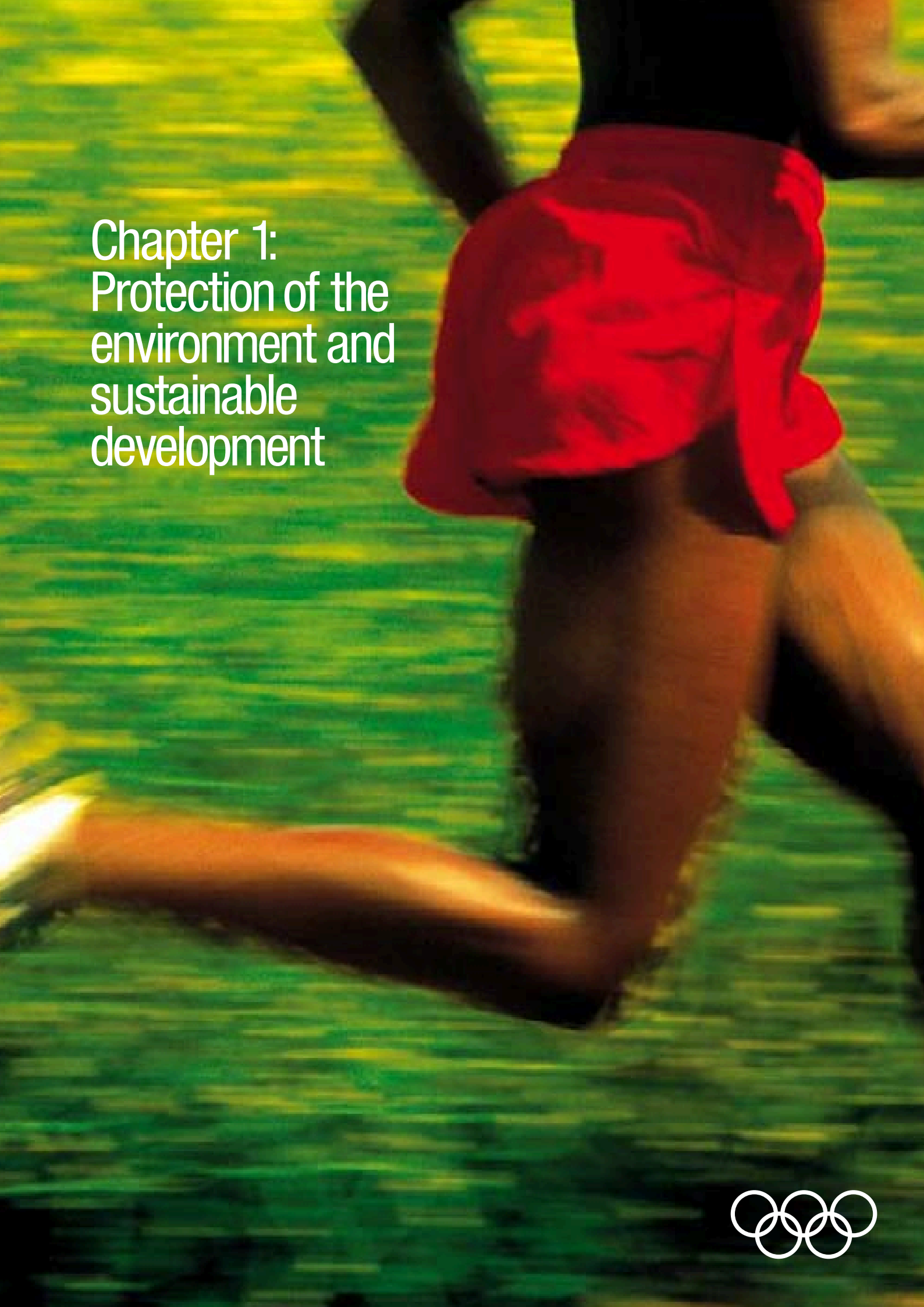

Chapter 1: Protection of the environment and sustainable development

1.1 Ecosystems and landscapes

The ecosystem is both our source of life and our living environment. It is a complex whole made up of mineral elements (water, air and soil), which are combined to create the natural or man-made environment, and living elements (microorganisms, plants, animals, humans). It includes physical mechanisms which influence the environment, such as hydrology, wind, tides and climate. All of these elements constantly interact with one another to generate a unique set of resources and biological diversity (biodiversity).

Human beings are heavily dependent on the elements of the natural environment. They can only survive:

- 3 minutes without breathing
- 3 days without drinking
- 3 weeks without eating

Plants are at the bottom of every food chain, converting minerals into organic matter through photosynthesis. This is known as the primary productivity of an ecosystem. The higher this level of productivity, the more able the ecosystem is to trap the carbon dioxide that causes the greenhouse effect. Primary productivity depends on the type of vegetable cover (Figure 2).

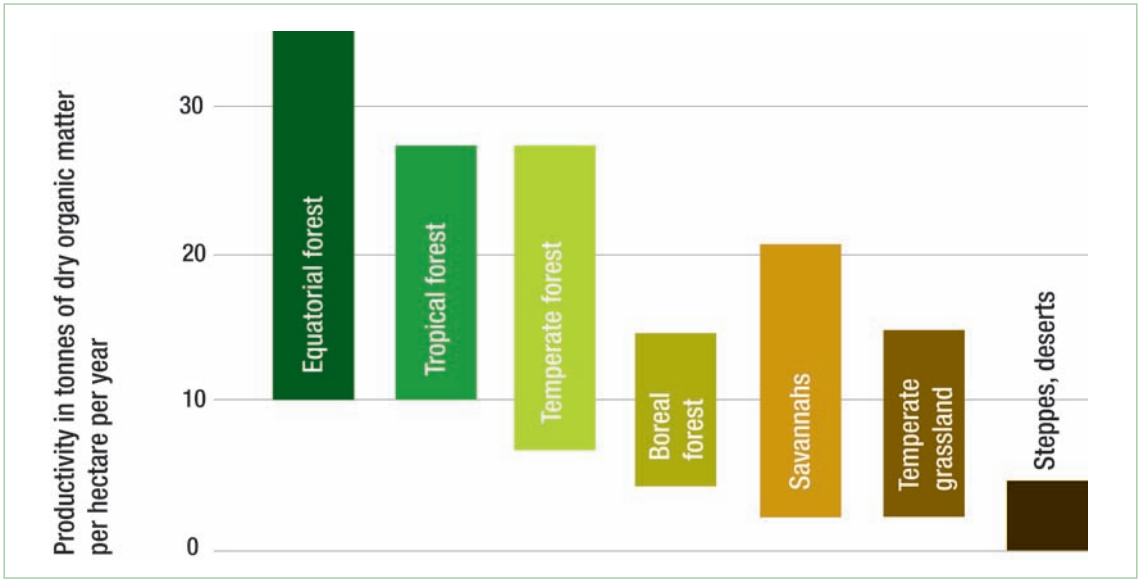

Figure 2: Primary productivity of some ecosystems.

An ecosystem's functions are not only ecological in nature, but also affect economic and social development:

- Production of goods (agriculture, wood);
- Protection against erosion and wind;
- Protection of communication routes;
- Recreational areas;
- Income for local populations;
- Conservation of biodiversity;
- Element of the landscape.

The landscape is the part of the ecosystem that is visible to human beings. It is the aesthetic and cultural dimension of the ecosystem that humans can observe directly. Landscapes are shaped by natural elements (water, wind) and, increasingly, by humanity itself (regional development, urbanisation).

Depending on the type of landscape, its quality is defined by several different functions:

- The aesthetic aspect (parks and urban gardens);
- Its capacity to accommodate housing, human activity or communication routes (urban landscape);
- Its capacity to preserve or even increase biodiversity (protected areas, nature reserves);
- Its capacity to maintain the water cycle (river basins);
- Its capacity to produce natural resources in a sustainable way (agricultural or silvo-pastoral landscapes).

The main threats to natural landscapes are:

- Intensive agriculture, which reduces biodiversity and ecological value;
- Developments that prevent natural disturbances (fires, floods) that support biodiversity and change the landscape;
- The increase in the greenhouse effect, which is threatening cold climate landscapes (Alpine regions or boreal forests);
- Mismanaged urbanisation, which is eroding the natural landscape and creating unattractive urban landscapes;
- Fragmentation, which reduces biodiversity by destroying biologically rich buffer zones between different types of landscape.

