

PART

4

Sustainability dimensions

Land

The loss of prime-quality land has put additional strain on agriculture to perform. Changes in landcover have caused the most pressing environmental issue in recent decades. Deforestation and land use intensification, and their impact on soil degradation, are at the heart of the issue. However, in much of the world, the current picture of landcover change shows a continuing slowdown in the conversion of forests to areas for crop or livestock production and the continued growth of protected areas.

While cropland, permanent meadows and pastures are still showing positive per annum growth, forest land is decreasing at the global level. The increase in cropland was more rapid in Africa than in other regions over the period from 1990-2009 (1.1 percent for Africa, 0.4 percent for Asia, 0.6 percent for the LAC regions and -0.8 percent for the DVD), while the increase of pastureland was more rapid in Asia (0.1 percent for Africa, 2.8 percent for Asia, 0.2 percent for LAC and -1.6 percent for DVD). (Table 44)

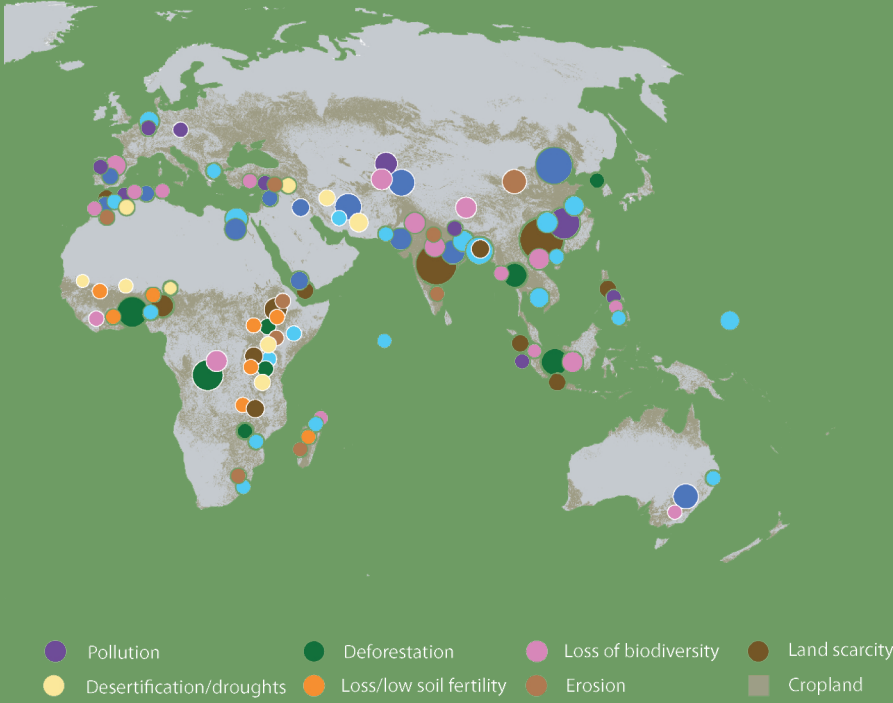
Regarding land use for crop production, the land with rainfed crop potential (land suitable to some extent for rainfed agriculture) is estimated to be 4.2 billion ha (30 percent of the total of world land surface). This rainfed cropland potential is 45 percent in sub-Saharan Africa (one billion ha of land with rainfed crop potential and more than one billion ha of land which is not suitable), 9 percent for the Near East and North Africa, 52 percent for Latin America, 52 percent for South Asia, 26 percent for East Asia, 27 percent for industrial countries and 22 percent for transition countries. (Chart 69)

With regard to the distribution of risks associated with main agricultural production systems, the situation in Africa in 2010 has been presented by country as follows: (Map 46)

- Floods/sea level rise: Egypt, Kenya, Madagascar, Morocco, Mozambique, Nigeria, Somalia, South Africa (east coast).
- Water scarcity: Algeria, Egypt, Morocco, Tunisia.
- Pollution: Algeria (sea borders).
- Desertification/droughts: Algeria, Burkina Faso, Ethiopia, Mauritania, Niger, Nigeria, Tanzania.
- Deforestation: Benin, Democratic Republic of the Congo, Nigeria, Tanzania, Togo, Zambia,.
- Loss/low soil fertility: Burkina Faso, Cote d'Ivoire, Ghana, Madagascar, Nigeria, Sudan, Togo, Zambia.
- Loss of Biodiversity: Algeria, Democratic Republic of the Congo, Liberia, Madagascar, Morocco, Tunisia.
- Erosion: Ethiopia, Morocco.
- Land scarcity: Burundi, Ethiopia, Malawi, Nigeria, Rwanda.

MAP 46: Global distribution of risks associated with main agricultural production systems (2010)





Source: FAO, Land and Water Division
 Metalink: P4.ENV.FAO.FOR.LCF.SOLAW, p. 240

CHART 69: Land with rainfed crop potential (2007)



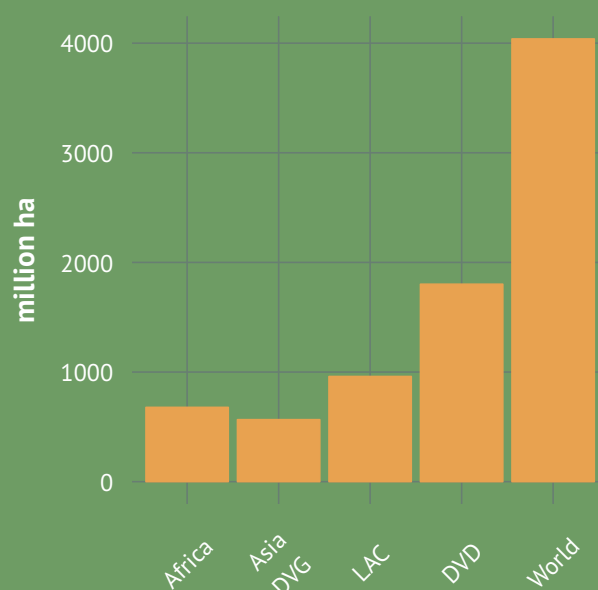
Source: Agricultural Development Economics Division
 Metalink: P4.ENV.LND.SUIT, p. 242

The latest estimate of the world's total forest area is over four billion ha, corresponding to 31 percent of total land area, or an average of 0.6 ha per capita. The five most forest-rich countries (Brazil, Canada, China, the Russian Federation and the United States of America) account for more than half of the total forest area. Ten countries or areas have no forest area at all, and an additional 54 have forest on less than 10 percent of their total land area. The estimated forest area in Africa is close to 675 million ha, accounting for about 17 percent of global forest area and 23 percent of the total land area in the region. At the sub-regional level, Central Africa accounted for 37 percent of the total forest area, Southern Africa for 29 percent, North Africa for 12 percent, and East and West Africa for 11 percent each. In Africa, the five countries with the largest forest area (Angola, Democratic Republic of the Congo, Mozambique, Sudan and Zambia) together contained more than half the forest area of the continent (55 percent). Countries reporting the highest percentage of their land area covered by forest were Seychelles (88 percent), Gabon (85 percent), Guinea-Bissau (72 percent), Democratic Republic of the Congo (68 percent) and Zambia (67 percent).

While the rate of deforestation and loss of forest from natural causes is still high, it is slowing down. At the global level, it decreased from an estimated 16 million ha per year in the 1990s to around 13 million ha per year in the last decade. At the same time, afforestation and natural expansion of forests in some countries and areas have significantly reduced the net loss of forest area at the global level. The net change in forest area over the period 1990-2000 was estimated at -0.2 percent per year, down by 0.1 percent over 2000-2010. The net change in forest area in the period 2000-2010 was estimated at -5.2 million hectares per year, down by 40 percent per year in the prior decade. However, most of the loss of forest continued to take place in countries and areas in the tropical regions, while the most gain took place in the temperate and boreal zones and in some emerging economies. Africa has the highest level of forest loss in the world but there was also a reduction in the rate of net forest loss in the region between the last two decades, from 4.0 million ha per year in the decade 1990-2000 (0.6 percent per year) to 3.4 million ha per year during the period 2000-2010 (0.5 percent per year).

With regard to carbon, carbon content in topsoil is high (more than 1.25 percent) for some African countries, including Congo, Guinea, Lesotho, Malawi, Swaziland, Tanzania and Zambia. However it has been very low (less than 0.5 percent) in Egypt, Libya, Namibia and Somalia. (Map 47)

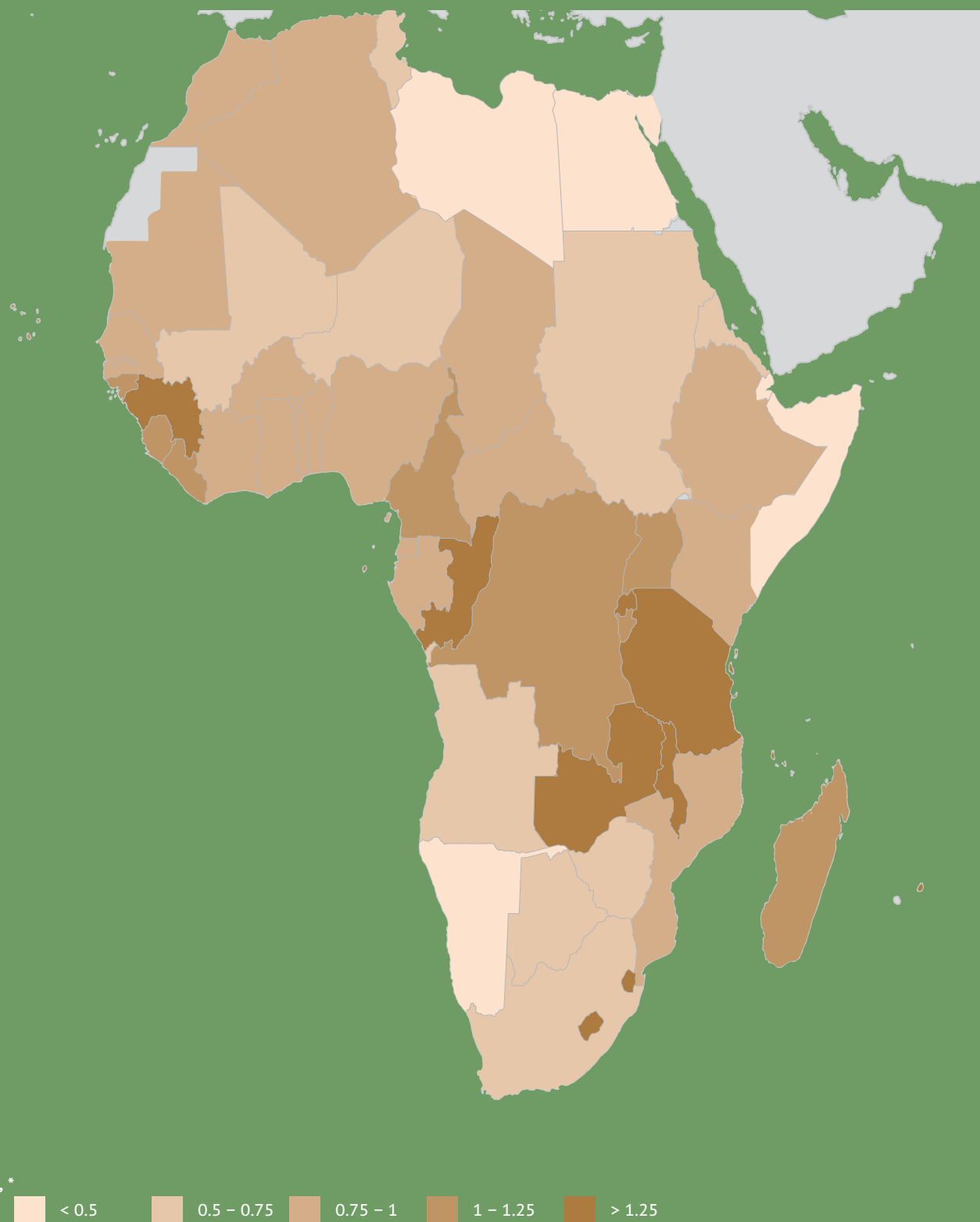
CHART 70: Forest area (2009)



Source: Statistics Division (FAOSTAT)

Metalink: P4.ENV.FAO.ESS.LAND.FOST, p. 239

MAP 47: Carbon content in topsoil (% , 2000-2008*)



Source: Statistics Division
 Metalink: P4.ENV.FAO.FOR.LCF.SQ, p. 236

The total forest is constituted by primary forest, other naturally regenerated forest and planted forest.

