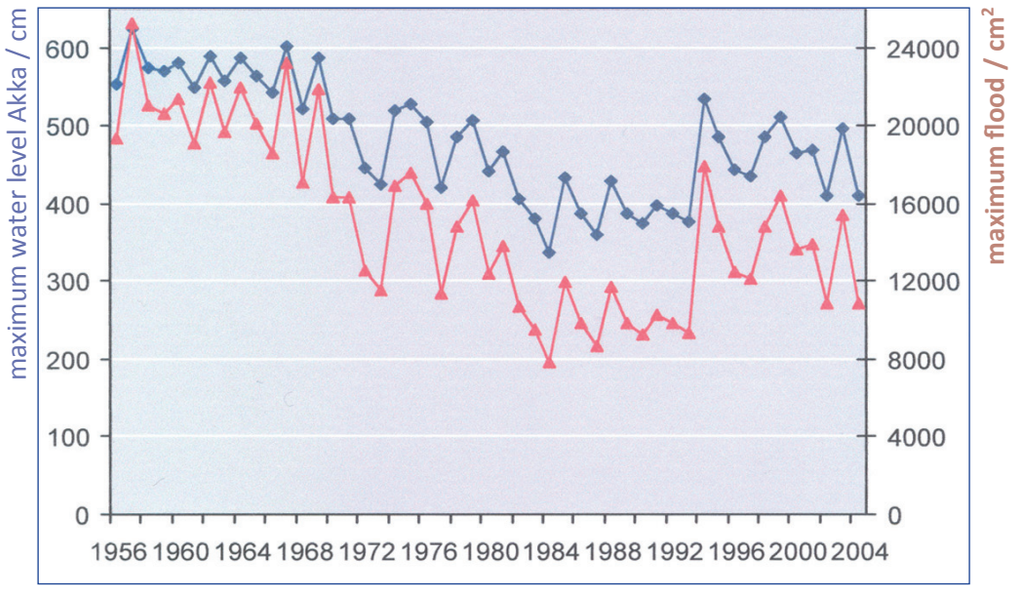
Effects of climate change

This region is highly vulnerable given the complexity of the hydrological system and associated ecosystems. The various population groups live traditionally to the natural rhythm of the ebb and flow of the water. The graph on p. 33 shows the maximum annual water level in the inner delta.

Between 1973 and 1993, it was much drier than in the period before that, which also meant that the flooded area in the Delta became smaller. Recent years have been somewhat wetter, but it is clear that the extent of the precipitation and the stability of the flooding level prior to the 1970s will not be reached again. The peak flow of the river in Markala[15] between 1900 and 1980 was only lower than 4,000 m^3/s twice; since then, this level of flow has only been reached on an exception basis.

It is difficult to explain the causes of the change in rainfall in West Africa unequivocally as havingaused by climate change. The mass clearing of the tropical rainforest in Ivory Coast and Ghana between 1950 and 1970 certainly disrupted the region's hydrological cycle.

15) Markala: existing dam that is the nearest upstream of the inner delta around Mopti.



But isn't this just part of the global environmental crisis? The overexploitation of natural riches, such as felling vital forest ecosystems in the South – to meet our own high consumer demand in the North, in this case for building – means that our unsustainable way of living causes problems for developing countries.

It is also true that in the decades ahead, there will be further extensive pressure placed on use of the land, forest and water in the Niger basin. Various countries are planning to build additional dams to meet the rising need for water, electricity and food. But this threatens the natural ecosystems, such as the inner delta around Mopti, causing damage and may even result in them disappearing.

The disruption of the hydrological cycle caused by climate change will also exacerbate the current problems, which may in turn have far-reaching consequences: migrations, internal conflicts between the various population groups for access to water, a decline in fish stocks, threats to nomadic livestock rearing, the disappearance of traditional growing of rice in the flooded fields, etc.

The Inner Niger Delta in the rainy season

UGANDA - GREAT LAKES REGION

Context

More than 60 million people live in the Great Lakes region of Central Africa.
The region is distinctive for its mountainous topography with its own climate and the natural and human ecology. Partly because of the fertile soil, the population concentration in the area is fairly high on average, with a clear peak in Rwanda.

The vast majority of the people in these countries or areas live off the land and are poor to very poor, depending on how the poverty threshold is calculated[16]. For example 87 % of the population in Burundi lives below the income threshold of 2 dollars per day. In Rwanda, 66 % of the rural population lives below the poverty line, and in both Kivu provinces in DR Congo the figure is 86 %.
Only Uganda does better: 'only' 48 % of the rural population is categorised as being poor.

Water availability and water supplies

Uganda covers an area of 241,000 km^2 of which almost 20 % consists of open water and swampland. Although the country is located on the equator, it is not so hot on account of its altitude. Uganda has a population of 30 million. Lake Victoria is the second-largest freshwater lake in the world and provides the greatest supply of water for the White Nile. Total annual renewable water supplies are estimated at 66 km^3 per year. This makes Uganda one of the highest-scoring African countries in terms of capacity of renewable water stocks. As a result, Uganda has an average availability of 2,200 m^3 of water per person per year.
Yet water management is a major issue in this region. This is due to the high population pressure, intensive farming and the very high level of the population's dependence on agriculture. Water is also an issue that the various parties must agree on, if even they disagree in other areas.

In terms of the provision of drinking water in Uganda, there is a big difference between the better supplied, water-rich south of the country and the poor, drier north, which is ravaged by civil war. The average provision of drinking water is 64 % and access to sanitary amenities (latrines) is 33 % (2006). But behind these averages lurk significant differences between the north and south of the country, with rural areas lagging behind the cities. Compared with the other countries in the region of the Great Lakes, Uganda is the most advanced in developing an Integrated Water Management system (IWM), both in terms of national policy and in the development of decentralised watershed management structures, i.e. management per river basin.
The rapid growth in population, urbanisation and industrialisation with the uncontrolled degradation of the environment and pollution are major challenges for freshwater management in Uganda.

16) The UN established in 2000 that poor = < $ 2 income per day ; very poor = < $ 1 per day.

Effects of climate change

Climate change is being felt in Uganda, including a 40 % reduction in the icecaps in the Rwenzori mountains in the west of the country (compared with 1955).

More frequent droughts in the north will have a detrimental effect on the underground water table. Some of the wells in the north and north-east are already running dry because of the lower water table.

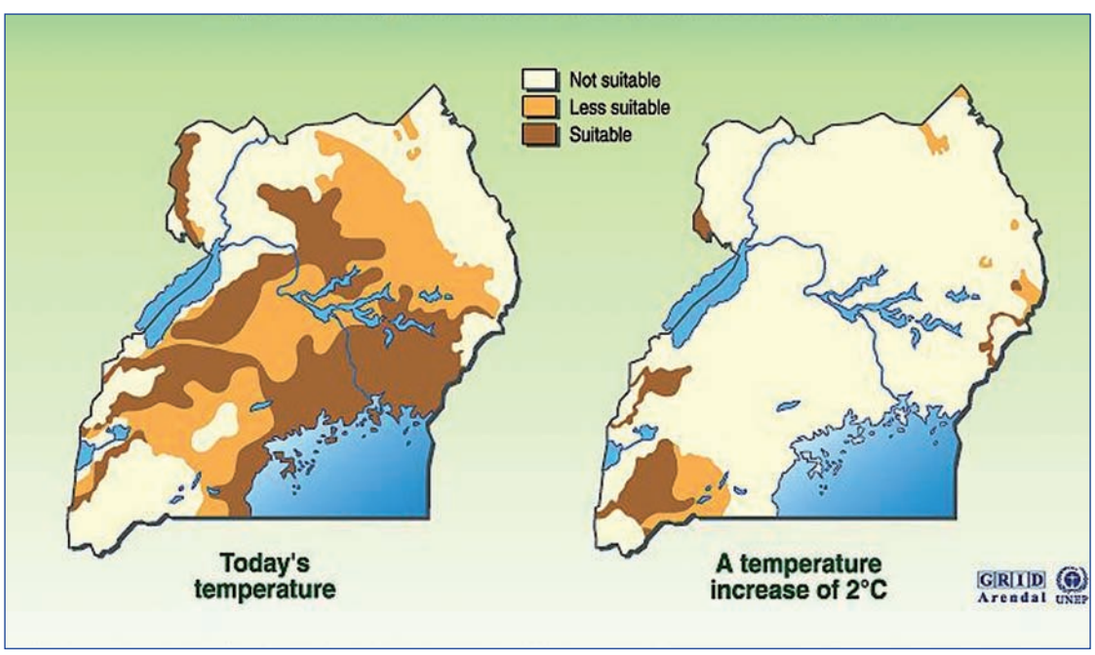
Yet the intensity of the rainfall is all the greater, with flooding in low-lying areas and landslides in the mountains as a result. Uganda is still recovering from the recent floods in the east of the country (beginning of 2008), while some parts of the north, close to the border with Sudan, are threatened with drought.

Higher temperatures are having an impact on the coffee crop, which is important for the Ugandan economy. Uganda was once the largest producer of coffee, which in addition to tea is still one of the most important export crops. Coffee grows well on the equator at an altitude varying between 1,500 and 2,200 metres, with the right constant temperature (20 to 25 °C) and sufficient rainfall.