Key points for sustainable development with regard to ecosystems and landscapes

- It is vital to maintain the key functions of ecosystems (biodiversity, productivity) in order to preserve, in a sustainable way, all the food chains on which human beings depend.
- A diverse natural ecosystem is not only more sustainable in terms of the production of goods, but also more capable of fulfilling its role as a recreational area and protecting against natural disasters.
- The landscape is the part of the ecosystem that is visible to human beings. The quality of natural or built landscapes has a considerable effect on social well-being.
- Extensive or traditional agricultural methods which respect the qualities and functions of the landscape should be developed as much as possible.
- Urban development, particularly in large cities, must involve the creation of a landscape which, though artificial, fulfils environmental (air quality, water seepage), social (recreation, sport) and economic (communication routes) functions.

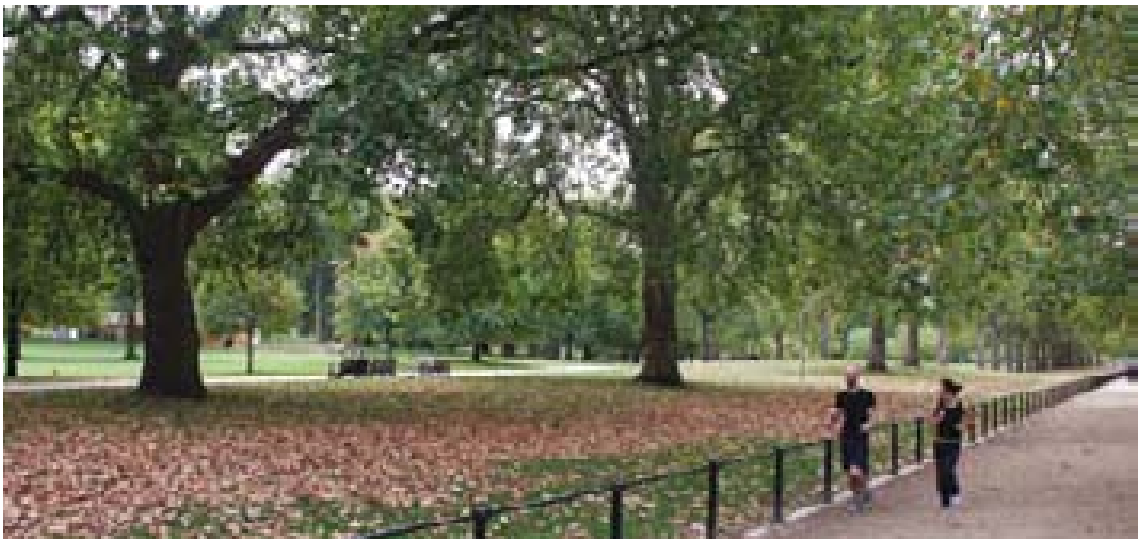

Figure 3: Parks are essential urban landscapes in large cities, where they fulfil vital functions in terms of recreation, sport and air quality maintenance (London).

1.2 Water

Water is life. It is necessary for all life on our planet because, in its liquid state; it is the only fluid that can transport the nutritive elements necessary for the growth of living beings through the natural environment and inside organisms. Water also helps to shape our natural living environment since it is the planet's most powerful erodent. Abrasion caused by run-off and the movement of the oceans and rivers is continually moulding our landscapes.

Water is a limited, non-renewable resource. The volume of water present on the planet is estimated at 1,355 million cubic kilometres. It is distributed as follows:

- Most is found in the oceans (1,330 million km^3) but this is salt water unsuitable for consumption or irrigation without an expensive desalinisation process. However, the oceans which cover two-thirds of the globe's surface, represent the most important terrestrial ecosystem in terms of productivity and, through their exchanges with the atmosphere, the source of all other forms of water;
- Ice (icecaps and glaciers) represents 24 million km^3;
- Continental fresh water, which is the only kind really suitable for human use, represents only 500,000 km^3, with 20% of terrestrial fresh water found in the Amazon river basin;
- Subterranean water reserves account for 150,000 km^3 while atmospheric water (clouds, humidity) represents only 13,000 km^3.

It is estimated that the quantity of water diverted by human beings for their own needs and activities is barely more than 3% of total precipitation. However, precipitation and needs are very unevenly distributed across the earth's surface.

For human beings, water is necessary for hygiene, drinking, food preparation and in particular for the creation of foods that form an essential part of the human diet. Figure 4 shows the quantities of water that are used to meet these different needs.

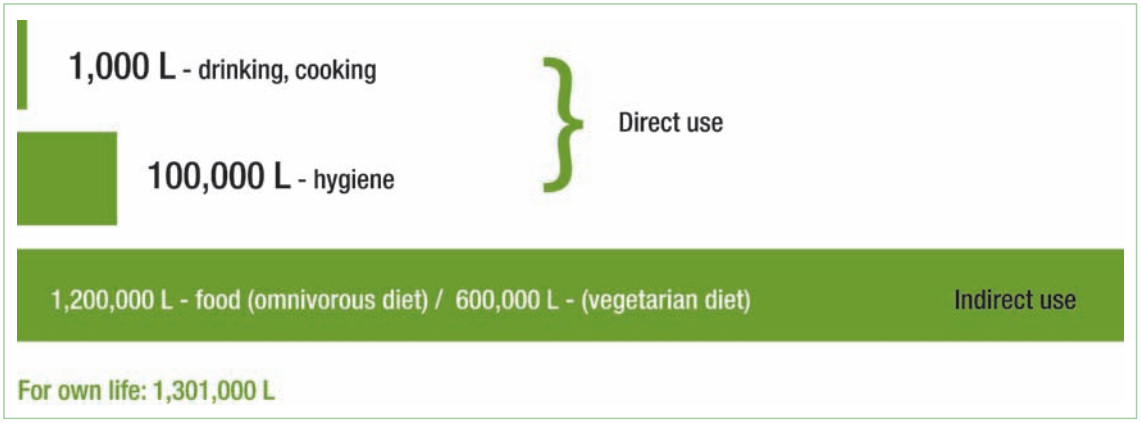

Figure 4: Quantity of water needed each year to meet an individual's needs (drinking, cooking, hygiene and quantity of water needed to produce food).

Clearly, agriculture is by far the main water-consuming activity. It follows that a country can only support itself in terms of food and sanitation if it receives (from rivers and rainfall) between 700,000 and 1.3 million litres of water per inhabitant each year.

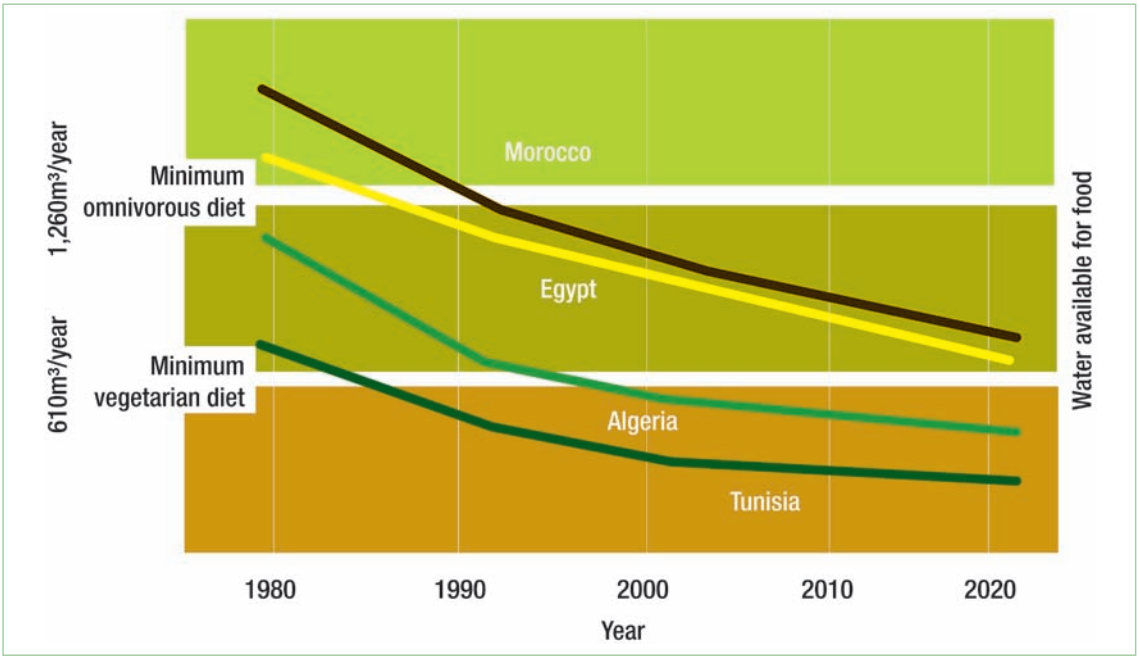

Figure 5: Change in amount of water available per inhabitant in North Africa.