Primary forests are very important in the LAC region; they represented more than 60 percent of total forest in 2009. In South Asia, they were more than 20 percent and almost 20 percent for East Asia. However primary forests were very small (less than 10 percent) in Sub-Saharan Africa in 2010. (Chart 72)

In contrast, the other naturally regenerated forests have been very important in Sub-Saharan Africa (more than 80 percent of total forest while they have represented more than 60 percent in South Asia, 60 percent in East Asia and about 30 percent in LAC regions. Planted forests are more important in East Asia (about 20 percent of total forest than in South Asia, and they are insignificant in LAC regions and in Africa. (Chart 72)

FAO takes in account these five primary designated functions of forest: 1) production 2) protection and conservation, 3) social services, 4) multiple uses, 5) other or unknown.

In Africa, 30 percent of forest land is devoted to production, 17 percent to protection and conservation, 0.6 percent to social services, 17 percent to multiple use and 35 percent to other or unknown uses. Compared with world levels, in which 30 percent is given to production, 20 percent to protection and conservation, 4 percent to social services, 24 percent for multiple use and 23 percent to other or unknown uses, insufficiency in levels of protection and conservation, in social services, and in multiple use, can be noted. However, the primary designated functions of forest as production was regular and it appears that too much functions of forest were identified as other use or unknown in Africa. (Chart 73, Table 45)

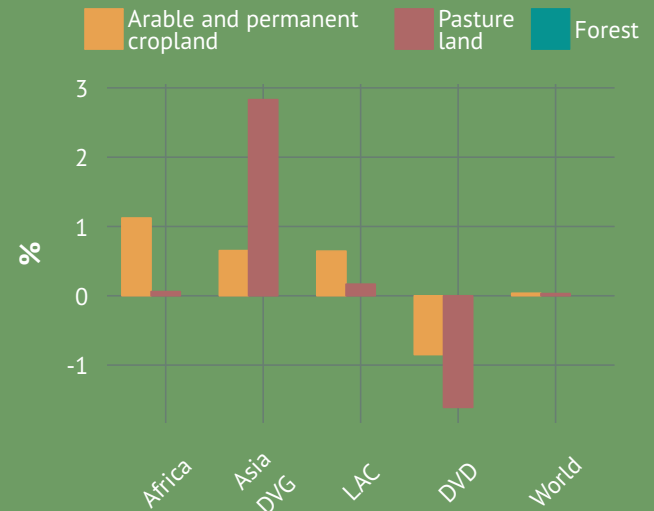
In Asia DVG, 35.8 percent of forest land is dedicated to production, 35.8 percent to protection and conservation, 0.9 percent to social services, 26.4 percent to multiple uses and 1.3 percent to other or unknown uses. Here the shortfall is at the social services level. (Table 45)

In the LAC regions, 14.5 percent is dedicated to production, 23.5 percent to protection and conservation, 8.7 percent to social services, 23 percent for multiple use and 32.3 percent to other or unknown uses. The percentage is insufficient at the production level and too high at the protection and conservation and social services levels.

For the DVD, 34.9 percent is committed to production, 27.9 percent to protection and conservation, 3.7 percent to social services, 29.4 percent for multiple use and 5.7 percent to other or unknown uses. The percentage is overly high at the levels of production, protection and conservation and multiple uses. Moreover, the social services level is a little insufficient. (Chart 73, Table 45)

With regard to the carbon stock at the world level, carbon stock in living forest biomass is decreasing slightly. For the world it was about 270 256 gigatonnes in 2010: 55 736 gigatonnes for Africa; about 34 883 in Asia DVG; 97 511 for the LAC regions; and 79 558 for the DVD. From 1990 to 2010, LAC regions have had the most important carbon stock in living forest biomass, followed by the DVD, then Africa and Asia DVG. (Chart 74, Table 44)

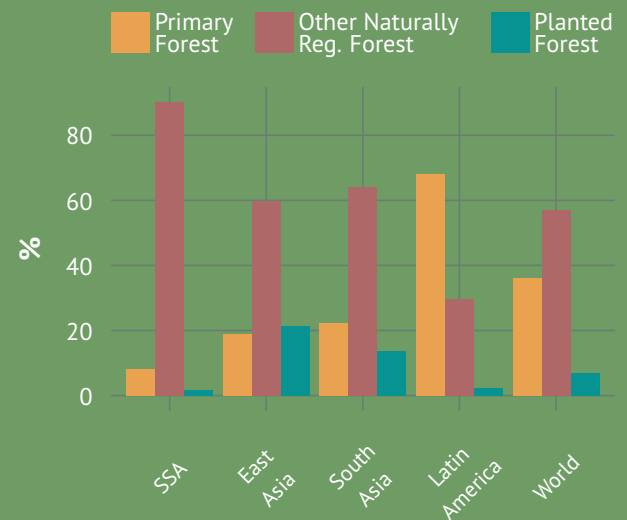
CHART 71: Land use p.a. growth (2009)



Source: Statistics Division (FAOSTAT)

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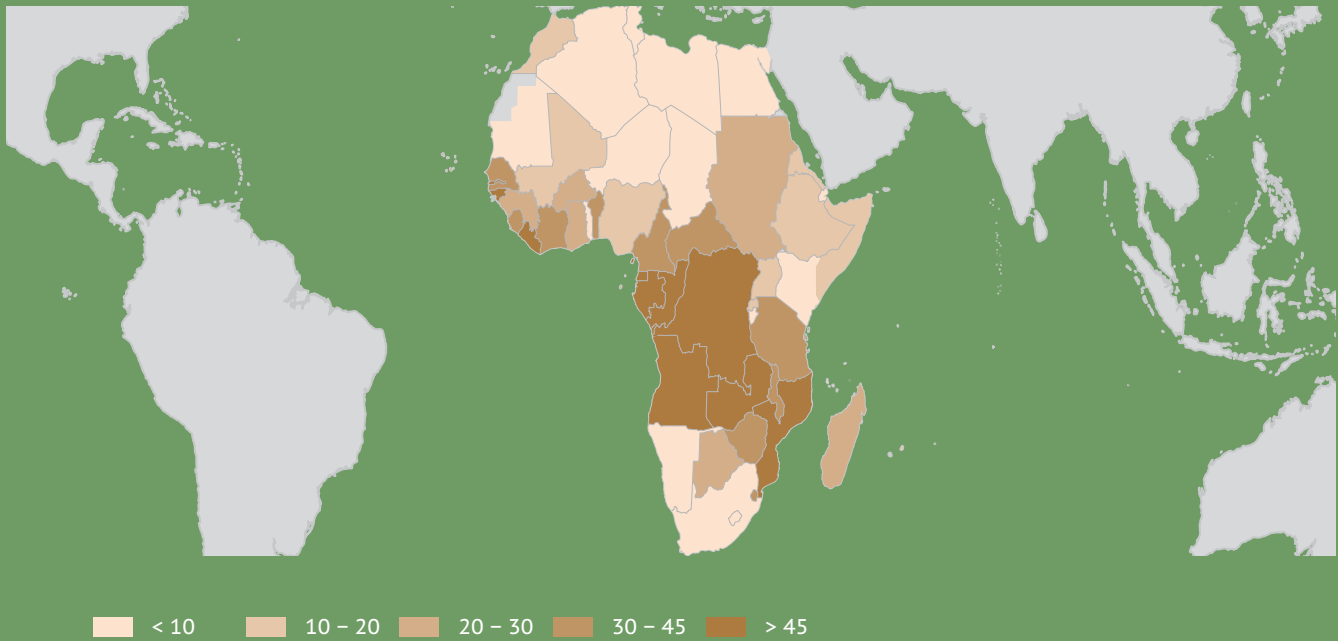
CHART 72: Forest characteristics (2010)



Source: Global Forest Resources Assessment 2010

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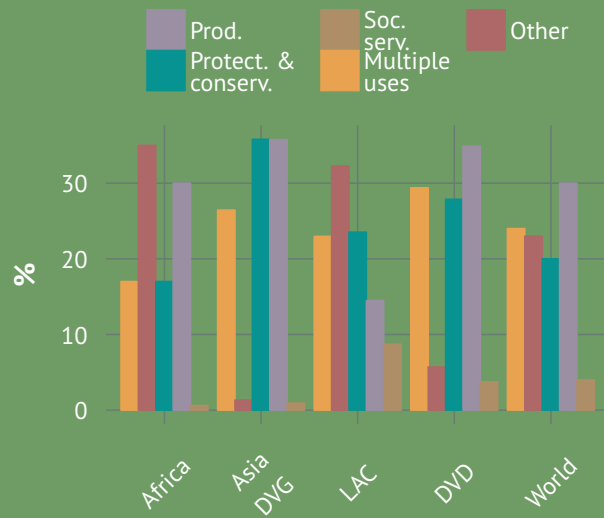
MAP 48: Forest area as share of total land area (% , 2009)



Source: Statistics Division (FAOSTAT)