This ideal climate is now threatening to change: the rains are becoming less regular and the temperature is rising.

The figure below shows how the country may lose 85 % of its potential coffee-producing areas (Robusta variety) if there is a far-reaching rise in temperature of 2 °C.

In previous decades, malaria was the main disease in Uganda. Almost 39 % of deaths in 2002 were attributed to malaria. As a result of the rise in temperature, malaria now occurs 30 % more in mountainous regions at altitudes of between 1,500 and 1,800 metres than it did at the beginning of the 20th century.



Source: Otto Simonet, Potential impacts of global warming, GRID-Geneva, case studies on climatic change, 1989

Impact of temperature rise on Robusta coffee Uganda

Grande Saline, village bordered to the south by Haiti's bigger waterway (Artibonite river), flooded with water from the river and the sea to the west

HAITI - THE CARIBBEAN

Context

Haiti is one of the poorest countries in the world, ranked 153rd on the list of 173 countries, according to the UNDP's Human Development Index (HDI index). It was the first republic with a predominantly black population to become independent, back in 1804. Since then, throughout its 200-year history, Haiti has endured a situation of political instability and under-development.
Covering 27,750 km^2, Haiti forms the western part of the island Hispaniola, together with the Dominican Republic, where pressure on the environment is far less dramatic. The country is made up of 8 different geo-morphological units (mountain ranges, plains, massifs). Large parts of the country are characterised by steep slopes: half of the country has slopes steeper than 40 %. Rainfall varies from 400 mm per year in the north-west to 3,600 mm per year in the mountains. 65 % of the population lives below the poverty line.

Combined with the population explosion (rising from 3.2 million in 1950 to 8.6 million in 2006) and the enormous population density (310 inhabitants per km^2), pressure on the ecosystem is very high, with the environment deteriorating as a result. Various things have contributed to the disappearance of ground vegetation and an enormous degree of erosion: the colonisation, deforestation, the land laws that are not geared to protecting the soil, the poverty of the people, cyclones and so on.
The level of tree coverage today is less than 1.4 % of the land area, whereas in 1960 it was still 60 %! Deforestation continues as a result of the need for charcoal to cook with. Extensive erosion means that most of the rainfall runs off the slopes immediately, ending up in coastal areas. The effects are as you would expect: flooding, heaps of waste and sediment carried away by the water and the destruction of mangroves.
Pressure on the environment is also resulting in an enormous loss of biodiversity. The historical and political legacy and government shortcomings have done nothing to mitigate this pressure.
As with all islands in the Caribbean, Haiti is also subject to earthquakes and seaquakes. And every year there are landslides and mudslides, caused by a combination of tropical deluges and erosion, mainly caused by humans (deforestation).

Water availability and water supplies

The provision of drinking water in 2006 was 51 % in rural areas and 70 % in urban environments. The theoretical water availability is an average of 1,628 m^3 per year per inhabitant – which is low, but acceptable – but regional differences are enormous. If the population continues to grow at the current rate (20 million by 2050), water availability will fall to 700 m^3 per year per inhabitant, which is below the standard for 'catastrophically low'. Because the rainfall is concentrated in heavy downpours, much of the rainwater simply runs away before it can be used, whereas in the dry season there is a chronic shortage of surface water.

The degradation of the environment is having negative consequences for the continuity of springs and rivers, as well as for replenishing groundwater tables.

It is clear that Haiti suffers mainly from an economic shortage of water availability. Theoretically, there is enough rainfall; but sufficient amounts of water are unable to be retained or stored naturally. There are too few resources for developing an infrastructure for drinking water and sanitary amenities, irrigation and water purification.

The effects of climate change

The location of Haiti in the Caribbean means that the country is very much exposed to tropical cyclones that cause devastation, flooding, landslides and mudslides. After cyclones, droughts are the main cause of the further disruption of the ecosystems. Deforestation, uncontrolled urbanisation in ecologically vulnerable areas, the mining of beach sand for building houses and the lack of any organised form of collection and processing of waste in the rapidly growing cities are the main human causes of threat to the living environment.

The likely effect of climate change can only exacerbate this problem. The average temperature is reported to have risen by over 1 °C during the period from 1973 to 2003. This is far more than the average for the entire planet and illustrates the fact that climate warming is subject to regional differences.

Rainfall has also become more irregular recently: the rainy seasons are becoming shorter, but the intensity of the rainfall has become greater and floods are also more frequent. Periods of drought are becoming more frequent and longer.

The increased unpredictability of the beginning and end of the rainy season is causing problems for farmers, who are no longer able to abide by their traditional growing calendar. Two weeks without rain during the growing season can result in a disaster for the harvest if there is no irrigation. Livestock and fish are also affected as a result.

Climate change is bringing more frequent cyclones, floods and droughts. Another important effect is that much of the land is becoming impenetrable, mainly as a result of the years of erosion.

As a consequence, when it rains heavily, most of the rainfall in the inland mountains cascades down to the urbanised coastal areas, where the majority of the population lives, often in slums or other similar districts.

Floodwaters that carry household waste and mingle with wastewater and human excrement increase the likelihood of epidemics and destroy the marine ecosystems off the coast.

A century ago, Haiti had a very high biodiversity index, but this has already declined significantly as a result of the harm caused to the environment. Species of plants and animals are also expected to continue disappearing.

As a result of the extensive degradation of the environment and the country's extreme poverty, the people's ability to adapt to climate change is exceptionally limited. This makes the challenges for and in Haiti particularly daunting.

ECUADOR

Context

Ecuador is one of the smallest countries in South America, although it is still 10 times bigger than Belgium: 283,000 km^2. The country has 4 different geographical areas: tropical rainforest, highland, the coast and the Galapagos islands.

Ecuador is a multicultural society where the most important groups are Mestizos (65 %), indigenous people (25 %), whites (5 %), and afro-descendants (5 %). According to UNDP rankings, Ecuador is in the category of countries with a medium income (< 3,200 dollars per year), while in the HDI rankings, Ecuador has risen to 83rd position (out of 173 countries). However, these encouraging figures hide a major gulf between rich and poor and in fact 57 % of the population lives in poverty (income <2 dollars per day) with 19 % in extreme poverty, characterised by food insecurity (<2,300 kcal per person per day). This gap of social inequality affects the rural population the most, made up of indigenous people and afro-descendants, and women.

The Andes cut through the centre of the country from north to south, with peaks as high as 6,310 metres (Chimborazo) and glaciers higher than 4,500 metres above sea level. “Páramo” vegetation grows above the tree line. This consists of grassland on shallow volcanic or highly organic soil and it has a greater capacity to store carbon, as well as having a very strong regulatory function in water storage. In addition to the local rainfall, the “páramo” water reserve from the Andes also feeds to rivers of the Amazon basin in the east and the coastal plain in the west.

Ecuador has a rich biological diversity, abundant water reserves and minerals, as well as a considerable potential in energy stocks, such as petroleum.

This enormous biodiversity is threatened by economic, social, political and external pressures. Ecuador’s rate of deforestation is the second-highest of all the Amazon countries.

Water availability and water supplies

Ecuador has average water availability in excess of 40,000 m³ per person per year. There are of course significant regional variations, including some areas with serious water shortages.

The official supply level of potable water for the whole country is fairly high: 95 % (2006). The available figures vary sharply between regions: access to drinking water in urban environments is very high, but in some rural areas is still only 20 %. The official statistics also appear to take little notice of the actual functionality of the infrastructure in place. Problems in the cities are, among others, the fact that 55 % of the systems do not guarantee constant supplies of water, and that 60 % of the water supplied is untreated. This means that only 12 % of the urban population has access to drinking water of a continuously good and monitored quality, in the sense that we are used to in Belgium.

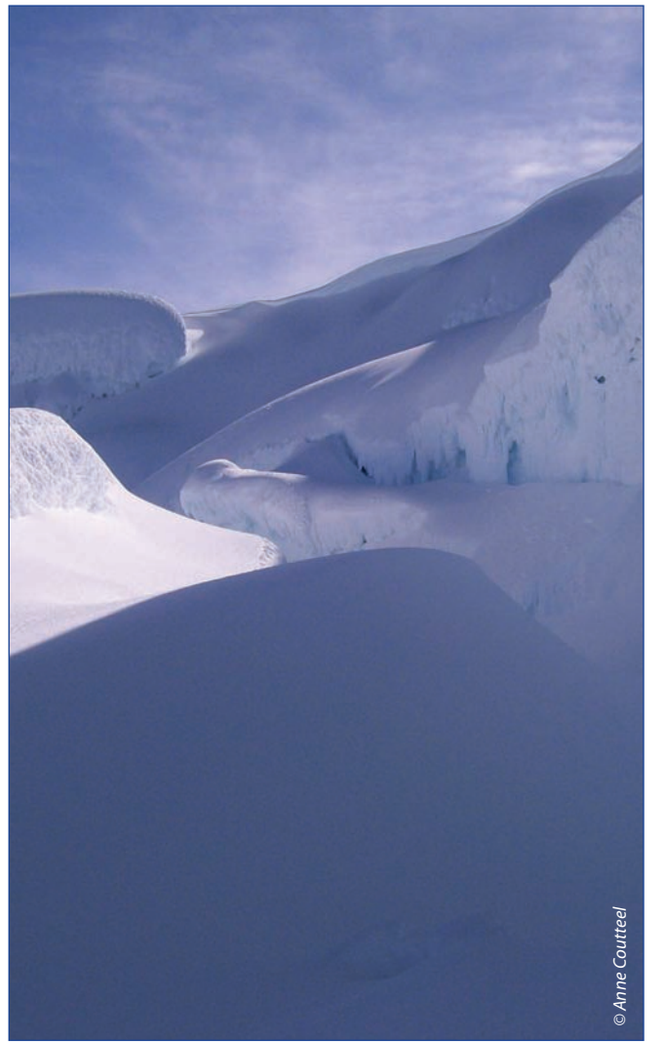
In the farming sector, production is often limited by a lack of irrigation. Out of a potential 3.2 million hectares, only 850,000 are developed. The existing irrigation systems labour under the effects of defective infrastructure, management, operation and maintenance. The government has only become involved with the management of the irrigation system on the coastal plains and never with the private, mainly small-scale operations run by the farmers in the Andes. In the past decade, the government has pulled out entirely and has not invested any further in increasing the area of land irrigated.