Figure 5 shows how the amount of water available in countries with low rainfall has fallen. The drop in precipitation levels, combined with demographic growth, has significantly reduced the self-sufficiency of North African countries in the space of a few years.

It is not only the quantity, but also the quality of water that poses problems. Many ground waters, springs and seas are irreversibly polluted. Industrial and household waste, as well as intensive agriculture, are largely responsible for this situation.

The main pollutants of natural water resources are:

- fertilisers (nitrates, phosphates);
- organic matter of biological origin (excrement, slurry);
- organic matter of anthropic origin (hydrocarbons, solvents);
- pesticides (herbicides, insecticides and fungicides);
- heavy metals (lead, cadmium, mercury).

Water can be polluted by tiny concentrations of pollutants, e.g.:

One drop of…

- petrol or domestic oil pollutes more than 25 m^3 of water;
- solvent (trichloroethylene, which is used to remove the grease from mechanical parts) pollutes around 300 m^3 of water;
- pentachlorophenol, a wood preservative and pesticide, pollutes around 25,000 litres of water.

1 mg of…

- tetraethyl lead, a petrol additive still used in some countries, pollutes approximately 20 litres of water;
- dichromate, used to treat certain metallic surfaces, pollutes around 50 litres of water.

Water is also a natural habitat that is indispensable to the smooth functioning of the planet and our food supply. For example, the absorption of atmospheric carbon dioxide and photosynthesis that take place in the oceans help to control the greenhouse effect, which regulates the temperature of the earth's surface. Furthermore, rivers, lakes and oceans have been vital sources of food since time began. Sea pollution, mainly caused by hydrocarbons and overfishing, is threatening both of these essential functions.

Key points for sustainable development with regard to water

- Water is the most precious commodity of all and it is everybody's responsibility to use it sensibly, to avoid contaminating it and to teach others to do the same.
- In regions where there is a shortage of water (precipitation of less than 600 mm per year), it is necessary to fight the overconsumption of water by intensive agriculture and to prioritise crops produced for local consumption rather than for export.
- It is important to avoid dumping waste water or untreated waste in natural waters and not to allow it to seep into the ground water. Cheap and simple methods (phytopurification, lagooning, composting) are often very effective.
- Overuse of fertilisers and pesticides in agriculture should be avoided, while preference should be given to plant varieties that require minimal chemical input and to integrated farming methods.
- Overfishing should be firmly opposed, particularly outside territorial waters, while the use of safe ships, especially double hull tankers, should be favoured.

Figure 6: Treatment of waste water in Africa (Burkina Faso) by phytopurification.

1.3 Soil

The soil is where plants put down their roots. It forms the basis for plant growth and for different food chains, and its exploitation provides us with agriculture and forestry production.

The soil, full of nutritive elements, is the home of numerous insects, such as centipedes, earthworms and acarids. They help to mineralize organic matter and decompose leaves and plants. These mineral elements can be used by plants. Acting as a buffer zone between the surface and parent rocks, the soil filters the water and some toxic substances on their way to the ground water or hydrological networks. It also regulates the flow of this water.

The soil is fragile. Other than the decomposition of leaves and twigs, human life is too short to notice how it changes.

The soil: a rich, fragile ecosystem

- Beneath the feet of every walker, between 5 and 10 million organisms are working and feeding from the soil. Mostly earthworms, their combined mass is estimated at around 2.5 tonnes per hectare.
- On average, the soil is thought to be more than 10,000 years old. It takes many years to form, but only a few seconds to destroy with an earth-mover or a landslide.
- In intensive agriculture zones, erosion can remove 50 tonnes of soil per hectare each year.

The soil plays a crucial role in the global cycles of vital elements: water, nitrogen and carbon.

The water cycle

The soil acts as a filter, helping to regulate the flow of rainwater and surface water, and as a reservoir, retaining water to feed the plants. It also plays a part in purifying water by filtering it and promoting the absorption or breaking down of pollutants, helping to preserve the quality of subterranean water, particularly as a source of drinking water.

The nitrogen cycle

Nitrogen is indispensable to life and there are enormous quantities of it on the planet, since it makes up approximately 78% of the atmosphere. However, in its elementary state, this nitrogen is very stable and a huge amount of energy is required to obtain forms of nitrogen that can be assimilated by plants and animals. This is largely achieved in the soil, where microorganisms fix the nitrogen, which is stored in a form accessible to living beings in the organic matter and clay contained in the soil. Without these two functions (fixing of atmospheric nitrogen and storage), life on earth as we know it would not exist.

The carbon cycle

Carbon dioxide is the main greenhouse gas. It can be reduced either by cutting the rate at which it is emitted into the atmosphere or by increasing the rate at which it is removed from the atmosphere through so-called carbon sinks in the intertropical regions. The excess CO_2 in the atmosphere could be trapped by ground vegetation and then by the top layers of soil. Agricultural soils are already among the planet's principal carbon reservoirs and their sequestration capacity could be increased. They could capture and store more than 10% of global carbon dioxide emissions.

Cultivable soils or arable land

Arable land represents less than 10% of the earth's surface and is decreasing due to neglect, climate change, erosion and urbanisation.

In many developing countries, rapid population growth has led in recent years to a sharp reduction in the area of arable land per person (see Figure 7). In 1961, for example, all developing countries had an average of approximately 0.3 ha of arable land per person; by 1992, the figure had dropped below 0.2 ha. If the current trends of demographic growth and land use continue, there will be barely 0.1 ha of arable land per person by 2050.

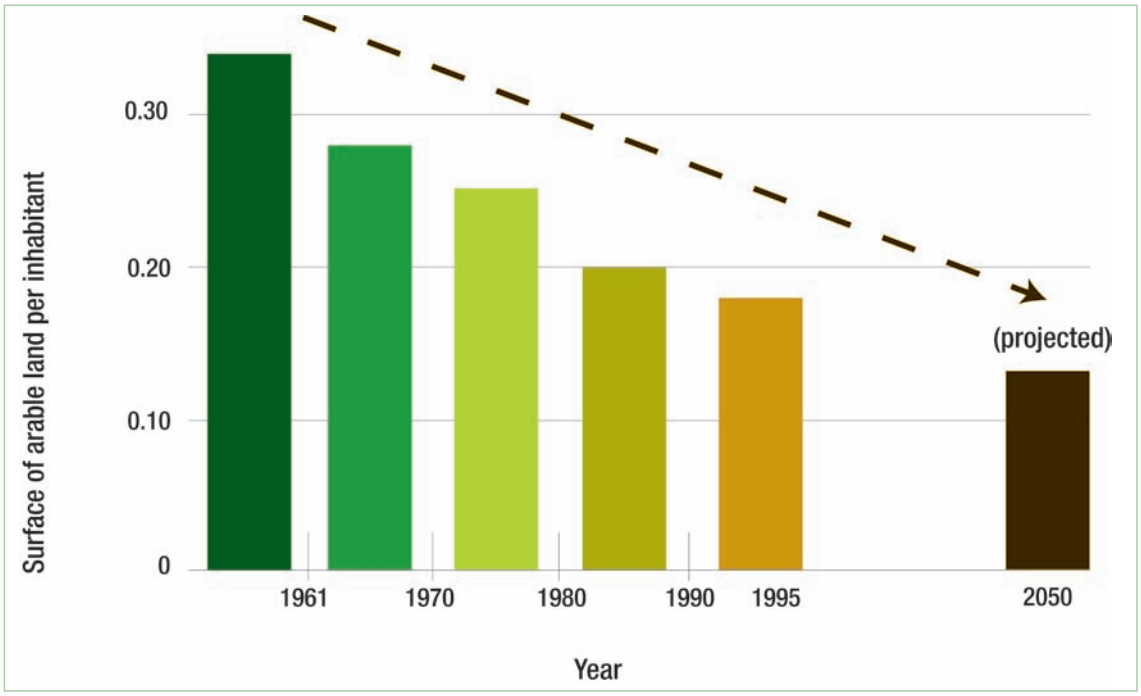

Figure 7: Fall in the quantity of arable land per inhabitant in developing countries (Bibliography: ref.3).