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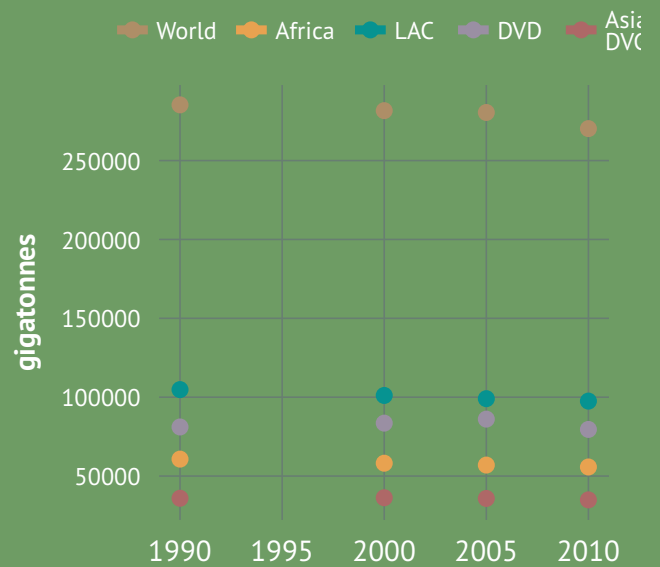
CHART 73: Primary designated functions of forest (2010)



Source: Global Forest Resources Assessment 2010

Metalink: P4.ENV.FAO.FOR.LCF.PFF.PR, p. 246

CHART 74: Carbon stock in living forest biomass (1990-2010)



Source: Global Forest Resources Assessment 2010

Metalink: P4.ENV.FAO.FOR.LCF.CSFO, p. 236

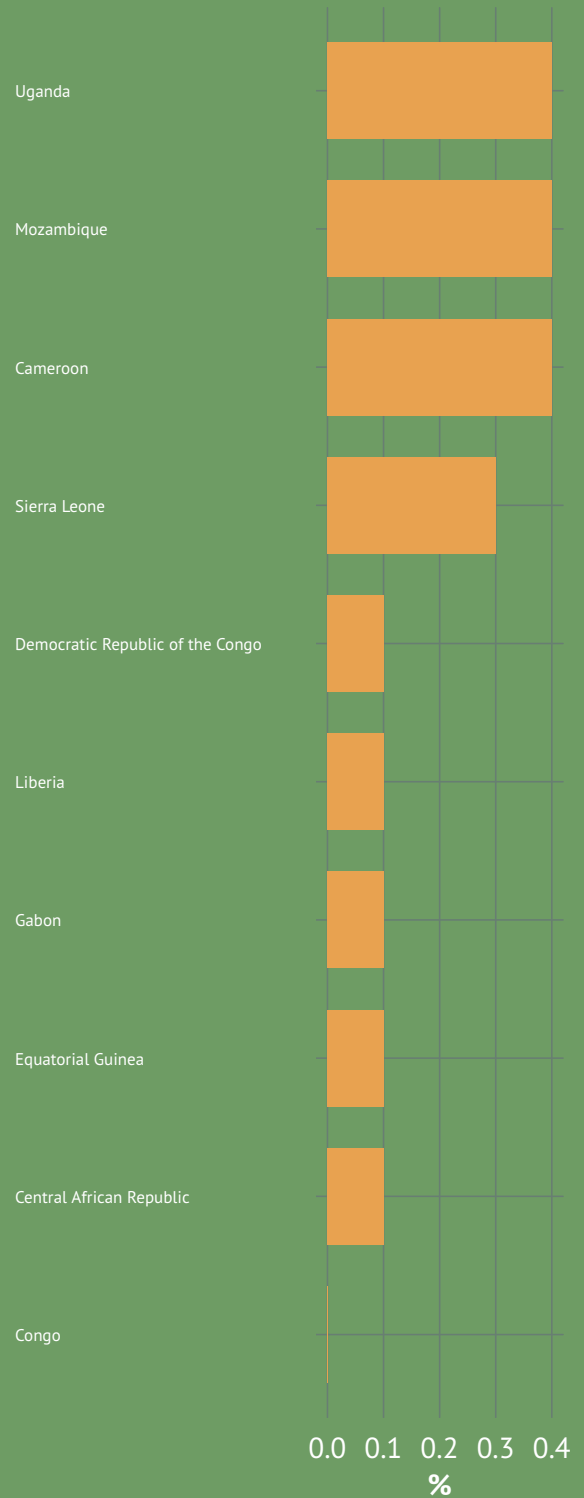
Water

A very small proportion of the planet's water is available for human use. Only around 2.5 percent of the world's water is freshwater. Of this 2.5 percent, more than two-thirds is locked away in glaciers, ice caps and permafrost. About 30 percent is groundwater, with the remaining 1.3 percent of the world's total freshwater being surface water in rivers and other forms, such as ice and snow, lakes and swamps.

Global demand for water has risen sharply within the last century. At the beginning of the twentieth century, each person withdrew 360 m³ of water on average per year. By the year 2005 this had risen to 607 m³, while total annual water withdrawal by agriculture, industry and municipalities together rose from 580 000 m³ to 3 941 000 m³ over the same period.

In Africa, the per capita water withdrawal is low in most countries compared with the global figure (<100 m³/person/year). Some countries are distinguished by a higher rate; Egypt, Libya, Madagascar, Sudan and Swaziland have high rates (>750 m³/person/year). Others are characterized by a low level, with less than 40 m³/person/year in 2005 (Benin, Burundi, Central African Republic, Congo, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Lesotho, Rwanda and Uganda). (Map 49)

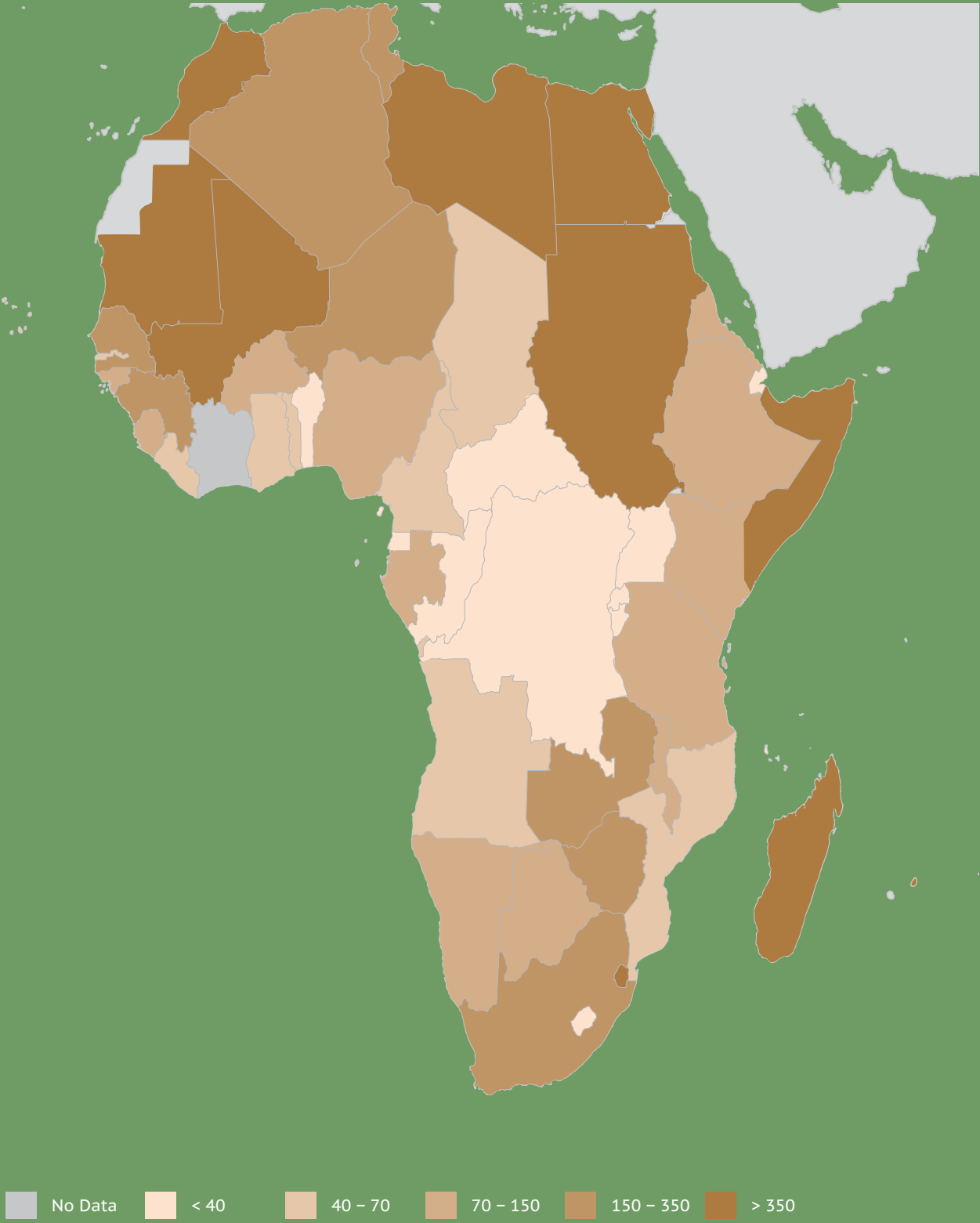
CHART 75: Share of freshwater resources withdrawn, lowest 10 (2005)



Source: Land and Water Division (AQUASTAT)

Metalink: P4.ENV.FAO.NRL.WAT.WWfr, p. 249

MAP 49: Total water withdrawal per capita (m³/inhab/yr, 2005)



Source: Land and Water Division (AQUASTAT)
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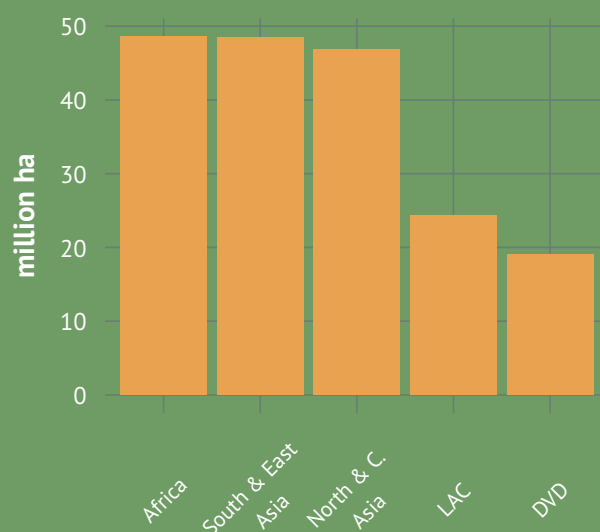
Today, agriculture accounts for about 70 percent of the freshwater withdrawals in the world, mostly through irrigation. This has been crucial for gains in food production. Irrigation reduces drought risk and encourages crop diversification, thus enhancing rural incomes. The pressure of irrigation on water resources can be defined as its share of water withdrawal in total renewable water resources.

While the pressure on water resources from irrigation was estimated at 6.5 percent for the world as a whole in 2005, there was wide variation across countries and regions. In the Near East/North Africa region and Central Asia, for instance, pressure on water resources from irrigation is estimated at 58 percent, while it holds at 52 percent in South Asia. On the other hand, in sub-Saharan Africa it is less than 3 percent. Variations are even wider at the country level. This indicates that some countries are already beyond the critical level, and their condition may even worsen with time.