Effects of climate change

Climatologists have calculated that in the past 30 years, the average temperature in Ecuador has risen by 0.8 °C.

Extremely high and extremely low quantities of precipitation are being observed. In other words, wet areas are becoming wetter and dry ones drier. As for the temperatures recorded, warm areas are becoming warmer (such as the Galapagos islands). Local and regional phenomena, such as ENSO (El Niño Southern Oscillation, better known simply as 'El Niño'), which are increasing in intensity and frequency, are undermining the country's socio-economic situation. The storms, cyclones and floods that go with it cause deaths, social disruption and economic losses. It has been estimated that in 1997-1998, Ecuador lost 14 % of its GNP as a result.

The glaciers are melting at such a rapid rate that scientists predict that all of the glaciers in the Andes will have disappeared by 2045. This is extremely worrying for the local people who are dependent on the glaciers for their drinking water supplies (such as the capital, Quito), as well as for generating electricity using hydroelectric power.



Volcan Cayambe 5.790 m

The glaciers on the Cotopaxi volcano shrank by over 30 % between 1976 and 1997. As a consequence of the glacier on Chimborazo melting, the flow of the river Mocha fell by 1,500 litres per second in 1978 to just 460 litres per second in 2006.

Glaciers control the supply of drinking water to the cities. During the rainy season, they absorb precipitation in the form of snow and ice, while releasing water throughout the year through natural melting. But the accelerated disappearance of the glaciers as a consequence of changes to the climate threatens to place drinking water supplies under pressure.

Glaciers are not only a major source of drinking water, but they are also vitally important for agriculture. In the dry season, streams of glacier water irrigate the potato and barley fields. If these watercourses dry up, there could be disastrous consequences for farming in the Andes. Harvests are already noticeably smaller on account of the rainy season becoming increasingly short.

Under the influence of the changing air temperature, water temperature, precipitation patterns and rising sea levels (Human Development Report, 2007/2008) the future will see increased flooding on the Ecuador coast, causing coastal erosion, a reduction in beach areas and the disappearance of the highly valuable mangrove ecosystems.
Changes in water mass (level of oxygen, salinity, temperature) will cause fish stocks to migrate and fish production in the estuaries will fall. This then places pressure on the remaining natural sources, causing illegal practices to rise and possibly resulting in conflict between various interest groups, such as fishermen and tourism.

Rising sea temperatures in the Galapagos have already caused coral-bleaching on several occasions. Recurrent, extended periods of bleaching may cause the coral to die, resulting in a reduction of marine fish species.

The Amazon tropical rainforest is under increasing threat from forest fires caused partly by periods of drought related to El Niño, but also as a result of changing land usage (forest clearance). Deforestation and climate change may transform huge swathes of the Amazon rainforest into savannah, with enormous consequences for biodiversity.

Because there is no proper monitoring of data and a lack of a firm base to start from, it is often difficult to attribute certain occurrences to a specific cause. For example, many people in the Andes assume that the floods and landslides in the rainy season are the result of climate change. Yet, a major cause here is the decline of the natural environment (deforestation, degradation of the "páramo" ecosystems by usage for farming, etc.), which plays an important role in the ability of the natural surroundings to withstand the downpours. It should also be noted that the precipitation intensity often reaches extreme proportions.
Studies show that by 2080, as many as 400 million people in Latin America will not have access to drinking water as a result of climate change.

The frequent occurrence of natural phenomena and disasters in Ecuador (El Niño, volcanic eruptions, landslides, etc.), together with the cultural identity of the people in Ecuador, who set great store by and respect the relationship between humans and nature, have raised people's awareness: urgent work is needed to protect nature.

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4/ ADAPTATION PROGRAMMES AND INTEGRATED WATER MANAGEMENT

Climate change and the right to development in the South

The traditional western industrialised countries are largely responsible for global warming as a result of their combined greenhouse gas emissions. At the same time greenhouse gas emissions are also rising at a very rapid rate in a number of important emerging countries (India, China, Brazil, Russia, Mexico, Indonesia, etc.).

But the countries in the South are the worst affected as a result. Most developing countries are not located in a moderate climate belt and therefore more susceptible. They are also less able to adjust to the effects of climate change. They have insufficient financial resources and technological knowledge to prepare themselves for natural disasters and other consequences of global warming. The least developed countries (LDCs) and the small island states are the most vulnerable.
Adaptation measures must counter this vulnerability.

The impact that climate warming has on farming, water supplies, biodiversity, health and infrastructure constitutes an acute threat to the development opportunities of these countries. All of the (modest) attempts made to achieve the Millennium Development Goals and to eradicate poverty from the world are likely to come to nought in the face of the impact caused by climate change.

Given their historical responsibility in the global issue of climate, the industrialised and OPEC countries not only have a moral duty to achieve their own ambitious reduction targets, but they also need to help developing countries to adapt to the effects of global warming. Industrialised countries also need to support developing countries in their choice of low-carbon, sustainable development and to avoid deforestation and degradation of their forests.

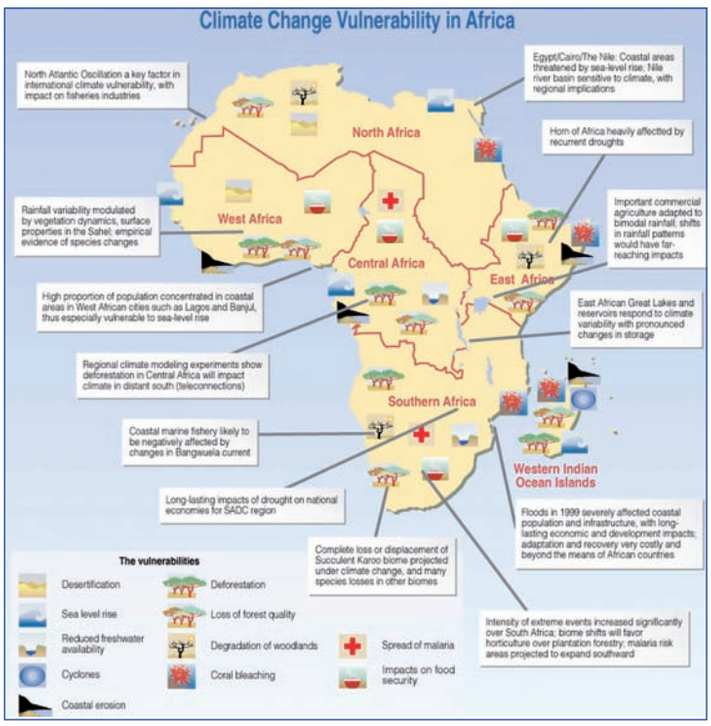
Particular attention in this regard needs to be paid to the integrated management of water. Global warming is having a major impact on the hydrological cycle, with a sharp increase in extreme weather-related events (lengthy droughts, increased rain intensity and flooding, rising sea levels, lower groundwater reserves, etc.).

The UNFCCC report on financial flows estimates that 200 to 210 billion dollars will be needed in mitigation measures by 2030, of which 46 % (or 96 billion dollars) will be in developing countries[17]. For adaptation measures, UNFCCC estimates are as yet far less precise: between 49 and 171 billion dollars, of which 28 to 67 billion is needed for adaptation programmes in developing countries. Obviously, developing countries will never be able to generate these amounts themselves.

17) This is based on a scenario where warming is greater than 2 °C, hence the cost of mitigation needed to remain below a 2 °C rise in temperature is likely to be higher.

Adapting to climate change

Scientific knowledge about climate change has filtered through to the policymakers in the North and South in recent years. The South knows that urgent work needs to be carried out in adaptation measures in order to restrict the negative effects of radical climate change.
Recent research (UNEP, 2007; IPCC, 2007) enables the most vulnerable areas to identify based on various criteria. But it is already clear that the South is the most susceptible to the serious consequences of climate change. Let's take Africa as an example.