It has been estimated that the planet has around 2 billion hectares of land that could be cultivated without damaging the forests. This figure is around 40% higher than the amount of land currently being used for this purpose. However, uncultivated land tends to be marginal, with poor quality soil and too much or too little rain. It would need to be improved at great expense before it could be used. In the meantime, however, a large amount of the land currently being cultivated is being lost. An estimated 5 to 7 million hectares of arable land is disappearing every year across the globe due to the accelerating deterioration of the soil or rapid urbanisation.

The main pollutants of and threats to natural soils are:

- pesticides (herbicides, insecticides and fungicides);
- heavy metals (lead, cadmium, copper);
- agricultural machinery which compacts the soil and prevents it from regulating rainwater seepage;
- the increased scarcity of vegetable cover which prevents erosion;
- overexploitation or deforestation, mainly of tropical soils, which results in laterisation or salinisation;
- neglect due to the urban exodus.

Key points for sustainable development with regard to the soil

- Arable land is limited and must be protected from any practices that make the soil unproductive by increasing erosion or using up mineral salts or organic matter.
- As far as possible, extensive farming techniques should be promoted rather than intensive methods which require high levels of chemical input and limit the biodiversity of the soil ecosystem.
- Any practice which leads to compacting of the soil, preventing it from regulating rainfall seepage, should be avoided.
- Measures should also be taken to stop traditional agricultural methods such as setting fire to vegetation before sowing, since they also reduce soil fertility.

- Soil without vegetation should be avoided as this promotes erosion.
- Agricultural land should not be extended to the detriment of forests, which are an irreplaceable biological treasure and play an essential role in the global carbon cycle and thus in controlling the greenhouse effect.
- Neglected agricultural land could be used to extend forests.

Figure 8: Soil in southern Vietnam which may be fertile but is susceptible to erosion due to a lack of vegetation.

1.4 Air

Air, like water, is vital. The atmosphere forms a thin layer around the earth. It is approximately 50 km thick, which is negligible compared to the approximately 6,370 km radius of the planet. Quite apart from the fact that the air is the reservoir for the oxygen that is needed to support life on earth, the atmosphere has many other essential functions.

The main vital functions of air:

- Oxygen reservoir;
- Protection against ultraviolet radiation;
- Formation of clouds and transport of water in the atmosphere;
- Thermic transfer and regulation of the earth's climate;
- Reproduction of plants through dispersal of pollen and seeds.

On the earth's surface, air is composed of:

- 78% nitrogen;
- 21% oxygen;
- 1% rare gases (mainly argon);
- Traces of carbon dioxide (0.03%), water vapour, hydrogen, helium and methane;
- The air also contains traces of ozone. This highly unstable gas forms a shield against harmful ultraviolet radiation. The maximum concentration of ozone is low, (0.0008%) and is located at an altitude of around 20,000 m, where it forms the "ozone layer".

Harmful effects of ultraviolet radiation

Cataracts
UV radiation reacts with the components of the eye lens, increasing the diffusion of visible light. This causes blurred vision.

Skin cancer
Research has shown a close correlation between UV levels and skin cancer. For example, a 10% reduction of the ozone layer would result in a 25% increase in skin cancer.

Effect on vegetable plankton (phytoplankton) and the greenhouse effect
Plankton protects itself from UV radiation by remaining deep underwater. The more UV rays there are, the longer the plankton remains deep, sheltered from the light. This reduces photosynthesis and therefore the consumption of carbon dioxide, which is responsible for the greenhouse effect.

Air, climate and vegetation

The air regulates the close relationship between vegetation and climate. For example, deforestation or overgrazing lead to the disappearance of vegetation and therefore to less absorption of light. The absence of plant transpiration means that clouds are not formed. This results in an energy deficit at ground level and the descent of higher air masses containing little water. Drought then takes hold and the desertification process is complete.

On the other hand, regions with dense vegetation benefit from thermic regulation which moderates the temperature. Plant transpiration results in an increase in cloud cover, which in turn limits the loss of energy to space. Wooded regions absorb a lot of solar energy, lose little heat through radiation and preserve humidity.

Air pollution has a wide range of different causes and effects

Pollution with global impact

Rise in greenhouse gas levels
Carbon dioxide levels are rising, either because of combustion emissions (internal combustion engines, power stations, heating) or as a result of the fall in absorption rates (deforestation, reduction in photosynthesis). The other greenhouse gas, methane, mainly comes from gases emitted by ruminants and rice fields.

Reduction of the ozone layer
Ozone is destroyed by several organic molecules known as chlorofluorocarbons (CFCs) that are used as propellants, refrigerants and insulators.

Pollution with local impact

Acidic gases
Gas emissions that have an irritant effect (chlorinated and sulphur compounds) and come mainly from the combustion of chlorinated plastic materials (PVC) or sulphur fuels (oil or coal) acidify rain. Acid rain sterilises the soil, prevents photosynthesis by plants and phytoplankton and dissolves the limestone materials used in buildings. It also indirectly kills fish.

Death of fish through aluminium
When water is acidified by acid rain, the concentration of aluminium in solution tends to increase. Inside fish gills, this aluminium is converted into a gelatinous precipitate which kills fish by suffocation.

Heavy metals
The main one is lead, which is used as an additive in petrol, but there is also cadmium, which is released by the wearing down of certain mechanical parts (brakes), and rare metals (platinum, etc.) used in exhaust pipe catalysts.

Hydrocarbons
Incomplete combustion processes emit carcinogenic hydrocarbons (PAHs), which form the black smoke emitted by badly tuned engines, heating systems or waste incineration equipment.

Ozone
Just as ozone in the upper atmosphere protects us from UV radiation, so the ozone formed at ground level through the combined action of light, nitrogen oxides and hydrocarbons emitted by vehicles can cause serious respiratory problems.

Particles
The ozone on the earth's surface can also react with organic compounds to form very fine particles (aerosols) which can reduce visibility, particularly in large urban areas, and which, when accumulated in the lungs, can cause breathing difficulties such as asthma.

Key points for sustainable development with regard to air

- It is vital to limit as much as possible the carbon dioxide emissions responsible for the greenhouse effect. To this end, it is important to promote public transport, low fuel consumption vehicles and energy production methods that do not emit carbon dioxide.
- Carbon sinks must be protected and developed by stopping uncontrolled deforestation, reforesting neglected land and promoting sustainable forms of forestry.
- The use of chlorofluorocarbons (CFCs) must be avoided and all countries should be given access to replacement molecules under the best possible conditions.
- All combustion processes, particularly of waste, must be controlled in order to prevent acidic gas, carcinogenic hydrocarbon and dust emissions.
- If necessary, road traffic should be restricted during hours of strong sunshine in order to prevent ozone formation.
- The use of unleaded petrol must be encouraged.
- Combustion engines and heating and incineration equipment must be checked regularly in order to ensure they are correctly tuned and emit minimum levels of Polycyclic Aromatic Hydrocarbons (PAHs) and dust.
- Wooded areas in and around large cities must be developed.

Figure 9: The atmosphere is where chemical reactions take place that are essential to life on earth, particularly the formation of ozone.

1.5 Biodiversity

Biodiversity, or biological diversity, means the whole range of living organisms from all origins, whether terrestrial or aquatic, and all the various ecosystems they form. The notion also encompasses diversity within and between species, and between different ecosystems, as well as the genetic variability of each species.

Biodiversity is not only an essential part of the richness of an ecosystem, but also the main factor behind the sustainability of its functions. All the vegetable or animal species which make up the biodiversity of an ecosystem have essential functions that need to be preserved.

Vegetables

Plants and algae

Vegetables, which include plants, herbs and algae, are an essential part of the diet of many animals and insects. Protecting vegetable biodiversity is important because our diet, health and well-being depend on it. This biodiversity may be jeopardised by human intervention (regional development, building work, intensive agriculture, genetic engineering) and by pollution of the soil, water, rain and air.

Plants, a treasure for humanity, a key to sustainability…

- Ruminants, such as cows, provide milk whose dietary value depends on the quality of the grass they eat. Bees produce honey by gathering pollen from flowers.
- Flowers also provide ingredients necessary for the production of medicines. Some compounds even help to relieve difficult chemotherapeutic treatments.
- Some long grasses are the natural habitats of endangered bird species.
- Plants protect the soil from erosion and help to regulate humidity and rainwater seepage.

Trees

Forests are the planet's original natural cover. On land, they play a crucial role in the absorption of atmospheric carbon dioxide and the regulation of rainfall. Unfortunately, they are the most endangered part of terrestrial biodiversity.