Regarding the use of freshwater for agriculture, in Africa, countries can be classified as follows: countries whose share of freshwater resources withdrawn by agriculture is the most noticeable, i.e. more than 15 percent in 2005 (all countries of North Africa, Somalia, South Africa, Sudan and Zimbabwe); countries whose share of freshwater resources withdrawn by agriculture is between 5 percent and 15 percent (Burkina Faso, Djibouti, Eritrea, Kenya, Mali, Mauritania, Niger and Senegal); and those for which the rate is less than 0.5 percent (Angola, Benin, Gambia, Lesotho, Liberia, Mozambique, Sierra Leone and almost all the countries of Central Africa). (Map 50)

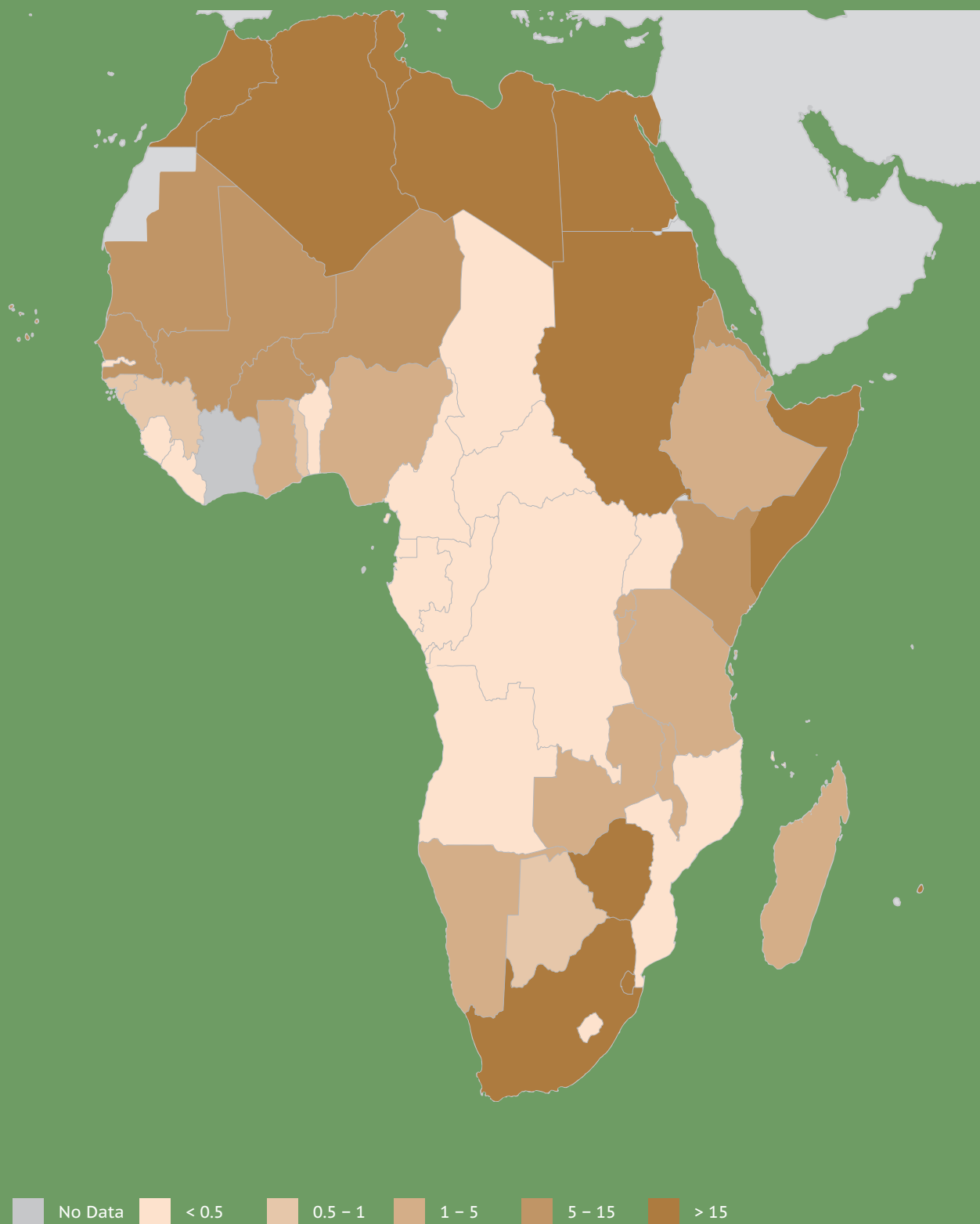
With respect to the issue of saline soils, Africa and South and East Asia have the most of saline soils (almost 50 million ha for each). In contrast, in the LAC region, saline soils represent 25 million ha, while in the DVD, they account for less than 20 million ha. (Chart 76)

CHART 76: Saline soils (2005)



Source: Natural Resources and Environment Department
Metalink: P4.ENV.FAO.POL.SAL, p. 249

MAP 50: Share of freshwater resources withdrawn by agriculture (% , 2005*)



Source: Land and Water Division (AQUASTAT)
Metalink: P4.ENV.FAO.NRL.WAT.WWfrag, p. 249

Pollution from agriculture

While public attention tends to focus on the more perceptible signs of agriculture's impact on the environment, the non-visible or less obvious effects of pollution have the greatest economic costs. Agriculture affects air quality and the atmosphere in four main ways: 1) particulate matter and greenhouse gases (GHGs) from land clearance by fire (mainly rangeland and forest) and the burning of rice residues; 2) methane from rice and livestock production; 3) nitrous oxide from fertilizers and manure; and 4) ammonia from manure and urine. Pollution from agriculture is not confined to atmospheric contaminants; the same pollutant sources – especially runoff from fertilizers, pesticides and animal wastes – can also affect both groundwater and surface water.

Methane is a principal GHG driving climate change. Its warming potential is about 20 times more powerful than carbon dioxide. At present, global methane emissions amount to about 540 million tonnes per annum, increasing at an annual rate of 20-30 million tonnes. Rice production currently contributes about 11 percent of global methane emissions (up to 90 percent of the methane from rice fields is emitted through the rice plant). Depending on the extent and level of intensification, around 15 percent of methane comes from livestock (from enteric fermentation by cattle, sheep and goats and from animal excreta).

With regard to Africa, for each of the countries below, the total methane emissions came to more than 50 000 Kt in 2005: Algeria, Democratic Republic of the Congo, Ethiopia, Nigeria, South Africa and Sudan. In contrast, for countries like Benin, Botswana, Congo, Eritrea and Togo, the total methane emissions were the smallest in Africa in 2005. (Chart 77)

The largest emitters of agricultural methane in Africa, each with over 15 000 Kt in 2005 are: Ethiopia, Nigeria, South Africa, Sudan and Tanzania. However, those that emitted less than 2 000 Kt in 2005 are: Benin, Botswana, Congo, Côte d'Ivoire, Eritrea, Gabon and Libya. (Map 51)

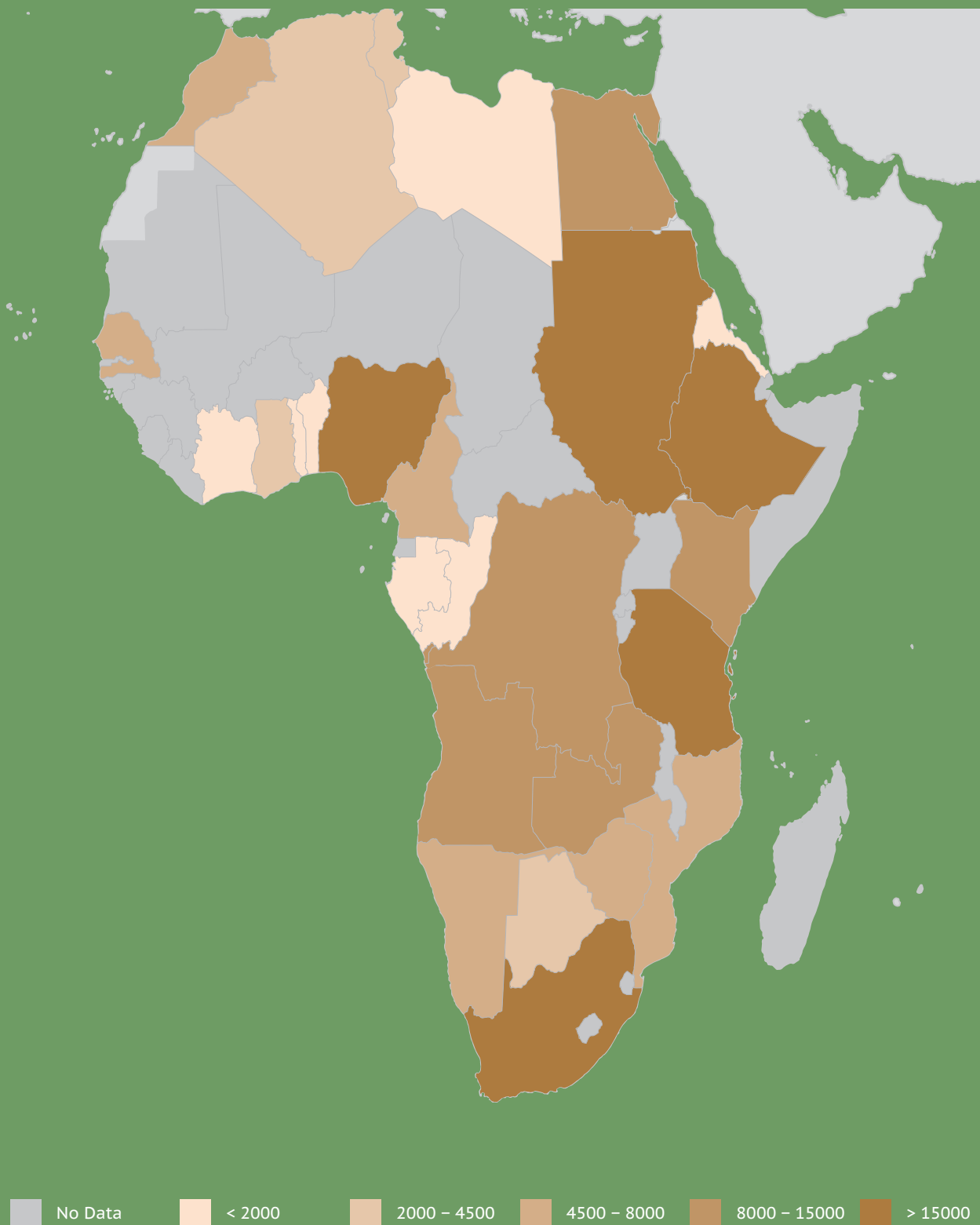
CHART 77: Total methane emissions (2005)



Source: World Bank (WDI)

Metalink: P4.ENV.WBK.WDI.POL.MTHE, p. 243

MAP 51: Agricultural methane emissions (kt of CO₂ equivalent, 2005)