UNEP/GRID Africa climate change vulnerability

A quick look at the map above (UNEP/GRID, 2007) tells us that the savannah areas and low-lying coastal regions of Africa are particularly vulnerable to climate change.
These areas are already showing a high level of natural variability. The high population pressure and unsustainable farming practices that this results in are exacerbating the situation further. These changes will have a negative impact on food security and health (expansion of the area affected by malaria) in many regions of Africa.

The link between various development problems requires an integrated approach. From page 30 on, we discussed the specific climate-related problems that exist in a number of regions.
However, in addition to immediate action on the ground, the appropriate policy response is also required. In the South, the option has been taken of a two-pronged approach. On the one hand, specific adaptation programmes will be outlined, while on the other, the plan is to integrate climate aspects better into the general policy strategies used to combat poverty. Improved collaboration between North and South is one of the main keys for success.

SPECIFIC ADAPTATION PROGRAMMES: NAPAs

The international community supports the South's policy on climate in various ways. For example, the United Nations climate convention has created new funds that assist developing countries in putting specific action plans in place to adapt to climate change.
These NAPAs (National Adaptation Programmes of Action) have been set up by the developing countries themselves. These documents list the adaptation measures required and rank them according to urgency and efficiency. NAPAs must be based on broad participation; they must complement existing policy initiatives, and must form part of an overall vision in which sustainable development, social justice, gender and flexibility all have their place. A NAPA sets out the priority adaptation measures and establishes the link regarding the development needs of the country (including those formulated in the PRSP, the Poverty Reduction Strategy Paper) and with other national and multilateral plans and agreements. A NAPA is therefore a summary document in which, based on existing information about vulnerability and risks, practical proposals can be made to adapt to climate change. The NAPA is an important tool in mobilising policymakers by providing them with usable basic information and clear specific measures.

NAPAs IN SOME OF THE COUNTRIES WHERE PROTOS OPERATES

Below we go briefly into the NA PAs for some of the countries where PROTOS is active. After that, we look in more detail at the plans for Ecuador.
We ask a number of critical questions:

- Is a specific link being made between the issue described and the actions proposed?
- How is the issue of water approached in general in the NAPAs?
- What role is Integrated Water Management given in the discussion on adaptation?

In view of our opinion that water-related problems are a major and possibly the most significant consequence of climate change, we paid particular attention to these issues when studying the NAPAs.

Burundi

In the diagnostic section, attention is paid to the changing rainfall pattern and the economic, social and ecological effects this is having.

Integrated Water Management (IWM) is mentioned on a number of occasions in the NAPA for Burundi. The summary of the adaptation measures for each sector mentioned IWM as an action point in the water sector, livestock rearing, landscape conservation and, of course, farming. The document also mentions the importance of the integrated management of natural resources and views this point as one of the basic criteria in selecting priority actions. It is interesting to see how IWM is defined in the farming sector: it is all about building capacity and education, installing dams in low-lying areas to retain the water, the appropriate usage of fields and anti-erosion measures, education in relation to capturing rainwater, promoting irrigation with measures against mosquitoes by keeping ducks, establishing irrigated rice fields. These activities are practical actions for adaptation that all come to a greater or lesser extent under the IWM umbrella. The Burundi NAPA also pays much attention to management plans, building up capacity and replanting trees. However, it does not go into enough detail about the risks of not implementing the plan properly. Insufficient proposals are made about strengthening weak government institutions so that implementation of the NAPA can be guaranteed.

The participative section appears to have been dealt with fairly briefly, which means that the knowledge of the local communities is not taken into account sufficiently.

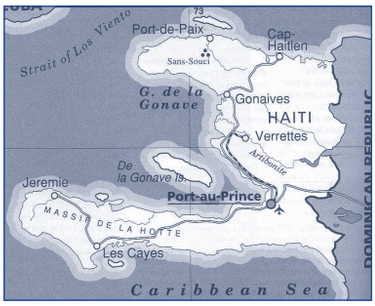
Democratic Republic Congo

The Congolese NAPA focuses on the vulnerability of the rain-dependent (subsistence) farming and mentions water as one of the most important factors for the ecosystems.

The Congolese NAPA emphasises the sustainable management of natural resources in the main. Drilling wells, measures to combat erosion and the establishment of water reservoirs are the main water-related actions put forward by the NAPA. However, there is no detailed development of water projects.

Although the poor are the most vulnerable population group in urban areas, the authors of the NAPA opt mainly for agricultural projects. Without wishing to call the value of these projects into question, it seems strange not to include any urban projects about water supplies and sewerage as part of the plan. Taken overall, the Congolese NAPA lacks structure and insufficient attention is paid to the potential of Integrated Water Management as an adaptation strategy for climate change.

Haiti



Integrated Water Management is not mentioned in the NAPA for Haiti. A number of activities are listed that could come under the IWM umbrella, but there is no integrated view of it (or not one that is explained in detail). The NAPA emphasises the sustainable management of surface water and building capacity. Initiatives to protect and retain water are not considered to be a particular priority in the ranking of options for action. The NAPA clarifies the links with the PRSP and uses a table to compare the objectives of both national strategies. The selection of priority projects is not decided solely on the basis of conventional criteria. The broader effects of the projects are also looked at (impact multiples). The link between the analysis section and the proposed actions is not always as clear as it could be. The projects focus among other things on soil retention, anti-flood measures and protecting the coast.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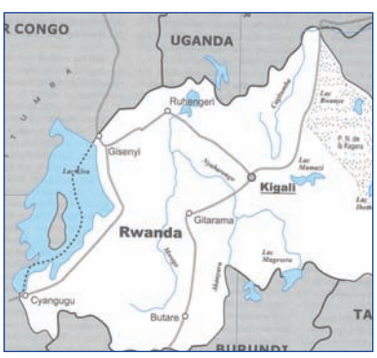
Madagascar

The inappropriate use of "water resources" is defined as one of the biggest environmental problems in Madagascar. Sustainable water management is one of the priority areas for action in the NAPA. Concrete proposals for action include supporting local organisations for water management and placing more accountability on the beneficiaries of the projects. The participation of the local people is a positive point, provided it does not come at the expense of input from the government.
The NAPA also focuses attention on anti-erosion measures and tree replanting programmes so that the river basins can be managed more sustainably.

Rwanda



The high level of vulnerability of the Rwandan people is stressed throughout the action plan and taken into account in terms of the predominantly rain-dependent agriculture sector. Integrated Water Management in the NAPA for Rwanda is one of the six most important strategies for adapting to climate change. The priority projects selected put this view into practice and include irrigation projects, activities to make it easier to store rainwater in the long term, anti-erosion and anti-flood measures. The plan gives a detailed description of the vulnerability of the Rwandan farming economy to climate change. The NAPA discusses the effect that changing rainfall patterns have on hydro-electricity, infrastructure, farming, ecosystems and health. Integrated Water Management is seen as the action with the greatest priority and is translated into projects to improve access to clean water, anti-erosion measures and a better network of meteorological information. Taken overall, the links between the analysis section and the proposed actions are well developed. However, implementation of the plan will depend on Rwanda's political commitment and its main partners.

Uganda

The NAPA for Uganda attempts to define what the best intervention strategies might be and what practical action plans might best combat the effects of climate change on a national level. Some of the challenges that might affect the efficiency of implementing a NAPA in Uganda may be: insufficient knowledge about climate change and its consequences, which may possibly result in poor allocation of resources to the various sectors. To this is coupled insufficient technical capacity, a lack of financial resources and weak institutional and coordinating mechanisms.

With regard to the water sector in particular, the report stresses the much-intensified use of Uganda's natural water resources over recent decades. The NAPA warns about additional vulnerability in the future to local water shortages (e.g. in the north of the country), declining water quality and the degradation of aquatic ecosystems that may cause serious disruptions for economic and social development, political stability, and the vitality of ecosystems. Given the importance of water in fighting poverty, improving human health and maintaining ecosystem functions, the sustainable management of water is given a central position. Although Uganda does not mention IWM specifically as a strategy in adapting to climate warming, it is a strategy that has already been one of the main priorities for some years in the area of sustainable development: the efficient, sustainable and fair use of water. In this sense, IWM can be considered as a first step towards the more integrated and coordinated management of development: effective cooperative links between all of the stakeholders on various levels.

Lake George - Uganda

Mali

Mali makes a distinction between various sectors that will be affected by climate change. Agriculture, on which over 70 % of the population depends, needs to be supported by increasing use of appropriate varieties and by a better system of gathering information in rural areas about meteorological readings. This will make it possible to establish a better water balance for the various crops.

In addition, the sustainable management of natural resources (water, forests and soil) is extremely important for the country. In practice, this comes down to Integrated Water Management at a river basin level given that protecting forests, restricting erosion and maintaining the fertility of the soil are all part of this approach.

The energy sector is a third important area within the NAPA: the significant potential of hydro-electricity must be used on an appropriate scale and in a sustainable manner and allowed to take the pressure off forests by reducing the high demand for firewood and charcoal. This will also make it possible in the future to limit soil erosion and expansion of the desert.

Health is the fourth priority in the NAPA. To conclude, the report also puts forward the general infrastructure as an important sector, thereby increasing the capacity of the Mali people to adapt to the effects of climate change.