It is estimated that forests cover around 3,500 million hectares of the earth's surface, half in the intertropical zone and the rest in temperate and boreal regions. The vast majority of forests are still natural or semi-natural, while forest plantations aimed at ensuring the sustainability of forestry represent only 5% of the planet's forests.

As shown in Figure 10, overleaf, forests are rapidly declining in Africa, Asia-Pacific and Latin America.

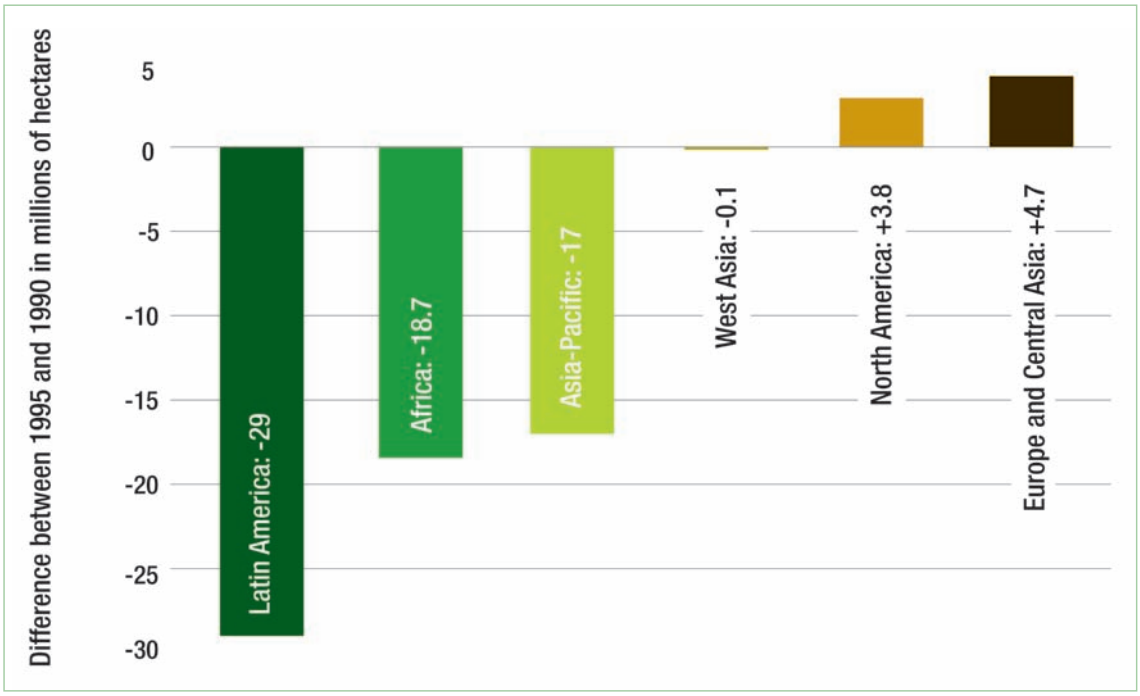

Figure 10: Change in forest surface areas between 1995 and 1990 in different regions of the world (Bibliography: ref.3).

Not only are forest surface areas declining, their biodiversity is also shrinking. For example, 6,000 of the 100,000 or so recorded tree species are considered to be endangered.

Forestry for wood production is not a problem as long as it is accompanied by systematic reforestation. Deforestation for the purpose of gaining arable land, however, is much more open to criticism, particularly in tropical countries where deforested areas are often susceptible to laterisation, which leaves them unsuitable for farming within a few years and leads to desertification.

Forests are highly valuable ecosystems with a variety of functions: first and foremost, they are a natural oxygen-producing lung. They also provide a natural habitat for numerous living species and an environment for wood production and for recreation. Their role in protection is also very important. In mountainous regions, trees help to keep the soil in place, thus limiting erosion (landslides and landslips) and avalanches that pose a danger to villages, communication routes and various infrastructures.

Finally, from a purely visual perspective, trees have therapeutic qualities. It has been shown that hospital patients who are able to look at trees are cured more quickly and with fewer complications than those who are not in such an environment. Also, in urban areas, trees have a positive effect on residents' moods and emotions.

Trees: important functions…

- Each day, one tree produces enough oxygen for four people by absorbing CO_2, the gas responsible for the green house effect.
- A tree can reduce the quantity of dust particles by a factor of 7,000.
- Trees have enormous energy-saving potential. The use of trees as windbreaks for houses can reduce heating costs by 10 to 15%. Conversely, they provide refreshing shade during hot weather, reducing the need for air conditioning.

- Trees play a significant role in purifying the air in urban environments.
- Wood is an excellent building material and can be used in a sustainable way as long as reforestation takes place.
- Very little energy is needed to make wood usable and it is neutral in terms of carbon dioxide emissions.

Fauna

There are several billion individuals and species of fauna on the planet. Each species has its own diet, habitat and way of life. Some hibernate, others are nocturnal, some gallop, while others fly, swim, crawl or climb. This diversity of living beings creates a fragile balance that is easily disturbed.

Insects

Insects play a fundamental role in the natural environment. They recycle organic matter and help to clean the forest floor and undergrowth. They also promote soil formation by aerating the earth and play a part in plant reproduction. Finally, they can provide a full diet for some animals or populations.

Animals

Animals are useful to human beings in various ways: emotional (companions), economic (pulling or carrying) and nutritional (fishing, hunting). Animals are fragile and generally do not like to be approached by or in the presence of human beings. Most of them flee in a process which, for those that hibernate or whose biological activity is slow (marmots, chamois, etc.), uses up precious energy that is meant only for the maintenance of vital functions during winter. If these animals are forced to use this energy, their very survival is jeopardised. In some animal reproduction zones, noise and chemical pollution compromises future generations of these species (e.g. capercaillies in mountain regions). In tropical regions, the disappearance of mangroves (due to the construction of tourist resorts or shrimp farms) is depriving a wide range of species of their reproduction sites.

Throughout the world, numerous animal species are endangered, as shown in figure 11.

	Mammals	Birds	Reptiles	Amphibians	Fish	Total
Latin America and Caribbean	263	353	76	27	103	822
North America	94	84	35	27	190	430
West Asia	23	22	8	0	5	58
Africa	289	207	48	17	127	688
Europe and Central Asia	89	53	29	12	104	287
Asia and Pacific	515	521	104	47	216	1,403

Figure 11: Number of endangered species in different regions of the world (Bibliography: ref.3).

In the oceans, overfishing is the primary cause of the fall in the number of fish species. Coastal marine species (birds, fish, shellfish) can be affected by accidents involving ships carrying hydrocarbons.

Key points for sustainable development with regard to biodiversity

- All vegetable and animal species are equally important.
- Where the climate allows, all the earth's surface should be covered in vegetation, whether herbaceous plants or trees.
- Deforestation should always be accompanied by reforestation, particularly in Latin America, Africa and the Asia-Pacific region.
- The use of wood for construction or heating does not jeopardise sustainable development as long as the wood comes from sustainable forestry, including reforestation.
- The hunting and slaughter of endangered animal species should be totally prohibited.
- It is particularly vital to protect ecosystems with high biodiversity, such as mangroves, tropical forests and savannahs, as well as the most fragile ones, such as mountains.
- Overfishing must be prohibited, particularly the use of drift nets which decimate species indiscriminately and threaten halieutic reserves.
- Extensive, integrated or traditional farming methods which preserve biodiversity should be promoted.

Figure 12: Seal populations have been particularly affected by maritime accidents involving oil tankers.

1.6 Energy

Ever since human beings first trod the earth, controlling energy has been one of the key driving forces behind progress and development. However, access to energy is currently spread very unevenly across the globe. For example, as Figure 13 illustrates, the most developed countries consume up to 30 times more energy per inhabitant than developing countries. Figure 14 shows world primary energy consumption (1990).