Source: World Bank

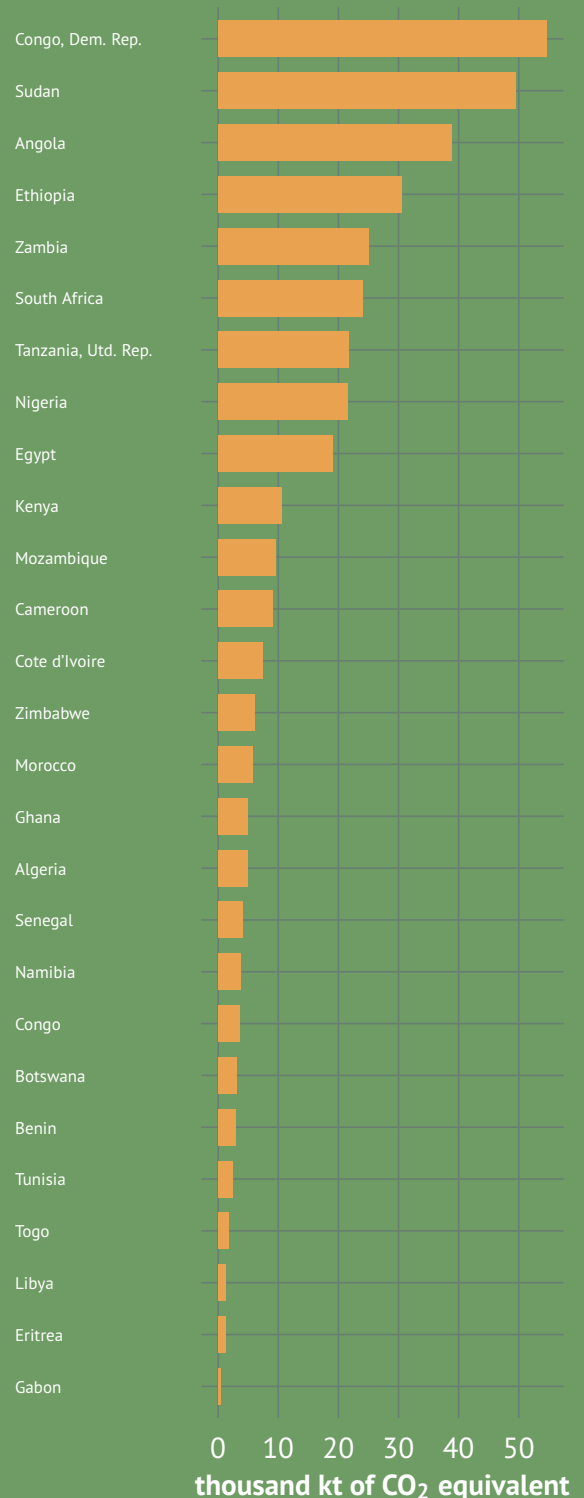
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Nitrous oxide (N₂O) is the other powerful GHG for which agriculture is the dominant human-induced, or anthropogenic, source. Mineral fertilizer use and cattle production are the main contributors. N₂O is generated by natural biogenic processes but output is enhanced by agriculture, through nitrogen fertilizers, the creation of crop residues, animal urine and faeces, and nitrogen leaching and runoff. N₂O formation is sensitive to climate, soil type, tillage practices and type and placement of fertilizer. It is also linked to the release of nitric oxide and ammonia, which contribute to acid rain and the acidification of soils and drainage systems. Nitrogen fertilizer, a major source of nitrous oxide emissions, is used very inefficiently in many developing countries.

In Africa for instance, the highest emissions of nitrous oxide (over 30 000 Kt in 2005) have been recorded in Angola, Democratic Republic of the Congo, Ethiopia and Sudan. They are followed by Egypt, Nigeria, South Africa, Tanzania and Zambia, with more than 20 000 Kt each, and the other countries, which have less than 10 000 Kt. Some countries, like Eritrea, Gabon and Libya, have a smaller, almost insignificant, quantity of nitrous oxide emissions. (Chart 78)

Agriculture is the predominant source of ammonia emissions, which are nearly fourfold greater than natural emissions. Livestock production, particularly of cattle, accounts for about 44 percent of ammonia emissions, while mineral fertilizers account for 17 percent and biomass burning and crop residues account for about 11 percent of the global total. Volatilization rates from mineral fertilizers in developing countries are about four times greater than in developed countries because of higher temperatures and lower quality fertilizers. Ammonia emissions are potentially even more acidifying than emissions of sulphur dioxide and nitrogen oxides. Extensive leaching of nitrates from soils into surface water and groundwater, which was originally an issue in almost all industrial countries, is now becoming a problem in many developing countries. It poses a risk to human health and contributes to eutrophication of rivers, lakes and coastal waters.

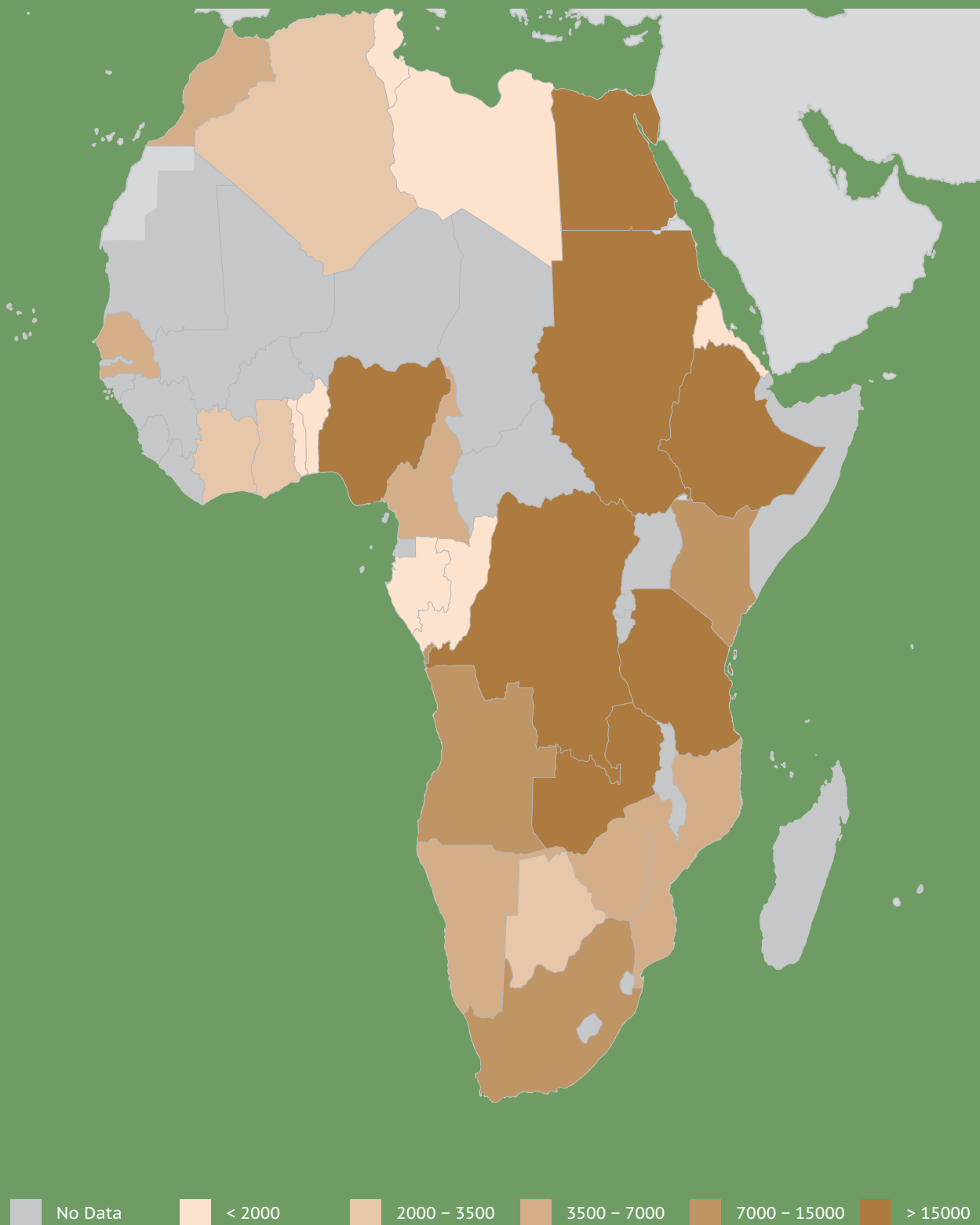
CHART 78: Total nitrous oxide emissions (2005)



Source: World Bank (WDI)

Metalink: P4.ENV.WBK.WDI.POL.NOE, p. 243

MAP 52: Agricultural nitrous oxide emissions (kt of CO₂ equivalent, 2005)