More recent NAPAs are available at:
http://unfcc.int/adaptation/Workstreams/national_adaptation_programmes_of_action/items/4585.php

ADAPTING TO CLIMATE CHANGE IN ECUADOR

Ecuador has signed up to and ratified the Kyoto Protocol, although it is only responsible for a limited contribution to CO_2 emissions on a worldwide scale and there are currently other pressing needs for development.

However, within the Clean Development Mechanisms little has been done in terms of practical action in this regard. Due to the current lack of quantified data in relation to the effects of climate change, it is extremely difficult to influence national and regional policies and to convince the politicians of the need for adaptation programmes (from the UNDP's HDR report 2007/2008). As a result, climate change is not viewed as a development issue by the political authorities, but as an environmental problem. This means that any funds being released for adaptation are very limited.

In the 1980s, Ecuador established a number of institutes and created a good legal foundation with strategic plans for protecting the environment. The most recent governments, however, have paid very little attention to the topic (CE, 2007).

The existing studies and programmes conducted to arm Ecuador better against the effects of climate change have virtually all been funded by international organisations. These studies and programmes show that the following measures may be effective:

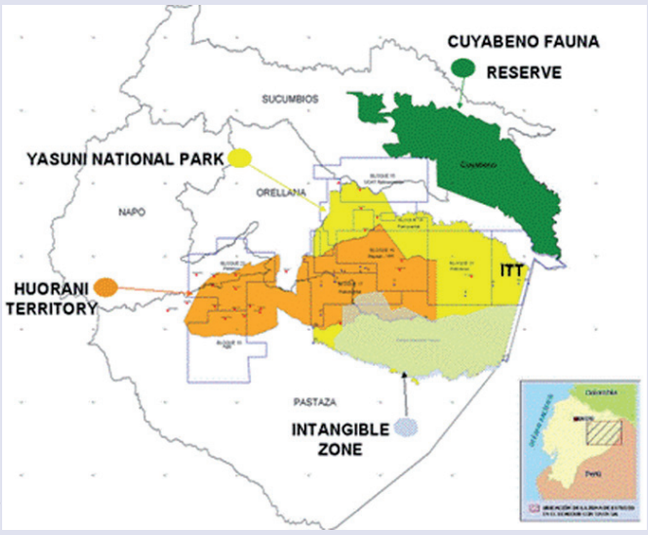
- increasing the production of energy using small and medium-sized hydro-electric power stations;
- reducing transmission losses and making more efficient use of fossil fuels;
- conducting sustainable forest management and extending afforested areas by new planting and opposing clearance;
- conserving and protecting mangrove ecosystems;
- installing drinking water and sewerage infrastructure;
- responsible management of grasslands for better food production from cattle;
- investing in manure, composting and recycling, combined with improved farming techniques;
- sustainable river basin management, with the protection of existing water sources and stocks;
- implementing a monitoring system.

However, the effective measures selected have not yet been converted into action on the ground. Yet since January 2007, with the new president Correa, there seems to have been a slight reversal. In October 2007, Ecuador held a Climate Summit. The results from the meeting were presented in May 2008 in Lima at the summit for the Capital Cities of Europe and Latin America.

In spring 2008, 3 wind turbines were built on the Galapagos islands to produce electricity.
The Ecuadorian government aims in the long term to ban fossil fuels in the Galapagos islands to better protect their natural assets. The wind turbines will save 3,000 tons of CO_2 from being emitted and 300,000 fewer barrels of oil will need to be transported. The location of the wind turbines was selected after a carefully conducted study of the flight paths used by the various bird species. The project cost 10 million dollars, yet the cost is not being passed on to users and electricity charges have even fallen.

Cotopaxi - Ecuador

The Yasuní-ITT oil field initiative



Map Yasuni Ecuador

On the international front, at the beginning of 2007, Ecuador launched a pioneering project on sustainable development aimed at encouraging cooperation between developing and developed countries. The programme in question is the Yasuní-ITT or Ishpingo-Tambococha-Tiputini (ITT) oil field project in the Yasuni national park in the Amazon basin. The Ecuadorian government proposed **not** to develop the largest petroleum reserve (estimated at between 412 and 1,531 million tons of crude oil or more than 20 % of the reserves in Ecuador) in the park, which is known for its huge biodiversity.

The condition for not going ahead and drilling for oil was that national and/or international funds would be released to compensate Ecuador for its lost revenue, or 350 million dollars over 10 years, possibly via the cancellation of debt.

Yasuní was declared a reserve in 1989 by UNESCO and many scientists believe the area to be one of the areas with the highest level of biodiversity. It is home to two indigenous tribes, the Tagaeri and the Taromenane, who wish to retain their traditional way of living and their isolation in Yasuní.

The Yasuní-ITT proposal was selected as one of the 20 most innovative ideas in the world (out of the 2,000 proposals submitted) in the Clinton initiative.

The project combines green development for Ecuador, while retaining natural riches, including CO_2 capture and reduced emissions of fossil fuels by not developing the oil field (www.amazoniaporlavida.org). The CO_2 captured in the Yasuní-ITT area corresponds to at least 436 million tons of CO_2, which represents saved "mitigation" costs of 4.36 billion dollars, calculated at $10 per ton of CO_2.

The proposal encouraged an actual financial commitment of 4 million dollars from Spain. Other countries also took an interest in the proposal: in Italy, 46 members of parliament tabled a motion to support the proposal; Norway and Germany also showed an interest, but there was little forthcoming in real dollars...

Unfortunately at the present time, avoiding carbon emissions by protecting indigenous culture, heritage and biodiversity is not accepted as a legal credit for reducing emissions (CER) under the UNFCCC's CDM.

As a result, in November 2007, Ecuador granted a permit to the Brazilian company Petrobas to start developing an initial oil field (Block 31), although only after the company had adapted its project to take account of the operating conditions imposed by Ecuador.

Clearly the actual revenue from oil dollars is even more important for development in Ecuador.

However, a campaign has been launched aimed at obtaining recognition for Yasuní-ITT initiatives as a model for post-Kyoto discussion.

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UMBRELLA STRATEGIES FOR DEVELOPMENT: PRSPs

In addition to specific, theme-based documents and action plans such as NAPAs, in the South, there are also umbrella national development strategies that often provide a guideline for policy.
The Millennium Development Goals state the importance of 'integrating the principles of sustainable development into country policies and programs and reverse the loss of environmental resources' (*Goal 7, Target 9*). The inclusion of Integrated Water Management in the policy was confirmed at the Johannesburg summit meeting in 2002.

In the current context, strategies to combat poverty, such as PRSPs (*Poverty Reduction Strategy Paper*), are important tools for development in the South. Updating these documents regularly offers an opportunity to incorporate the adaptation to climate change – including via Integrated Water Management – in an umbrella, cross-sector strategy.

A PRSP is a document drafted by a developing country putting forward an overall framework for combating poverty and promoting development. Although initially the PRSP approach was introduced by international institutions, such as the World Bank and the International Monetary Fund, the emphasis today is very much on the country-specific side of the PRSP. A PRSP is assumed to set out the development priorities of a country, describing the social and economic measures and taking stock of the situation. In theory, the document should also focus on environmental aspects, but an analysis of the PRSPs of some PROTOS partner countries shows us that this is not always the case.

Whereas all of the NAPAs examined pay attention to synergy with the PRSPs, the same is not always true in the other direction in terms of including a discussion of climate issued in the PRSPs.

For example, the first PRSP from Benin, covering 2003 to 2005, paid the appropriate attention to water quality and availability, although it proposed no integrated approach to climate. The participative 'green' second PRSP dates from 2007 and focuses more on climate.

The unstable political situation in DR Congo means that this country has only issued an incomplete interim PRSP, which simply does not mention climate change. Burundi also scores poorly. Mali pays a great deal of attention to the issue of water, but lacks any long-term vision on climate change. In the Ugandan PRSP (2005), water and climate are included, although Integrated Water Management is not specifically mentioned as an innovative conceptual framework in this context. Rwanda does not mention climate change in its PRSP.

We note that the PRSPs, despite their so-called completeness, do not deal sufficiently with climate change. However, as an umbrella strategy, they offer a good opportunity to link the various aspects of development to one another. Focusing on Integrated Water Management is particularly relevant as an answer to the effects that climate change is having on water management in the South. Access to drinking water and water for agriculture is a major social problem that can only be resolved by integrating social, economic and ecological measures.

Although the policymakers in the South are aware of the issue to a greater or lesser extent, they must realise that policy strategies also need to include actual adaptation measures is something that takes a long time to come to fruition.