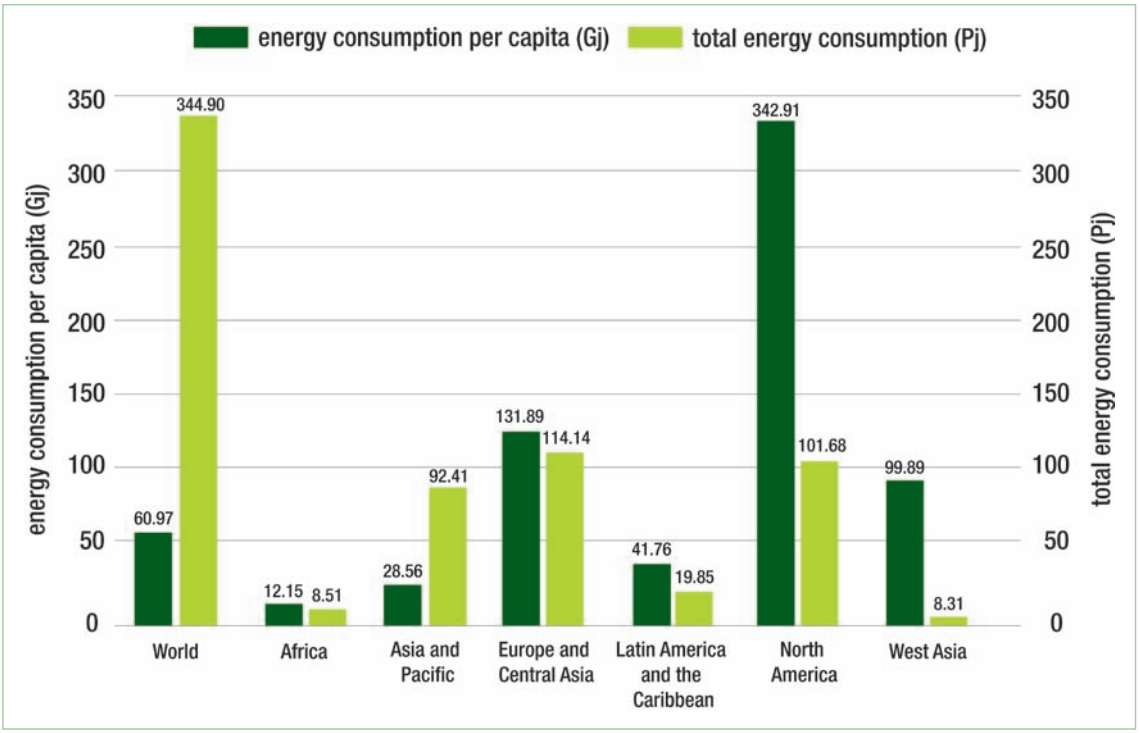

Figure 13: Total energy consumption and energy consumption per capita in different regions of the world (Bibliography: ref.3).

Energy sources	watt./year	%
Coal, lignite, peat, wood	$3.6.10^{12}$	33
Oil products	$4.1.10^{12}$	38
Gas	$2.3.10^{12}$	21
Hydroelectricity	$0.3.10^{12}$	3
Nuclear	$0.6.10^{12}$	5
Wind, solar	$0.001.10^{12}$*	0.01
Total	$10.9.10^{12}$	100

Figure 14: World primary energy consumption in 1990 (*: estimate).

As Figure 14 shows, 92% of the energy resources used are not renewable and cannot, in the long term, meet the increasing energy needs of emerging and developing countries.

Energy-saving by the countries that use the most energy and the introduction of new and renewable forms of energy are indispensable to sustainable development, particularly in the poorest countries.

Energy-saving

Energy-saving measures do not need to compromise our modern way of life. They are also vital in order to cut atmospheric pollution. Thanks to scientific and technical progress, energy production should become increasingly efficient and less and less polluting. The increasing use of insulation and natural light in buildings and the use of low-energy and therefore "cleaner" transport are simple, easy ways of saving huge amounts of energy.

CO_2 emissions, in kg per 100 km for different modes of transport:

- 31 : Aeroplane, short-distance flight (< 800 km)
- 20 : Aeroplane, long-distance flight (> 800 km)
- 21 : Petrol car (light load)
- 16 : Diesel car
- 10 : Motorbike, 4-stroke
- 9 : Bus, post van
- 8 : Motorbike, 2-stroke
- 8 : Stopping train
- 3 : Fast train
- 2 : Trolleybus, tram

Promoting locally produced goods is a very effective way of cutting energy use linked to the transit of goods as well as reducing associated accidents and pollution.

Renewable energy sources

Wind power

Wind power is produced by converting the wind's energy. It has been the energy source for sailing boats and windmills for centuries. Today it is mainly associated with wind turbines which drive electricity generators. Wind power is indirectly created by the sun, since wind results from the temperature and pressure differences caused by the sun's heat in the atmosphere.

The wind turbine market is growing steadily. Apart from a small level of noise pollution, wind energy is totally clean, although reservations are often expressed for aesthetic reasons when large numbers of wind turbines are erected. This type of energy seems particularly suitable for windy coastal regions.

Solar power

Solar energy is used to produce electricity (photovoltaic energy) or heat.

Photovoltaic energy is the direct conversion of sunlight into electricity. It is the cleanest way of producing electricity. It is silent, uses no mechanical components and does not release any toxic products. The use of photovoltaic cells is more efficient in the sunny regions of southern countries, but they can be used anywhere in the world. Photovoltaic energy is particularly suitable for the following uses:

- Public lighting (motorways, bus stops, etc.);
- Decentralised communications (telephone relay stations, emergency telephones on motorways, mobile telephones, etc.);
- Provision of electricity at sites remote from the normal network;
- Remote sensors (weather information, road traffic, seismic measurements);
- Small desalination and pumping stations for drinking water or irrigation;
- Charging of car batteries;
- Electricity on boats;
- Protection against corrosion (pipelines and other underground or underwater pipes rust and can be protected if there is a difference of potential, i.e. an electrical current).

Solar energy is a source of heat and health. It is a source of directly usable heat. In temperate countries, a large amount of water can be heated using solar water-heaters. Drinking water can also be decontaminated using solar water-heaters.

Other renewable energy sources

Hydraulic energy (dams, micro power stations) has enormous potential in developing countries, while geothermal and tidal energy are limited to particular geographic areas.

Key points for sustainable development with regard to energy

- Energy is indispensable to the development of the most disadvantaged countries. For their energy requirements to be met, non-renewable energy sources need to be shared more equally by the developed world, while at the same time more energy-efficient technologies should be used and renewable energy sources developed.
- The use of public transport and house insulation are easy ways of reducing energy expenditure.
- Wind power, if it can be harnessed, is a totally clean, high-yield form of energy.
- Photovoltaic energy is particularly suitable for small installations.
- Solar energy is very effective as a heat source for heating and even decontaminating water.
- Hydraulic energy also has enormous potential, especially in developing countries.

Figure 15: Wind turbines at the entrance to the port of Ostend (Belgium).

1.7 Pollutants and waste

We shall distinguish between hazardous pollutants and waste (nuclear, chemical), which can only be destroyed using appropriate and often costly technologies, and every-day waste (waste water, household refuse, packaging), which is less expensive to deal with and is mainly a case of education, motivation and organisation.

Hazardous pollutants and waste

Hazardous pollutants and waste are produced mainly by industry and intensive agriculture.
Most nuclear waste comes from nuclear power stations. It has a very long life and requires highly expensive, sophisticated treatment techniques. This is the only disadvantage of nuclear energy, which does not produce any greenhouse gases. Some irradiation devices used in medicine and various industries may also contain radioactive material. These must be properly identified, monitored and treated as dangerous waste once they are taken out of use.

Hazardous chemical waste and pollutants are composed mainly of toxic heavy metals (mercury, lead, cadmium, arsenic), compounds and persistent organic pesticides. The 2004 Stockholm Convention on Persistent Organic Pollutants (POPs) is aimed at eliminating the 12 most dangerous POPs (dioxins, dibenzofurans, PCBs, hexachlorobenzene, DDT, aldrin, chlordane, deldrine, endrine, heptachlor, mirex and toxaphene). There are often traces of these products, which are untreatable, and therefore the only way of controlling them is to prohibit their use or eliminate them at source.

The Basle Convention strictly limits trade and cross-border transportation of waste which, as far as possible, should be treated where it is produced.

Every-day waste

This category is composed mainly of waste water, household refuse and discarded objects.

Waste water contains faeces and organic chemical compounds which pollute water, damage aquatic environments and make the water they contaminate unfit for consumption. The purification of waste water is not a difficult technical process, requires little energy and can be inexpensive. It can be a decentralised process, with latrines and septic tanks capable of purifying waste water for a limited number of people or dwellings. Centralised water purification in towns and cities requires the construction of a sewerage system leading to a purification station where the water is treated through decantation, bacterial disinfection, lagooning or phytopurification. During the treatment process, the pollutants are separated in the form of sludge, which may be composted and used as a fertiliser in agriculture.