Source: World Bank

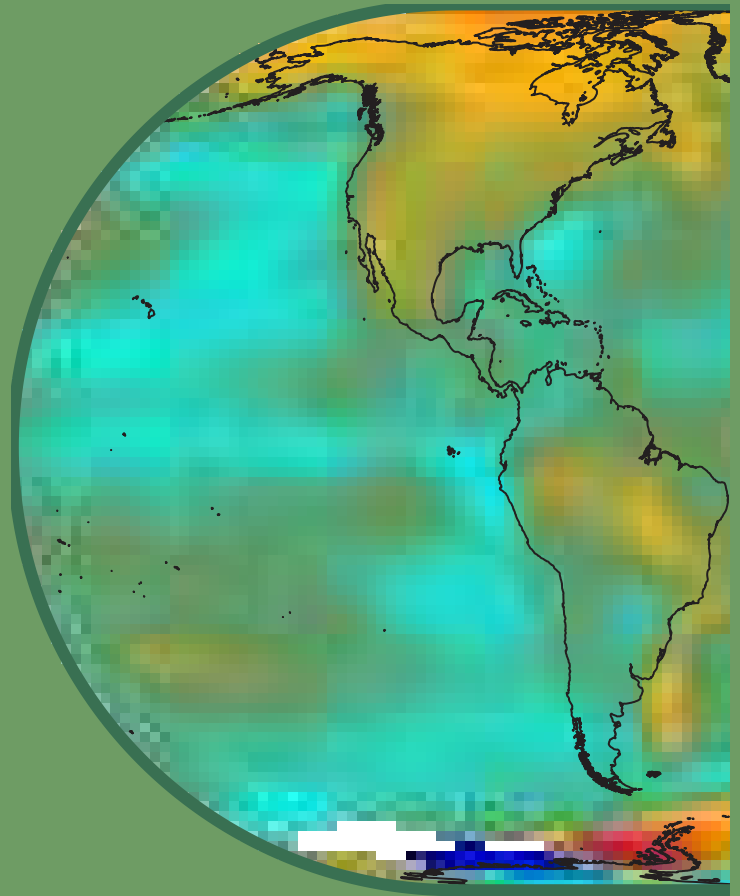
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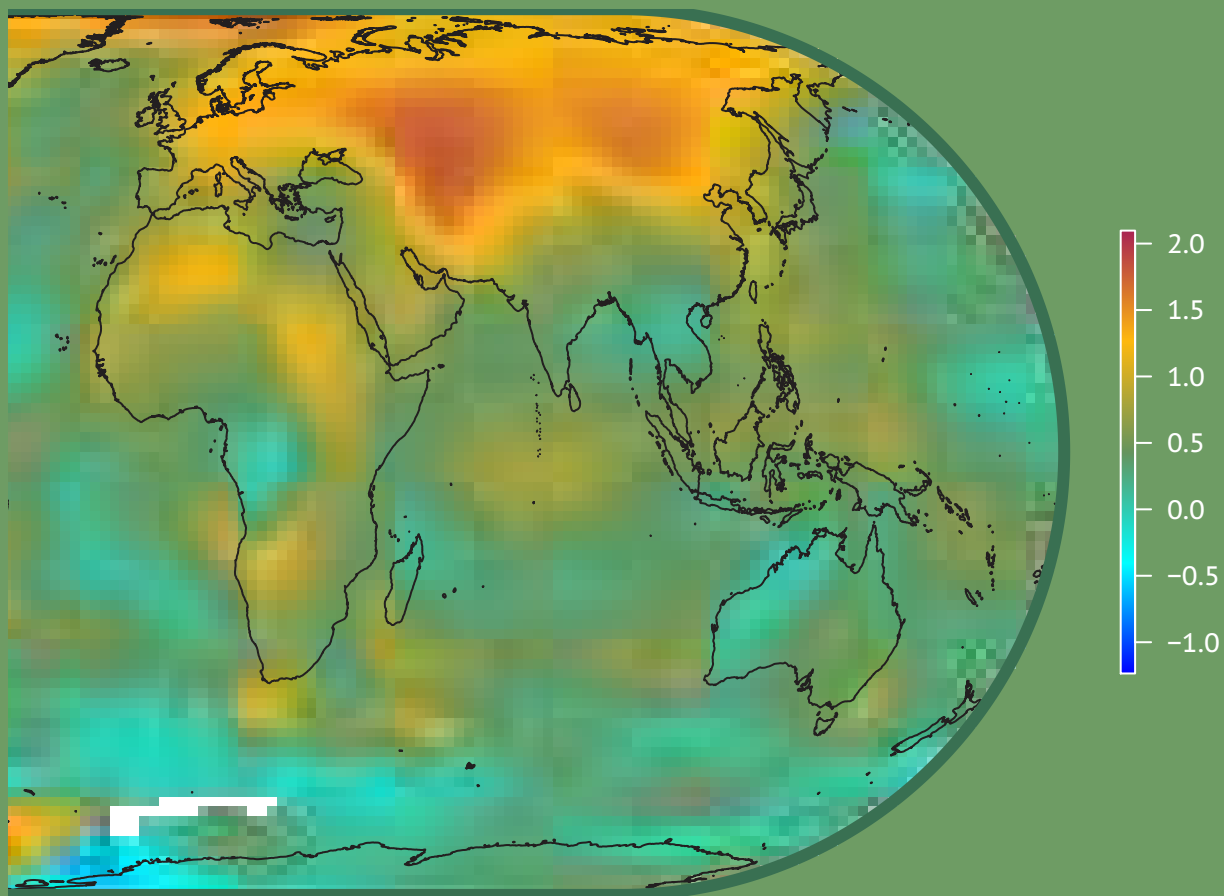
Climate change

In Africa, low levels of food security and economic development combine with high levels of climate risk, while large populations, heavily exploited natural resources and climate risk threaten South Asia's poor. Climate change will have a significant impact on agriculture by increasing water demand, limiting crop productivity and reducing water availability in areas where irrigation is most needed or has a comparative advantage.

Global atmospheric temperature is predicted to rise by approximately 4°C by 2080, consistent with a doubling of atmospheric CO₂ concentration. Mean temperatures are expected to rise at a faster rate in the upper latitudes, with slower rates in equatorial regions. Mean temperature rise at altitude is expected to be higher than at sea level, resulting in intensification of convective precipitation and acceleration of snowmelt and glacier retreat. In response to global warming, the hydrological cycle is expected to accelerate, as rising temperatures increase the rate of evaporation from land and sea. Thus rainfall is predicted to rise in the tropics and higher latitudes, but decrease in the already dry semi-arid to arid mid-latitudes and in the interior of large continents. Water-scarce areas of the world will generally become drier and hotter. Both rainfall and temperatures are predicted to become more variable, with a consequent higher incidence of droughts and floods, sometimes in the same place.

MAP 53: Temperature map

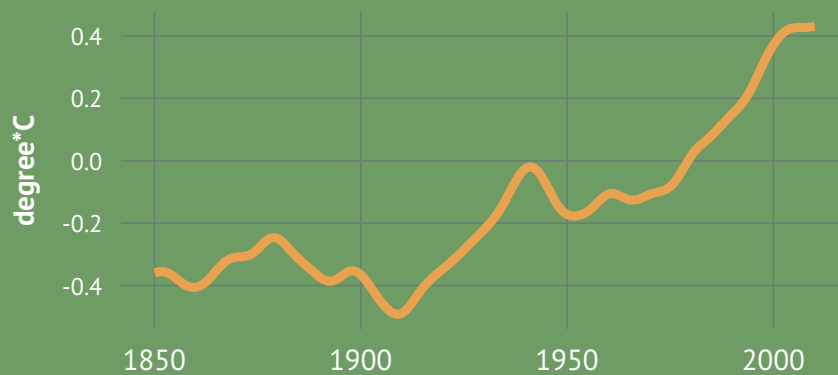




Global surface temperature (°C, Temperature difference of 2000–08 versus 1940–80)

Source: IPCC Data Distribution Centre
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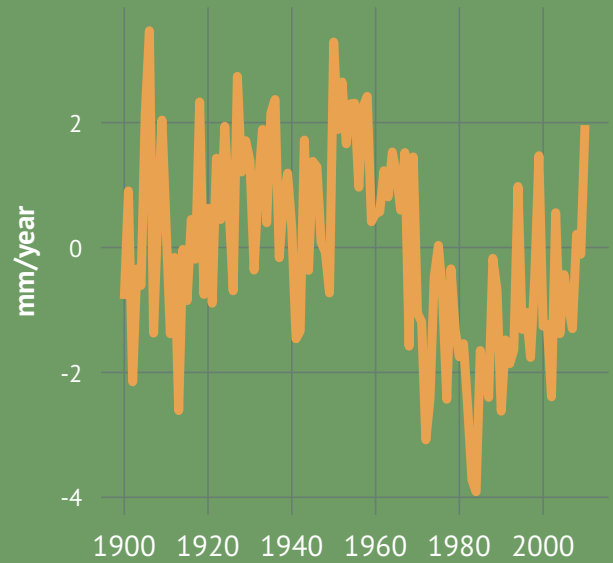
CHART 79: Global surface temperature (1850-2010)



Source: IPCC Data Distribution Centre
 Metalink: P4.ENV.IPCC.CC.GST, p. 240

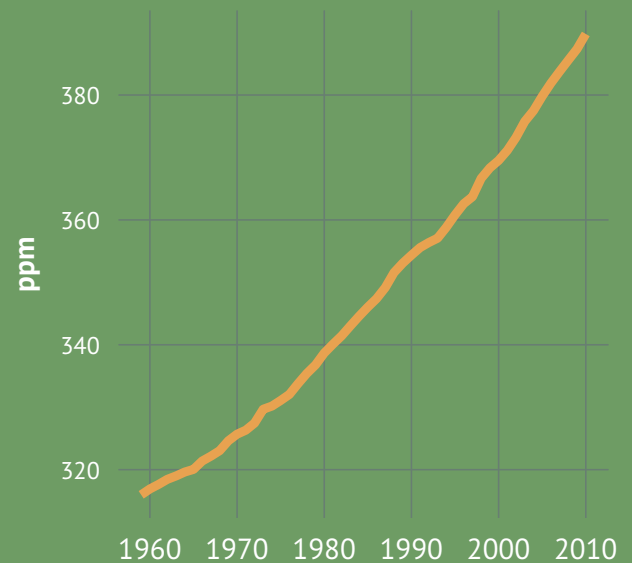
For countries like Congo, Cameroon, Democratic Republic of the Congo, Gabon, Guinea, Guinea Bissau, Liberia, Madagascar and Sierra Leone, the average precipitation levels (in 2000-2010) were higher than 1 500 mm per year (the highest level of precipitation in Africa). Countries like Mali, Mauritania, Namibia, Niger, Somalia, and most of the countries of North Africa except Morocco, have recorded low levels of precipitation (less than 300 mm per year on average). (Map 54)

CHART 80: Sahel rainfall anomalies (1900-2010)



Source: JISAO data (<http://jisao.washington.edu/data/sahel/>)

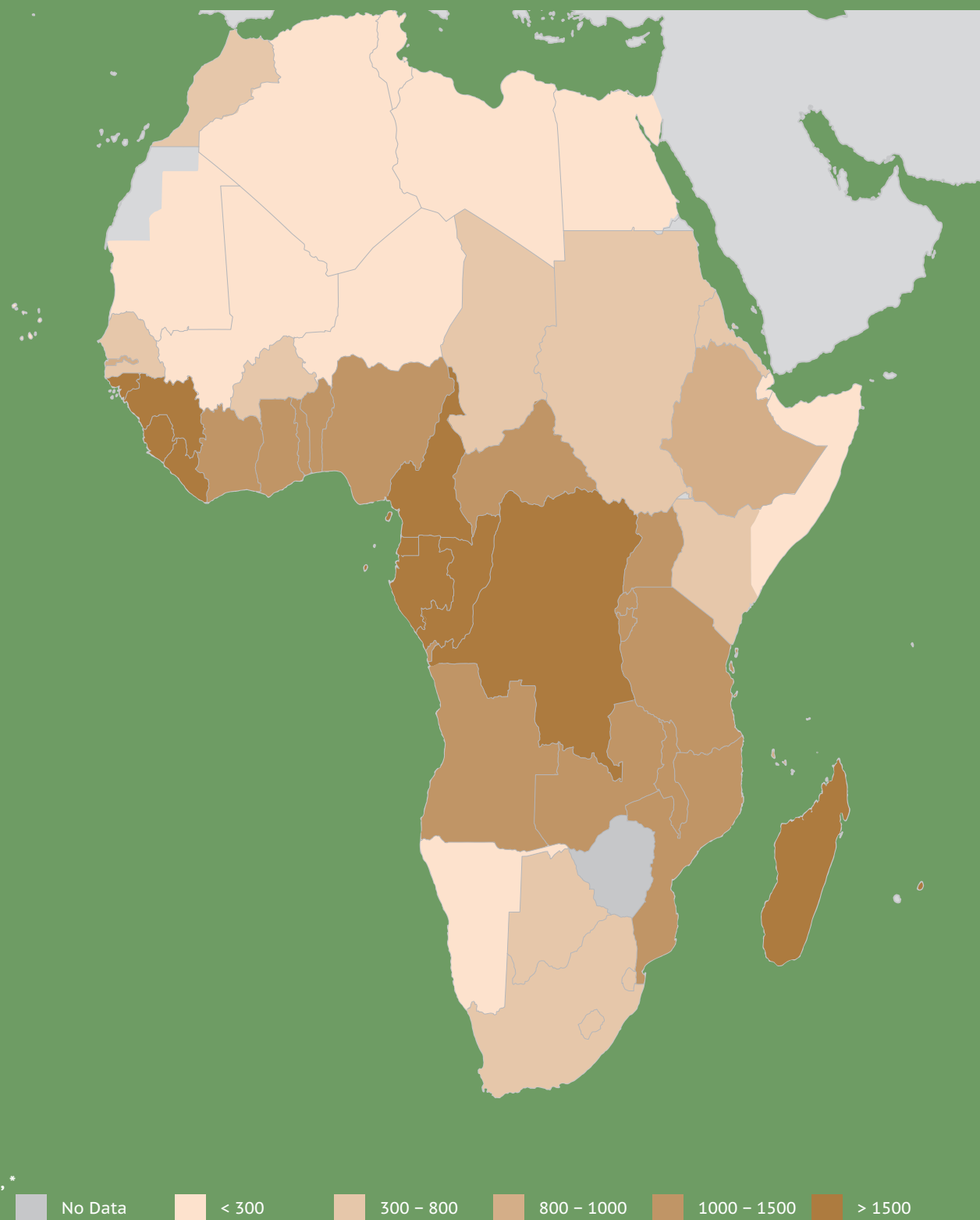
Metalink: P4.ENVJISAO.CLIM.SAHEL, p. 249