More recent PRSPs are available at
http://www.imf.org/external/np/prsp/prsp.aspx

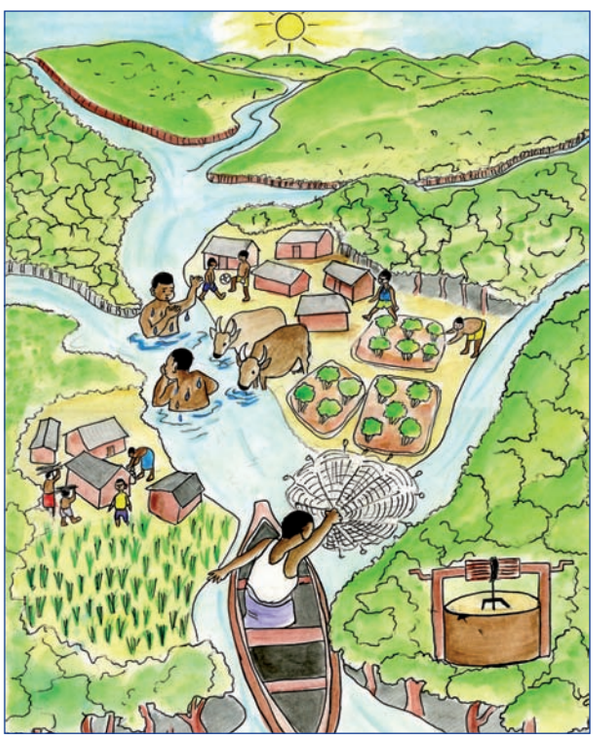
Integrated Water Management for policy and adaptation

The fundamental changes brought about by climate change in rainfall patterns, land usage and local circumstances require more than just a technical response.

As the IPCC says in its report (2007), Integrated Water Management should be a tool for defining and implementing adaptation measures. However, in practice this is not always the case.
A fully developed IWM programme features the various social viewpoints to be taken into consideration, as well as linking water quality with water quantity, coordinating land and water management, etc. IWM can also contribute towards avoiding and resolving conflicts between competing users and hence lead to a negotiated and broad-based transition to a more sustainable society.

In their search for the most appropriate strategies, policymakers are responsible for providing a response to the consequences of climate change. In addition to scientific support, society in general and individual citizens have an important role to play. Internationally, for example, the 'Dialogues for Water and Climate' sent out a strong message to the policymakers (IPCC, 2007). In Belgium, the climate coalition brings together a range of community organisations that work on reducing emissions and aim for the better integration of climate-related issues in their activities. Also in the South, local populations are asking for an appropriate policy response. For example, local NGOs in Benin are increasingly aware of the practical effects of climate change.

Scientific facts and broad-based social support are additional arguments to convince policymakers of the importance of adapting to climate change. An improvement in the quality of PRSPs and implementation of the NAPAs are necessary next steps. However, this is a shared responsibility: the wealthy North needs to provide the support required for these initiatives. The historical responsibility borne by the industrialised nations is significant, but a long-term solution for the current climate crisis will only be possible if the 'new' industrialised countries (i.e. emerging countries), OPEC countries and developing countries also make their own contribution.



IWM-education - Benin

Sources:

- *NAPAs for Haiti (2006), Madagascar (2006), Rwanda (2006), Burundi (2007) Democratic Republic Congo (2006), Uganda (2007), Mali (2007)*
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A number of PROTOS programmes

INTEGRATED WATER MANAGEMENT AND PROTOS

PROTOS applies the principles of Integrated Water Management (IWM) to all of its programmes.
IWM is aimed at dealing with water sustainably. In doing so, account is taken of the multiple functions of water (drinking water, water for agriculture and traditional or industrial activities, water working on behalf of nature and ecology), as well as the various types of water users and the impact of the programmes across the board. Attention also needs to be paid to conserving water for future generations.

Carrying out water projects without taking their effects on water management in downstream areas into account may be counterproductive for local development and create a source of friction and conflict.
Today, the scientific world and practical specialists consider IWM as the appropriate way of achieving a sustainable policy on water. In doing so, the best way to approach the issue is through the water management of an entire water basin. By 'water basin', we mean the whole area encompassed by a river, stream or groundwater table, with all of its sources and tributaries. However, it is clear that acting on a scale such as this is usually beyond the capabilities of an organisation such as PROTOS and its partners. Yet certain IWM methods and policy principles can be applied successfully to smaller (sub)basins around minor rivers and aquifers.

IWM assumes an in-depth analysis of water management and serious consultation and collaboration with the various interest groups involved with local development within the (sub)basins in question. A management committee made up of the various water users, local authorities and services is responsible for guiding the whole process. This way of working guarantees that knowledge is obtained and account taken of the water situation in the area and with the various interests of humans and nature. The proposals put forward regarding the optimum and proper use and sustainable management of the water are then put into action by (a large proportion of) the people. Conflicting interests are mitigated as much as possible and conflict situations avoided.

This vision is in line with the mission of "fair, sustainable and participative water management" for which PROTOS stands.

The capacity-building contribution of local players (local communities and their basic organisations, local authorities, etc.) and the guidance of these parties in establishing participative management models for handling basins are part of the strategy for local development. This strategy must enable local people to come up with an answer to the effects of climate change and propose actions for (pre)adaptation.

Below we discuss in brief some examples of programmes from PROTOS partner countries.

INTEGRATED WATER MANAGEMENT IN HAITI

Despite the difficult social and political context in Haiti, PROTOS has been active for many years in providing support for the development process in Haiti. This is done through programmes to promote sustainable water management.
Since it began working in 1977, PROTOS has carried out numerous projects, mainly in the area of drinking water supplies. In recent years, PROTOS has been one of the pioneers in testing out practical projects based on Integrated Water Management (IWM), in which drinking water, sanitation and irrigation are still the focus of practical action, albeit in as integrated a manner as possible.

One of these IWM projects, focusing on agriculture, is located in the semi-arid north-west of Haiti in the area of the "Les Moustiques" river.
The aim of this project is to anticipate current and future problems resulting from climate change (see p. 52).

A range of innovative initiatives has been launched in conjunction with local partners aimed at achieving more integrated and sustainable water management. The action on the ground is spread over various parts of the country (Central Plateau, Saut d'Eau, Terreneuve, Gressier) and is run in direct cooperation with 5 partner organisations.

In 2006, the programme was expanded to include an innovative project in an urban environment (Cap Haïtien) based on drinking water and sanitary amenities. Collaboration with all of the parties involved in local development was the focal point, which is resulting more and more in multi-partnerships. PROTOS encourages collaboration between international and national NGOs operating in the area in question, greater involvement from local authorities, cooperation with local government departments and, of course, local water users. They are encouraged, via a process of capacity strengthening, to play a more active role in the development of their community. PROTOS is also involved in networking, the exchange of knowledge and in capacity building to achieve a wider impact on a national policy level. This does not always run smoothly against a background where there is no entirely clear statutory context amid a climate of political unrest and insecurity.

Capacity strengthening in terms of the provision of drinking water and Integrated Water Management prepares communities and the various parties involved for the adaptations needed to cope with the effects of climate change.

A water reservoir by a dam on the Moustiques river - Haïti. Construction: PROTOS

The river basin of the Moustiques

The basin of the Moustiques river is located in the "North-West" department of Haiti, which is the driest and most backward region in the country, also known as the 'Far West'. The river basin of approximately 222 km^2 is home to some 35,000 people, mainly farmers (subsistence farming producing bananas, corn, barley, beans and manioc, as well as the rearing of goats and sheep).

Water is an extremely scarce commodity in the area, both as drinking water and for irrigation. Works related to water in this region mean making the most of the available supplies. PROTOS has been working in the area for some time with the strongly locally established development organisation UEBH-ODRINO.

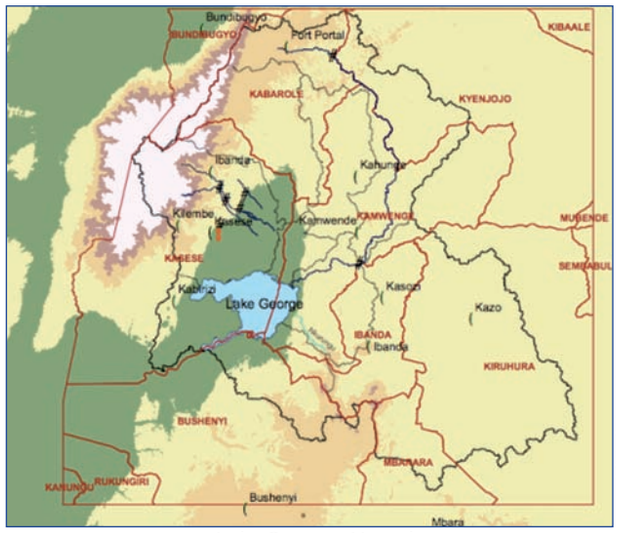
Given the importance of farming in local food security and as the main source of income in the region and after further analysis of the local issues (dwindling quantity of water as a result of forest clearance and the threat to the main crop – bananas – as a result of the 'sigatoka' disease), the project was expanded to include the entire river basin in conjunction with support for farming production.

A dam was built halfway up the river to interrupt the rapidly rising flow, as well as to provide better penetration and retention of the water in the soil. The positive effects are clearly visible, demonstrating the potential of this type of construction works for increasing local production and protecting against flooding.
Upstream in the areas at a higher level, a programme was begun to plant fruit trees in zones at risk from erosion. The project trained 15 or so local people, mainly women, to grow seedlings, which are currently used to stock the project. Between 2005 and 2008, some 150,000 seedlings were distributed at these critical locations and planted by 3,500 families.
At the mouth of the Moustiques river is a flat area extending over 10 km^2, which in principle is reasonably fertile. About half of this area has the potential for irrigated farming. But because of the degradation of the old irrigation and drainage ditches, production capacity had declined significantly over the previous 20 years. Repeated long-term flooding from the river had damaged the crops and in many cases destroyed the harvest. To make the best possible use of the farming potential presented by these plains, the first thing to do was to reduce the frequency, severity and length of any flooding.