Purification stations operate best if they treat a constant amount of water. It is therefore preferable if large installations that are only used occasionally (theatres, conference centres, stadiums) are linked to central urban purification stations so that the sudden changes of flow that they create are barely detectable.

Household waste should always be separated into inert and organic waste. Most inert waste can be recycled (glass, aluminium, paper) or re-used. Organic waste (kitchen waste) can be composted and used as fertiliser in agriculture.

Discarded objects are a blot on urban and even rural landscapes. Cars, household appliances, old furniture and packaging (usually made of non-degradable plastic) are dumped on public land. Proper disposal of these items is not expensive and can even be profitable if they are recycled or re-used. It is essentially a question of consumer education and community organisation.

Key points for sustainable development with regard to pollutants and waste

- Highly toxic pollutants and waste must be combated at source and systematically identified, monitored and possibly destroyed or stored.
- Drugs, doping and narcotics are pollutants of the body and must be eliminated because they always have serious long-term effects on mental and physical health.
- Waste water can be purified fairly simply, both at individual level (family, group of dwellings) and collectively (town, small business and industrial parks).
- Sludge resulting from the treatment of waste water can be composted and used as an effective fertiliser in agriculture.
- Solid waste and household refuse should be recycled or composted, depending on whether it is inert or organic.
- Through consumer education and community organisation, it is possible to prevent damage to the landscape and the living environment by discarded objects.

Figure 16: Plastic waste is a blot on urban or semi-urban landscapes (suburb of Ouagadougou, Burkina Faso).

1.8 The political dimension of environmental protection and sustainable development

At the political level, protection of the environment and sustainable development involve passing binding national, regional or local legislation. This includes the adoption of different Agenda 21s as the inspiration behind the long-term development policies of public authorities. However, it should be noted that political measures are only ever translated into practical action if the population is actively supportive. Such public backing is achieved through education rather than obligation.

At international level, protection of the environment and sustainable development are covered by a series of Conventions and Protocols which are binding only on the countries that have ratified them.

United Nations Montreal Protocol on Substances that Deplete the Ozone Layer (entered into force in 1989)

This Protocol concerns regulations aimed at combating the production and use of substances that deplete the ozone layer. It mainly sought to eliminate CFCs by 1995, bromochloromethane by 2002, methyl bromide by 2005 and HCFCs by 2030. Delays are in place for developing countries, which do not need to apply the Protocol until 2010.

Basle Convention on the Control of Transboundary Movements of Hazardous Waste (entered into force in 1992)

This Convention aims to restrict the movement of hazardous waste between countries and to promote the management and elimination of such waste in order to protect the environment.

United Nations Convention on Biodiversity (entered into force in 1994)

The purpose of this Convention is to protect the ecological, social, cultural and economic potential of nature (living species and ecosystems). It lays down the principles for recognition of access rights and rules on the sharing of prof its from the exploitation of these natural resources, in order to contribute to their conservation. It obliges the signatory states to monitor and list their biodiversity, to include it in sectoral policies, to carry out environmental impact studies and to draw up national biodiversity strategies or programmes.

Rotterdam Convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade (entered into force in 2004)

This Convention is designed to help countries that lack the necessary infrastructure to control the import of hazardous chemicals and pesticides by providing them with relevant information on this subject.

Stockholm Convention on Persistent Organic Pollutants (POPs) (entered into force in 2004)

This Convention is aimed initially at eliminating the 12 most persistent organic pollutants: dioxins, dibenzofurans, PCBs, hexachlorobenzene, DDT, aldrin, chlordane, deldrine, endrine, heptachlor, mirex and toxaphene. It makes provision for aid mechanisms for developing countries and can be extended to cover new products as knowledge increases.

Kyoto Protocol on Climate Change (entered into force in 2005)

This Protocol lays down legally binding detailed targets for the reduction or limitation of greenhouse gas emissions

in developed countries. It aims to cut these emissions by 5.2% by 2008-2012 compared to 1990 levels. It deals with the six main greenhouse gases not covered by the Montreal Protocol: mainly carbon dioxide (CO2) but also methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

Key points for sustainable development with regard to its political dimension

- Sustainable development needs to be the subject of binding legislation.
- The population needs to be actively supportive if environmental protection and sustainable development policies are to be implemented.
- A number of international Protocols and Conventions are aimed at combating global climate change and the effect of toxic chemicals.
- These international Protocols and Conventions include adaptation mechanisms and financial aid for developing countries.

Figure 17: Cross-border transport of hazardous waste is regulated by the Basle Convention.

1.9 The social dimension of environmental protection and sustainable development

Sustainable development requires all members of human societies, irrespective of gender, age, race, religion or colour, to have equal opportunities to participate in such development and to enjoy its benefits.

Firstly, access to education is the top priority, not only for sustainable social progress but also for effective awareness-raising and motivation of individuals in relation to political and economic development and protection of the environment.

Social development is the responsibility not only of states which legislate in this area, but also of companies. Following the quality standard model, there are several standard-setting approaches for social development at international level. These take the form of three different kinds of initiative: labels, certification and codes of conduct.

Labels are signs designed to distinguish a product or service on the basis of specific criteria, whether ecological, biological or social. They are based either on the intrinsic qualities of the product or on the manufacturing process, and can therefore operate in tandem with codes of conduct. Certification is granted to a product or body which complies with specific criteria and whose conformity has been verified by an independent body. Codes of conduct set out the commitments which an organisation either enters into itself or imposes on its economic partners.

There are several international initiatives which can shed some light on the social dimension of sustainable development.

The Global Compact

The International Chamber of Commerce is among the organisations formally supporting the Global Compact initiative following an appeal by Kofi Annan in January 1999.The Global Compact is designed to be a platform for the promotion of institutional learning and good business practices based on universal values. It reflects the principles enshrined in the Universal Declaration of Human Rights, the main labour law principles of the International Labour Organisation and the principles contained in the Rio Declaration. As far as the social dimension is concerned, the Global Compact proposes ten principles for companies to follow, urging them to:

- support and respect the protection of internationally proclaimed human rights within their sphere of influence
- make sure that they are not complicit in human rights abuses
- uphold the freedom of association and recognise the right to collective bargaining
- eliminate all forms of forced and compulsory labour
- effectively abolish child labour
- eliminate discrimination in respect of employment and occupation
- support a precautionary approach to environmental challenges
- undertake initiatives to promote greater environmental responsibility
- encourage the development and diffusion of environmentally friendly technologies
- work against all forms of corruption

To date, several hundred companies have informed the United Nations Secretary General Mr Kofi Annan that they subscribe to these principles.

OECD Principles of Corporate Governance and Guidelines for Multinational Enterprises (2000)

The Organisation for Economic Co-operation and Development (OECD) has 30 member states and offers governments a framework for examining, drafting and refining economic and social policies. The OECD's

Principles of Corporate Governance cover five main fields: the rights of shareholders and their protection, equitable treatment of all shareholders, the role of employees and other stakeholders, transparency and timely disclosure of information regarding the structures and activities of the company, and the responsibilities of the board vis-à-vis the company and the shareholders.

The Principles form part of a vast international process whose aim is to improve transparency, integrity and respect for human rights. Along the same lines, the OECD Guidelines for Multinational Enterprises lay down principles and standards of responsible conduct for companies in compliance with the laws relevant to these principles. The notion of social responsibility is particularly prominent. The Guidelines also aim to harmonise governments' policies. None of these principles are binding.

ISO standards and Copolco reports

According to the International Standard Organisation (ISO), corporate social responsibility is linked to companies' general relations with all stakeholders, clients, employees, owners, investors, governments, suppliers and competitors. It is exercised through investment, a community approach, relations with staff, job creation and protection, responsible management of the environment and financial return (ISO, 2002).

The "Consumer Protection in the Global Market" working group of the COPOLCO (ISO Committee on Consumer Policy) was asked by the ISO to produce a report on the desirability of corporate social responsibility standards. The report's conclusions suggest that:

- The creation of ISO corporate responsibility standards is feasible and desirable. These standards would be established in the same mould as the ISO 9000 (Quality management) and ISO 14000 (Environmental management) standards;
- The standards will need to be flexible and practical so that they can be used by both small and large companies in developing as well as developed countries.
- ISO corporate social responsibility standards should include:
    1. compliance with the law and relevant international standards
    2. consideration of the views of the stakeholders when the standards are established
    3. the development of corporate ethics policies, including anti-corruption policies
    4. verification of the quantity of training offered to staff
    5. the quality of relations with local communities
    6. the frequency of communication with stakeholders and the public in general.