CHART 81: CO₂ concentration (1959-2010)

Source: Global Climate Change: key indicators

Metalink: P4.ENV.IPCC.CC.CO2, p. 237

MAP 54: Average precipitation in depth (mm/year, 2000-2010*)



Source: Land and Water Division (AQUASTAT)
Metalink: P4.ENV.FAO.ACQ.CLIM.APD, p. 236

Biodiversity and conservation

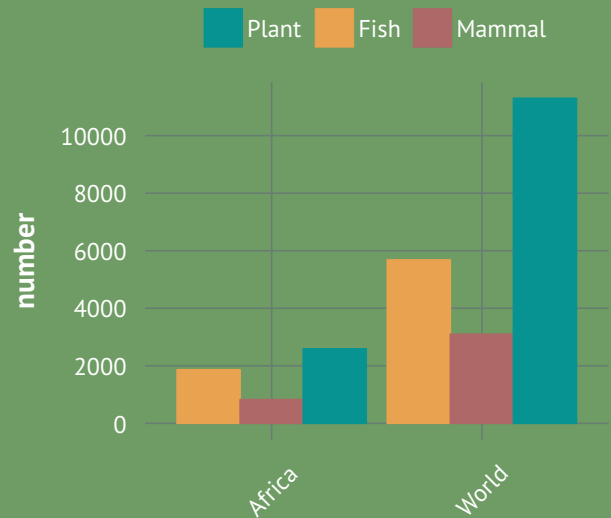
Biodiversity underpins the functioning of the ecosystems on which humankind depends for food and fresh water, health and protection from natural disasters. Such diversity is the result of thousands of years of farmers' and breeders' activities, land and forest utilization, and fishery activities, combined with millions of years of natural selection. Most of the human population lives in areas where food production and nature coexist.

Agriculture's main impacts on biodiversity are diverse. For instance, the expansion of agriculture can lead to losses of natural wildlife habitat and reduction in the area of natural forests, wetlands and so on, with an attendant loss of species. It also causes a general decline in species richness in forests, pastures and field margins, and the reduction of wild genetic resources related to domesticated crops and livestock. Moreover, the observed reduction of micro-organisms that help sustain food and agricultural production is another way that agriculture's life support system has been damaged.

Globally, in 2010, more than 10 000 species of plants, about 6 000 species of fish and over 3 000 species of mammals were threatened. In Africa, in the same year, over 2 000 species of plants, about 1 000 species of mammals and nearly 2 000 species of fish were threatened. (Chart 82)

Some countries have more natural areas protected relative to total surface area (as of 2000-2009). Those which had more than 15 percent protected natural areas include Benin, Botswana, Central African Republic, Congo, Ethiopia, Gabon, Guinea Bissau, Malawi, Mozambique, Senegal, Tanzania, Zambia and Zimbabwe. However, other countries had only a very few protected natural areas (less than 3 percent of the total area). These include Gambia, Lesotho, Libya, Mali, Mauritania, Morocco, Sierra Leone, Somalia and Tunisia. (Map 55)

CHART 82: Species threatened (2010)



Source: World Bank (WDI)

Metalink: P4.ENVWBK.WDI.BIOD.PST, p. 245

MAP 55: Nationally protected areas, share of total area (% , 2000-2010*)



Source: World Bank (WDI)
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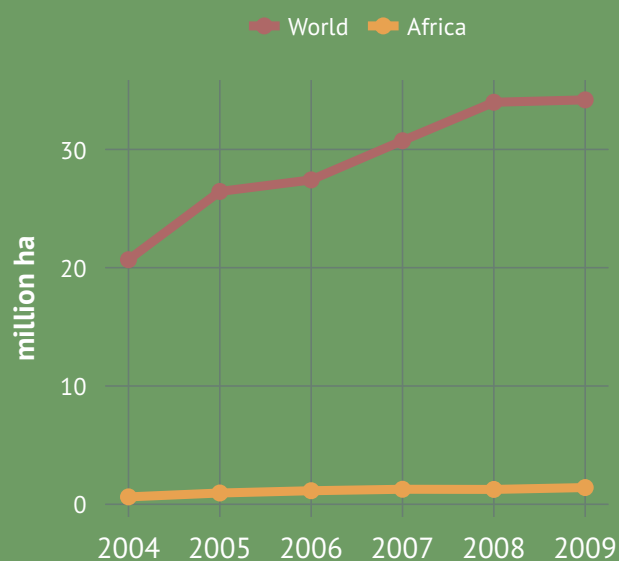
Organic farming

Organic agriculture is a production management system that aims to promote and enhance ecosystem health, including biological cycles and soil biological activity. It is based on minimizing the use of external inputs, and represents a deliberate attempt to make the best use of local natural resources, using methods that minimize pollution of air, soil and water. Organic agriculture comprises a range of land, crop and animal management procedures, circumscribed by a set of rules and limits usually enforced by inspection and certification mechanisms. Synthetic pesticides, mineral fertilizers, synthetic preservatives, pharmaceuticals, genetically modified organisms (GMOs), sewage sludge and irradiation are prohibited in all organic standards.

At the global level, world organic agricultural areas grew from 20 million ha in 2004 to about 34 million ha in 2009. In Africa, these areas were very small, less than 2 million ha in 2009, and they have grown only very slightly. (Chart 83)

Growth rates of land under organic management in Western Europe, Latin America and the United States of America have been impressive, despite low-base beginnings and the reclassification of land. Between 1995 and 2010, the combined area of organic land tripled to 38 million ha.

CHART 83: World organic agriculture area (2004-2009)



Source: Statistics Division (FAOSTAT)

Metalink: P4.ENV.FAO.BIO.ORGAN.HA, p. 244

MAP 56: Organic agriculture area (thousand ha, 2005-2009*)



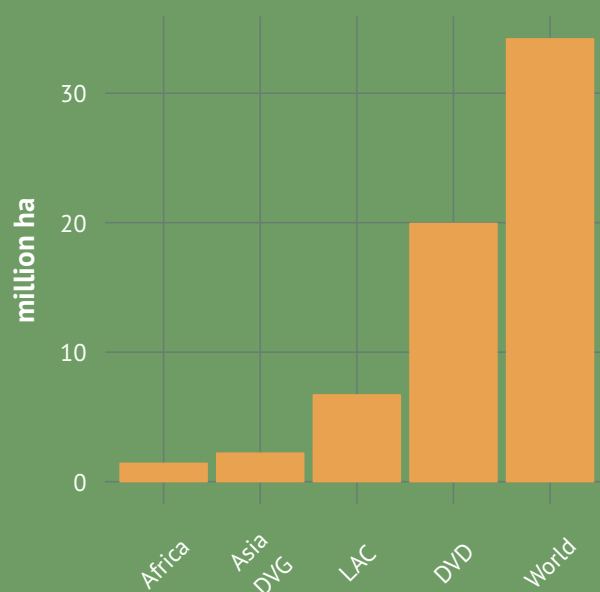
Source: Statistics Division (FAOSTAT)
 Metalink: P4.ENV.FAO.BIO.ORGAN.HA, p. 244

The distribution of organic agriculture areas worldwide (as of 2009) was led by the DVD, which operated 20 million ha in 2009, followed by LAC regions with about 7.5 million ha, Asia DVG (roughly 3 million) and finally Africa (roughly 2 million ha). (Chart 84)

In Africa, countries like Egypt, Sierra Leone, South Africa, Sudan, Tanzania and Tunisia had the largest organic agriculture areas (more than 50 000 ha in 2005-2009), compared with other African countries. These same areas in Burkina Faso, Côte d'Ivoire and Mali were between 10 000 ha and 50 000 ha. In Democratic Republic of the Congo, Madagascar, Morocco, Nigeria and Zambia, organic agriculture areas were between 5 000 and 10 000 ha. In contrast, these areas were much smaller, i.e. less than one ha in Algeria, Burundi, Cameroon, Lesotho and Niger.