To gain a better insight into the problem, PROTOS-UEBH was able to rely on the support of an American study bureau, which took a team to the valley at the beginning of 2007 to conduct an in-depth analysis. As part of two site visits, the data already gathered by PROTOS-ODRINO, including GIS information[18)] was supplemented by specific data about the soil structure. The study produced a set of alternative recommendations to be applied ideally to achieve optimum restoration of the area. The project was carried out in 2 stages, starting with structural work aimed at gaining immediate control of the irrigation flows in some of the channels as well as improvements to the drainage ditches to enable the water to discharge more quickly. Phase two involved more long-term work. For some of the ideas, an additional study was required, such as the artificial relocation of the river's natural bed in order to prevent it moving spontaneously, with disastrous consequences. Replanting trees in the river basin and installing a buffer zone of plants along the river and the main channels was strongly recommended to counter the whimsical nature of the river.
The results in terms of development for local farming are extremely good: when the first phase of the project was carried out, 291 hectares of previously marginal farming land was brought back to productivity, using 57 % of the potential of the plain. Phase two will deliver an additional 183 hectares.
In the period 2003-2007 in the same river area, 14,760 people gained access to clean drinking water.

Since then, partner UEBH-ODRINO has been applying the principles "Social Water Management" and IWM.

18) GIS: Geographical Information System.



map: SORESMA N.V.

Lake George - Uganda

INTEGRATED WATER MANAGEMENT IN UGANDA

The Kamwenge district is situated to the east of Lake George in western Uganda and is one of the three districts that border the lake. Kamwenge contains the lower valley of the major Mpanga river, as well as three other small rivers.
A large proportion of the programme proposed is taking place in this region.

Together with two partner organisations (JESE and FORUD) and in conjunction with the local district authorities, the initial work here is related to drinking water and sanitation. Better access to good-quality drinking water is one of the main priorities for a healthy population.

The vision of IWM is then gradually expanded to include other aspects of development, which are translated into long-term action. This means focusing on the sustainable management of the drinking water systems and combining the various management committees for the drinking water points into the umbrella management structures. As a result, having a higher number of water users will enhance the financial viability of providing water and also improve maintenance. In addition, improvements to sanitary conditions will be fully integrated into the provision of drinking water: environmentally-friendly toilet facilities, promoting personal hygiene, monitoring the quality of the drinking water. The issue of Aids, which is a highly topical one in the intervention area, will be incorporated into the sanitation programme.
The life expectancy of infected individuals is extended considerably by paying greater attention to the prevention of contracting water-borne diseases.

In terms of the Lake George basin, other important aspects of IWM are being tackled, such as fighting erosion and silting up, uncontrolled exploitation of the wetlands. Working the local technical services, a Belgian study bureau and thesis students have drawn up a simple GIS system for a number of water basins. In 2007, the project studied in detail the hydrology of one river (Nkurungu) that flows into the lake. The work was continued in 2008 for two other sub-basins. The programme also includes a detailed study of water pollution by the nearby mine and the use of pesticides from cotton-farming. More knowledge is needed about these sub-basins and the various water users (humans, animal, nature). To do this, readings are being taken (rainfall, flow measurements, water and fish quality analyses) and long-term measuring systems are being set up in conjunction with local services and authorities.

At the level of the entire river basin, there has been recent official collaboration with and support by LAGBIMO, the inter-district "Lake George Basin Integrated Management Organisation". In the first instance this work is monitoring the volume of fishing on the lake. The programme also needs to concentrate on other problems, such as possible contamination by copper and cobalt (from the mining round Kasese), pollution from urban wastewater (from Kasese and Fort Portal), the decline in the average flow rates of the small rivers flowing from the Rwenzori mountains to the north-west and the high plateau to the east of Lake George, the fall in the lake's water level, the importance of the wetlands on the northern side of the lake, etc.

This will make it possible to understand the problems better and work out solutions.

INTEGRATED WATER MANAGEMENT IN MALI

In 2004, PROTOS began working on a project in the Inner Niger Delta, using as its base Mopti, a densely populated trading city and fishing port servicing more than a million people for the Inner Delta.

Activities are being carried out within the context of Integrated Water Management, focusing on:

- improving access to drinking water by installing new wells and water pumps and expanding the existing network of drinking water pipes in smaller towns;
- improving sanitation conditions;
- improving the capabilities of irrigated farming production (rice and vegetable crops) to ensure food security and to make sure that people can handle their own maintenance;
- integrating the value of nature and practical programmes such as the regeneration of bourgou[19].

Integrated Water Management also works by:

- establishing a clear relationship between the various subsectors of water, such as: drinking water, irrigation, livestock rearing, fishing, transport, tourism, hygiene, nature;
- providing a clearer picture of the problem of pollution and doing something about it;
- working with and involving the various interest groups in the programme: local authorities and mayors, the provincial authorities, local village communities who help the contractors build the irrigation and drinking water infrastructure, local NGOs who train the people and encourage them to support the sustainable management of the infrastructure and to achieve a change of mindset in relation to sanitation and hygiene;
- establishing good collaboration with the state department for water supplies and international research institutes such as the IRD[20]. Their research on a national hydrological level is then translated to the local communities in the intervention zone, just as these communities also provide valuable information from the field about their water requirements, measuring water stocks, recording rainfall details, etc.;
- setting up simple Geographical Information Systems (GIS) that map the various sources of surface water (inlets, small lakes, etc.) and enable the programmes to be better coordinated, planned and the results monitored;
- making practical improvements to everyday life so that certain concepts can be introduced, such as sustainable development and protection of the ecosystems, fauna and flora.

Integrated water management assumes a balance between the natural supply of water and meeting the people's needs.

In terms of achievements, between 2005 and 2007 (3 working years) the following concrete results were achieved with a budget of approximately € 1,000,000:

- installing or repairing a total of 45 drinking water wells in villages situated in the 4 partner localities for approximately 20,000 people;
- improving the supply channels for 4 irrigation networks of 50 hectares each for growing rice and the establishment of 5 vegetable gardens of 2 hectares each to improve food security for 2,000 families;
- 5 environmentally-friendly public latrines (in schools and markets) to improve sanitary conditions and using these pilot programmes to create a snowball effect;
- extensive integrated action to clean up the city of Mopti: thorough cleaning of 30 km of wastewater channels and removing 7,000 tons of litter from the city, followed by the establishment of more sustainable systems of rubbish collection systems in conjunction with other parties;
- numerous training processes for management committees and local players for capacity building;
- setting up sustainable collaborative links between local authorities (municipalities) and service-providers via contractualisation;
- supporting hydrological readings and establishing GIS for the Inner Delta, with detailed research in two local communities as part of the IWM process.

PROTOS is not the only organisation carrying out development programmes relating to water in this area. But the way that PROTOS operates is much appreciated on account of its practical commitment and the involvement of a large number of parties (public, private, NGOs), as well as the large number of projects completed for a relatively small budget. By working locally, but at the same time taking the results to a higher level and disseminating the benefits, the PROTOS approach is much appreciated and new programmes can be

19) Borgou is a local fodder that grows on the banks of the Niger and keeps growing when the water in the river rises.
20) Institut de Recherche pour le Développement: international organisation that conducts scientific projects with regard to the relationship between humans and nature, operating in West Africa and elsewhere.

planned. This programme began in 2004 in 4 local communities and since 2008 has been expanded to 14 municipalities. The experiences gained are consolidated and the approach is used for other parties and (local) NGOs as a source of inspiration.

Irrigation ditch - Mali

INTEGRATED WATER MANAGEMENT IN ECUADOR

Through its programmes in Ecuador, PROTOS uses improved and sustainable drinking water supplies and Integrated Water Management to try and meet the needs of the people and to counter the effects of climate change.
Working with its partners CEDIR and SENDAS, the PROTOS programme focused from 1997 to 2005 in the southern highlands (Sierra) of the Andes. The expertise built up in the province of Cañar (cantons of Cañar, Suscal and El Tambo) in relation to social growth through drinking water, sanitation and irrigation is established and exchanged with the other provinces in the Southern Sierra (in particular with Loja and Azuay). In 2006, a new intervention area started on the coast and in 2007, PROTOS began work with local partner CEFODI in the province of Esmeraldas.

As a result of its programme in Ecuador over the past 8 years, PROTOS is able to look back on a series of successes. Below is a brief summary of some of these practical achievements. In the province of Cañar, more specifically in the cantons of Cañar, Suscal and El Tambo, the supply rate for drinking water has risen from 10 % to approximately 80 %. Later, drinking water and sanitation programmes were also started around Loja. Through the creation of district management structures, some 180 drinking water committees in the 4 cantons receive on-going training and services to promote sustainable water supplies. Investments have been made in some 25 irrigation systems and in committees for the sustainable use and management of these systems. Family farming companies are also supported in diversifying their crops and marketing their products. Thanks to additional funding from the European Commission, 4 small wastewater stations have also been built for 4 hamlets or communities, complete with drainage pipes and collector systems.