Global Reporting Initiative (GRI)

Established in 1997 at the initiative of the Coalition for Environmentally Responsible Economies (CERES), in partnership with the United Nations Environment Programme (UNEP), the GRI is composed of corporations, NGOs, commercial organisations and associations, and other stakeholders' representatives. Its aim is to draw up and disseminate guidelines for voluntary reporting on sustainable development by companies wishing to be accountable for the environmental and social dimensions of their activities, products and services.

The GRI proposes a common framework for reporting on the three aspects of sustainable development:

- Economic aspect: salaries, welfare benefits, staff productivity, job creation, subcontracting expenditure, expenditure on research and development, investment in training and other forms of human capital;
- Environmental aspect: impact of processes, products and services on air, water, soil, biodiversity and human health;

- Social aspect: health and safety in the workplace, staff retention, labour law, human rights, salaries and working conditions amongst subcontractors.

The GRI aims to develop indicators that are applicable to all companies in all economic, social and environment sectors. These are known as the core indicators, i.e. those that are relevant in all cases. There are also industry-specific indicators and a degree of flexibility is allowed for company indicators applied by firms on a case-by-case basis. The GRI's guidelines are intended to provide a framework for sustainable development reporting, although they do not suggest how the information should be verified. Finally, it should be noted that this is a voluntary initiative.

SA 8000 standard

The SA 8000 standard was developed in 1997 by Social Accountability International. It is designed to improve working conditions by promoting voluntary standards backed up by an independent verification system and an external communication policy (public reporting). The structure of the SA 8000 standard is based on the ISO 9000 management system. The principles are inspired by several conventions of the International Labour Organisation (ILO), the Universal Declaration of Human Rights and the United Nations Convention on the Rights of the Child.
The nine areas of certification are:

- Child labour
- Forced labour (slavery)
- Freedom of association
- Health and safety
- Racial or sexual discrimination
- Discipline
- Working hours
- Compensation
- Management systems

The verification process is conducted by independent third parties. The Advisory Board, which is responsible for drafting and reviewing standards, audit systems, conferences, training and the complaints system, comprises representatives of all stakeholders in the SA 8000 (workers, trade unions, companies, socially responsible investors, non-governmental organisations).

As far as the Olympic Movement is concerned, the social dimension of sustainable development is particularly relevant to women, young people and native populations. Persons with disabilities should be added to this list. Sport is particularly conducive to the social integration of all strata of the population. Involvement in a sports club is an ideal way of learning about citizenship.

For women

- Women should enjoy the same access to sports activities as men;
- Sports clubs and authorities should be a springboard for the promotion of women's education, particularly by ensuring that sports centres have an educational dimension;
- Women's participation in sport should be facilitated through the development of social support measures;
- Women should be given equal access to management posts in sports governing bodies;
- Women's and men's sport should be treated equally by the media and given the same financial support.

For young people

- Membership of a club is a way of learning about community life;
- Clubs are places where youngsters can learn by example;
- Sport can be a means of acquiring a new status and of social rehabilitation;
- Participation in sports management bodies should give young people the chance to be involved in

decision-making relevant to them;
- The Olympic family should play a part in condemning and opposing the human rights violations committed against young people.

For native populations
- The world of sport should encourage their sporting traditions;
- Their traditional knowledge and know-how in terms of managing the environment should be respected and used to promote the environment and sustainable development, particularly in their native regions;
- Political and sports authorities should promote access for these populations to participation in sport.

For people with disabilities
It is indispensable that people with disabilities are able to participate in sport, that their competitions are treated with the same respect as other types of sports event, and that sports facilities are adapted to their needs.

Key points for sustainable development with regard to its social dimension

- Access to education is the fundamental pillar of social development.
- Equal opportunities and social development are indispensable to sustainable development.
- All types of discrimination (sex, age, race, colour, religion) should be condemned and combated.
- Forced labour should be condemned.
- Recommendations and standards exist at international level for the evaluation of the social dimension of sustain able development in companies.
- The Olympic Movement attaches particular importance to the social development role it can play for women, young people, native populations and people with disabilities

Figure 18: Young people should be primary beneficiaries of the social dimension of sustainable development (Ouahigouya, Burkina Faso).

1.10 The economic dimension of environmental protection and sustainable development

Sustainable development is dependent on economic development that makes it possible to fill the gaps between rich and developing countries by ensuring more equal distribution of resources, while also respecting the environment. Economic practices often involve short-term strategies that are difficult to reconcile with the demands of sustainable development.

Among the economic and technical development strategies designed to enhance the management of resources in an environment-friendly manner, industrial ecology is a particularly interesting example. It involves focusing on various activities (exploitation of resources, conversion, consumption and management of waste) and forming a network to ensure that the energy and waste generated by an activity become a resource for an associated activity. In this way, for all parties involved, the need for raw materials and energy, along with waste emissions, are minimised.

Life cycle analysis, which evaluates the environmental impact of products and services throughout their life, including the extraction of raw materials, manufacturing and the use and treatment of associated waste, is an invaluable tool for identifying the real economic consequences of the environmental impact of a type of consumption.

With regard to the exploitation of genetic resources, the traditional right of free usage or patented protection of such usage by biotechnology firms are extremely important issues in which social and environmental concerns conflict with economic factors, leaving little room for sustainable development in this field.

In industry, the main tool for ensuring respect for the environment and sustainable development is the series of ISO 14001 standards on Environment Management Systems, which was introduced in 1996.

ISO 14001 standards on environmental management

An Environmental Management System represents the whole organisational system created by a company in order to ensure that the products and services that it designs, manufactures and sells do not threaten the environment either directly or indirectly. According to the standard, the environment is composed of all the elements that make up the setting in which the company operates, i.e. water, air, soil, natural resources, flora, fauna, humans and their interactions. An Environmental Management System must be coordinated with the company's other systems: health at work, safety, quality, finance.

An Environmental Management System should involve:

- a preliminary investigation which enables the company to evaluate its respect for environmental laws and regulations and its environmental impact;
- the definition of an objective and an action plan, taking into account the impact of the materials used and emitted by the company and the training of its staff in protection of the environment;
- the drafting of a policy which states the company's commitments in terms of respect for the law, the establishment of a suitable management system, performance evaluation, consideration for the life cycle of its products and services, the design of new products and services, the reduction of pollution, recycling and staff training.

An Environmental Management System must be certified regularly by means of an independent auditing system.

Key points for sustainable development with regard to its economic dimension

- Industrial ecology and life cycle analysis are invaluable tools for determining whether business activities are compliant with sustainable development.
- ISO 14001 standards enable companies to create an environment-friendly economic development strategy.

Figure 19: Environment-friendly economic development in developing countries is crucial to the sustainable development of the planet (Vietnam, Mekong Delta).

1.11 The Millennium Development Goals

A special effort is needed to help the poorest developing countries. Therefore, the 191 Member States of the United Nations Organisation have committed themselves to achieving eight specific objectives between now and 2015/2020. The Olympic Movement, through the application of its Agenda 21, can participate in the achievement of several of these objectives.

The Eight Millennium Development Goals

1) Eradicate extreme poverty and hunger
   Reduce by half the proportion of people living on less than a dollar a day.
   Reduce by half the proportion of people who suffer from hunger.

2) Achieve universal primary education
   Ensure that all boys and girls complete a full course of primary schooling.

3) Promote gender equality and empower women
   Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015.

4) Reduce child mortality
   Reduce by two thirds the mortality rate among children under five.

5) Improve maternal health
   Reduce by three quarters the maternal mortality ratio.

6) Combat HIV/AIDS, malaria and other diseases
Halt and begin to reverse the spread of HIV/AIDS.
Halt and begin to reverse the incidence of malaria and other major diseases.

7) Ensure environmental sustainability
Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources.
Reduce by half the proportion of people without sustainable access to safe drinking water
Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020.

8) Develop a global partnership for development
Develop further an open trading and financial system that is rule-based, predictable and non-discriminatory. Includes a commitment to good governance, development and poverty reduction—nationally and internationally.
Address the least developed countries' special needs. This includes tariff- and quota-free access for their exports; enhanced debt relief for heavily indebted poor countries; cancellation of official bilateral debt; and more generous official development assistance for countries committed to poverty reduction.
Address the special needs of landlocked and small island developing States.
Deal comprehensively with developing countries' debt problems through national and international measures to make debt sustainable in the long term.
In cooperation with the developing countries, develop decent and productive work for youth.
In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries.
In cooperation with the private sector, make available the benefits of new technologies especially information and communications technologies.