The drinking water, sanitation and irrigation programme tries to disrupt natural resources as little as possible. That, of course is not always simple, because PROTOS and its partners often find themselves faced with the dilemma of water for people or water for nature?
In addition to the practical achievements in the field, setting up consultation structures with local authorities and the local organised water users is just as important.

Working in a participative manner with local players and local authorities in a number of river regions, PROTOS has developed river basin management plans, converting them into actual programmes on the ground. These include: protecting water sources through agreements with landowners to fence and replant the area with trees, applying integrated agricultural and forestry techniques in small family farming businesses, reaching agreements on overgrazing and countering the associated destruction of the unique vegetation in "*páramo*" areas and providing better conditions for farming in lower-lying areas.
PROTOS has also worked intensively on bringing about a district bylaw for Cañar that offers a legal framework for protecting and managing natural water resources in river areas.

To be able to measure and assess vulnerability to the effects of climate change, good knowledge is essential from the outset. As the leading player in the regional water forum for the province of Azuay, PROTOS has collaborated on a study to draw up an inventory of water resources on a provincial level. This enables us to develop a measuring tool for managing water on a district and regional level.

Mathematical models as a tool for integrated water and soil management

Working in conjunction with PROMAS, a research institution from the University of Cuenca, PROTOS conducted a study between 2005 and 2008 into the relationship between land usage and the availability of water in 3 different river sub-basins around Cañar in the southern highlands. The area studied is characterised by high and intensive rainfall discharge during the rainy season and limited water availability in the dry months. The study was brought about by the concern of the basin committees about declining water availability during the dry months. This study aimed to find out how the availability of water can be guaranteed during the dry season and possibly increased.

Using the calibrated and ratified mathematical models built up beforehand, PROMAS simulated scenarios of a decline, as well as an increase in the river sub-basin areas, based on the soil and vegetation. Where a degraded part river area has grassland, half of it was replanted with indigenous species of trees, which can multiply the basic supply of water during the dry months by a factor of up to 5. When the area is 90 % replanted, that basic water flow can be increased in volume up to 8 times. Taken in the other direction, clearing an area of natural forest for agricultural use poses a serious threat to water supplies during the dry months and reduces flows to just one-sixth of their original volume. The value of these mathematical models is that they give both local government and the user committees an insight into how they need to manage and protect their water sources and stocks.

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5/ CONCLUSION WATER AND CLIMATE: A CROSS-BORDER CHALLENGE TO WORLDWIDE SOLIDARITY FOR SUSTAINABLE DEVELOPMENT

Climate warming is a scientific fact. At the same time, it is also true that the rapid increase in climate warming is the result of the exponential rise in human activity and energy consumption and the CO_2 emissions that go with it. The burning of fossil fuels since the Industrial Revolution has played a major part in this increase and still continues to do so today.

A positive aspect of this is the huge level of mobilisation and cooperation on an international scale to highlight the global problems and challenges related to the environment.
Never before has there been so much scientific knowledge about ecological systems and the Earth's ability to cope – and never before has this knowledge been shared by so many people.

The action to be taken is subdivided into 2 groups:

- limiting the causes of climate warming through a dramatic reduction in CO_2 emissions (mitigation);
- adaptation measures enabling us to absorb the negative effects of the minimum scenario of 2 °C warming (adaptation).

(1) Mitigation, or the reduction of emissions

We impose pressure on the Earth's ability to cope ecologically with everything we do. There are 3 factors that are important for the future: the rising total world population (estimated at 9 billion by 2050); our energy consumption; and the way that energy is generated. The quest of developing countries to achieve more welfare is a legitimate one and should not be held back. On the other hand, we know that it is absolutely impossible for everyone to live with the same consumption level as the average European or North American. Yet, there are currently 1.3 billion Chinese and almost as many Indians waiting to eat more meat, own their own computer and car, book flights and build a modern house with electricity and running hot water. And hopefully the people from the genuinely developing countries will be able to follow suit.

Clearly western countries need to take the lead in reducing CO_2 emissions and using energy more rationally, given that our development level model is ahead that of the rest of the world. Technology can play an important role here, but far more important is changing our mindset in relation to consumption.

Geographically, we can't just take the "rich North" and the "poor South" at face value. There are elite classes everywhere in the world, including in developing countries, who live with a large ecological footprint and who stand as a "model" for the less fortunate. The oil-rich Gulf states earned twice as much in 2008 than they did in 2007 through the sale of their black gold, while they invest that money building more luxury skyscrapers with air-conditioning and expanding luxury tourism into areas where there is virtually no freshwater. In these new offshoots and hubs of the free market, the "desire for more" continues to be aroused and the question can justifiably be asked about the sustainable nature of building cities where there is insufficient freshwater and they have to desalinate seawater, which takes a great deal of energy.
On the other hand, in 2009, China became the greatest emitter of CO_2. This can be explained by its huge population and more welfare, but also by the unbelievable level of production of consumer goods destined for the world market. This means that western consumers are also partly responsible for the high level of energy requirements in China.

The biggest challenge facing western economies is developing a model in which a high standard of living for humans is compatible with the Earth's ability to accommodate it – a balancing exercise to identify the real material needs for general welfare and sustainability.

(2) Adapting to the effects

Climate warming undoubtedly leads to higher vulnerability for those people with a lower level of development in the South.

The developing countries need to ensure that the various policy documents incorporate the issues of climate change and the measures needed are planned in a cohesive manner. To this end, many countries have drawn up a National Adaptation Programme of Action (NAPA). However, these plans are not always in line with the development strategy stated in the PRSPs. Nonetheless, we can see that these countries still have gigantic problems in terms of trying to achieve ordinary development, meaning that implementing adaptation measures will certainly have to wait.

For this reason we argue for a far greater transfer of knowledge and for resources to support development in the South. That way, these areas that will be more vulnerable to the effects of climate change will be able to protect themselves better. It is vital for the South to be supported so that its continued development can take place in as climate-friendly a manner as possible, with their rising energy needs generated sustainably (solar, wind, hydro, etc.), with the establishment of public transport and assistance for protecting vital ecosystems such as water and forests.

The Stern study (see p. 15) has calculated that investing in adaptation and limitation of the climate crisis will involve less cost than doing nothing and then sending emergency assistance to affected areas.

The current water problem in the South is particularly worrying. In many places physical water shortages are increasing and unrenewable sources of water are becoming exhausted. In other areas, the water shortage is mainly related to economics: there is sufficient water, but a lack of financial resources to enable that water to be used for drinking water, sanitation and/or for irrigation.

Sustainable water usage must be based on renewable stocks of water determined by annual precipitation and surface water that flows in to replenish those stocks. The scale or level at which Integrated Water Management needs to be applied is generally that of a river basin. This makes it possible to produce hydrological modelling, calculate the supply and demand for water, take measures such as conserving forest, protecting water ecosystems, achieving fair distribution between all users, water purification, reusing water, etc. Close cooperation between the interest groups among the population and governments in the proper distribution of that water is vitally important for sustainability. A form of Integrated Water Management, combined with "habitat" planning, is also necessary in the major cities of the South. These cities have insufficient time and resources to invest in providing backward districts with sufficient drinking water and sanitary amenities, proper drainage and water purification. The big cities built on the flats of river deltas are doubly under threat: from the rise in sea levels and their exposure to storms and cyclones, on the one hand, and from the danger of flooding caused by the rapid run-off via rivers when there are torrential rains, on the other.

Better knowledge of water stocks and better management of water today, through the Integrated Water Management of each river basin, will enable the people to manage these systems better themselves, should the amount of water available and demand for it change as a result of climate change. It is an ideal way of preventing friction and disputes relating to water, now and in the future.

(3) Resources

A clearer, more unequivocal commitment is required between North and South so that the South can be supported in coping with the effects of climate change, in addition to all of the other issues surrounding development. There are great opportunities in exchanging knowledge and expertise, and in immediately providing the “best available technology” to countries in the throes of development.

The budget provisions made to achieve the Millennium Development Goals on fighting poverty need to be supplemented to accommodate the negative effects of climate change. Even if OECD countries spend just 0.7 % of GNP on cooperation for development, further investment funds still need to be released to help guide the South in its plans for “adaptation”.

The budget for development cooperation must remain available to help kick start the ordinary development of a country, and of that money, none should be used to absorb the effects of climate change.

The OECD and OPEC countries need to make an extra effort here, too: is it not logical that we should do something about paying off our ecological debt to the South?

Changing our individual lifestyles is probably only a very small drop, unless it also becomes the standard of what is “good living” that we can be proud of...

Many drops can make an ocean...

Colophon

Climate, Water en Development - 2013

This brochure was published for the first time in Dutch under the title «Klimaat, Water en Ontwikkeling» (2008).
The brochure was translated into English in 2013.
The basic concepts have not changed since 2008.

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Design
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Printing
Druk in de Weer, Ghent
This brochure is printed on recycled paper,
using plant-based inks and without volatile organic compounds.

protos
water maakt vrij
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With the support of
THE BELGIAN
DEVELOPMENT COOPERATION