The share of organic agriculture area in the total area was more than 0.3 percent for Egypt, Guinea Bissau, Sierra Leone, Sudan, Uganda and Tunisia. It represented between 0.08 percent and 0.3 percent in Benin, Burkina Faso, Côte d'Ivoire, Rwanda and Tanzania, and it was even smaller (less than 0.02 ha) in Burundi, Kenya, Lesotho and Malawi. (Map 57)

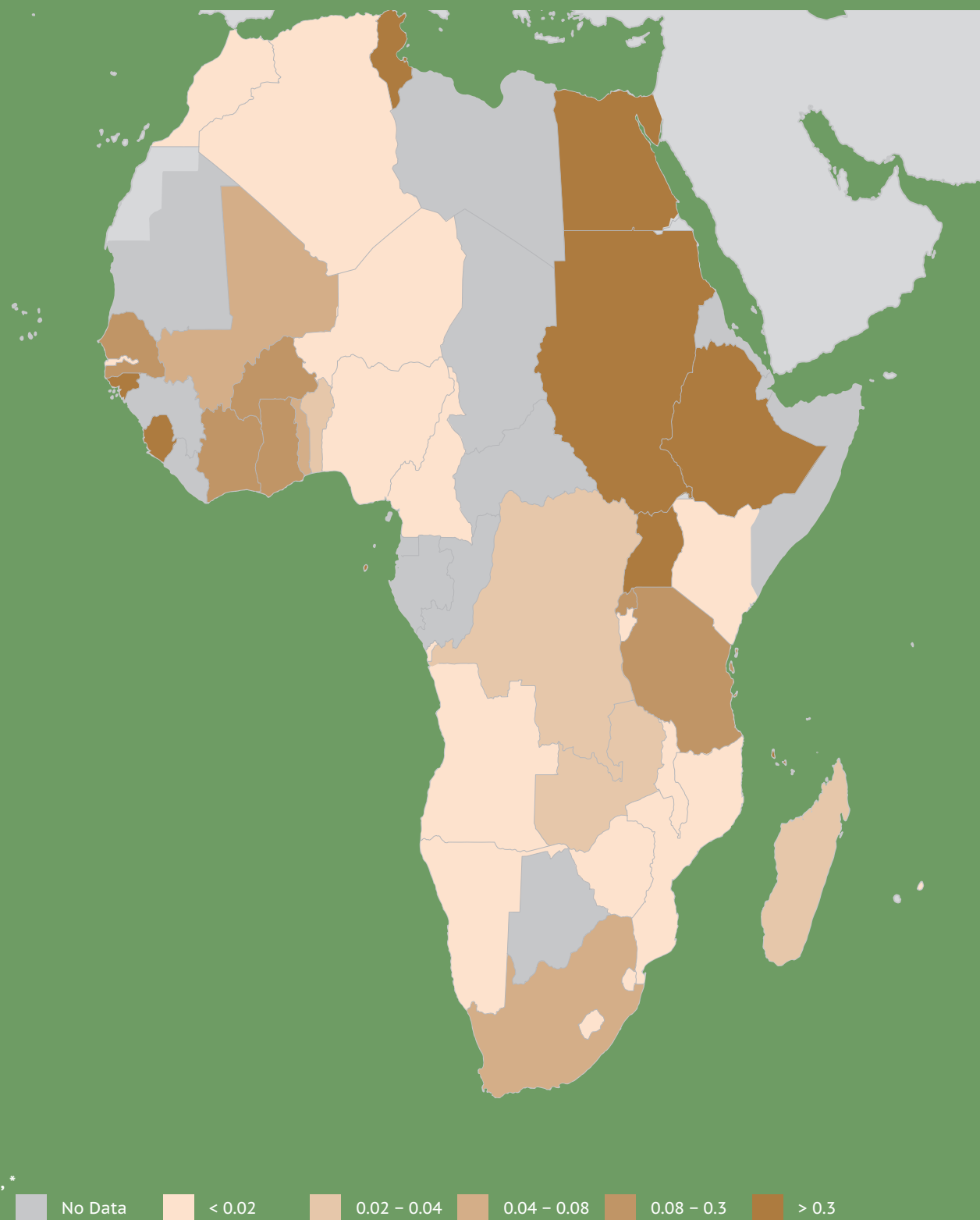
CHART 84: Regional organic agriculture area (2009)



Source: Statistics Division (FAOSTAT)

Metalink: P4.ENV.FAO.BIO.ORGAN.HA, p. 244

MAP 57: Organic agriculture, share of total area (% , 2005-2009*)



Source: Statistics Division (FAOSTAT)

Metalink: P4.ENV.FAO.BIO.ORGAN.HA.SHL, p. 244

Genetically modified crops

The benefits of agricultural biotechnology arise from its potentially large contribution to productivity gains and quality improvements. Productivity gains can encompass essentially all factors of agricultural production: higher returns on land and livestock, labour and capital, or simply lower input requirements per unit of outputs. This may mean higher crop and livestock yields, lower pesticide and fertilizer applications, less demanding production techniques, higher product quality, better storage and easier processing, or enhanced methods to monitor the health of plants and animals.

Higher productivity also holds the key in the fight against rural poverty. Biotechnology promises to boost productivity and thus raise rural incomes, much in the same way that the green revolution did in large parts of Asia during the 1960s to 1980s. But there are also numerous risks and uncertainties associated with these new technologies that have given rise to a host of concerns and questions, especially regarding GMOs.

In accordance with the precautionary approach contained in Principle 15 of the Rio Declaration on Environment and Development, the objective of the Cartagena Protocol on Biosafety is to contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking into account risks to human health as well, and specifically focusing on transboundary movements.¹¹

The Biosafety Protocol makes clear that products from new technologies must be based on the precautionary principle and allows developing countries to balance public health against economic benefits. It will, for example, let countries prohibit imports of a living modified organism if they feel there is not enough scientific evidence that the product is safe, and it requires exporters to label shipments containing genetically altered commodities such as corn or cotton. The required number of 50 instruments of ratification/accession/approval/acceptance by countries was reached in May 2003. In accordance with the provisions of its Article 37, the Protocol entered into force on 11 September 2003.

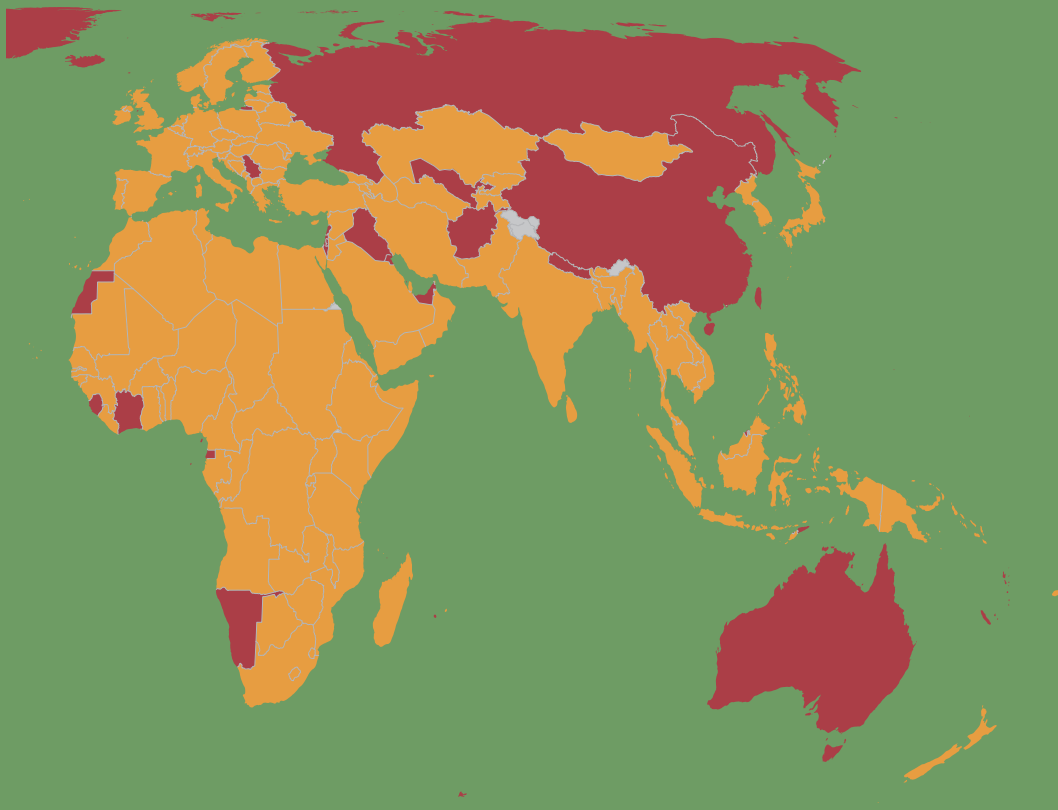
In Africa, almost all countries have ratified the Cartagena Protocol on Biosafety except for Côte d'Ivoire, Equatorial Guinea, Sierra Leone and Western Sahara. Worldwide, major countries, such as Australia, Canada, China, the Russian Federation and the United States of America, have not yet ratified it. (Map 58)

Nevertheless, areas in the world under GMO crops in 2010 came to about 150 million ha but they were a small, almost negligible, number in Africa. (Chart 58)

MAP 58: Countries that have ratified the Cartagena Protocol on Biosafety (number, 2010)



¹¹United Nations, Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Text and Annexes, Article 1. 2000. Montreal. <http://www.biodiv.org/biosafety/protocol.asp?lg=2>.



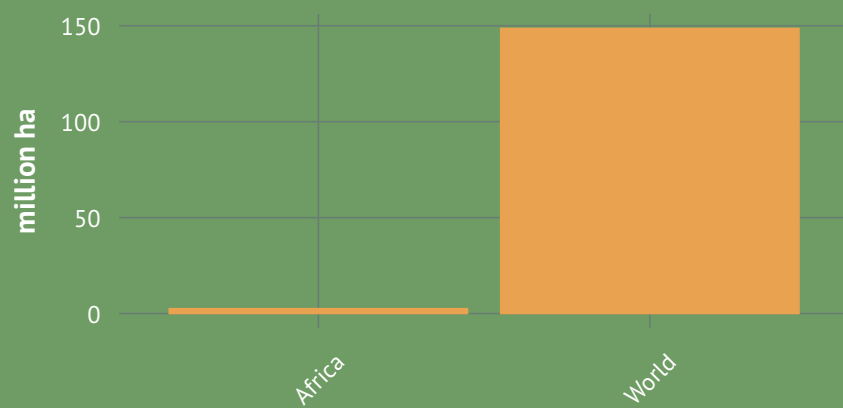
Countries that have ratified the Cartagena Protocol on Biosafety (number, 2011)

No Data
 No
 Yes

Source: www.cbd.int

Metalink: P4.ENV.CBD.GMO.CBP, p. 244

CHART 85: Area under GM crops (2010)



Source: Clive James, Global Status of Commercialized Biotech and GM Crops: 2010

Metalink: P4.ENV.ISAAA.BIO.GM.HA, p. 236

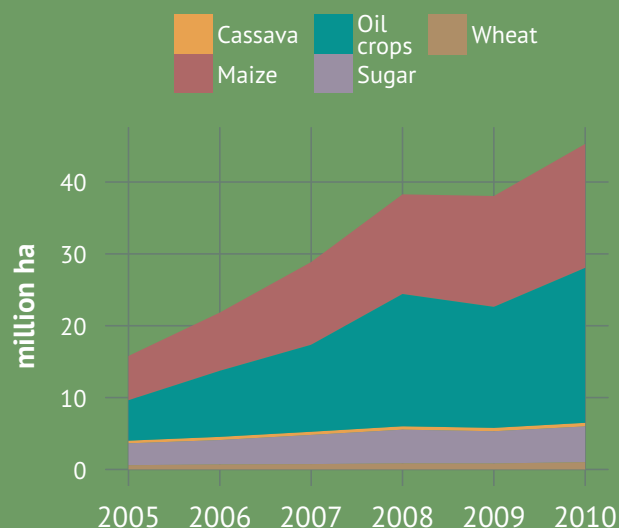
Agriculture and the bio-based economy

Agriculture is playing an increasingly important role in the bio-based economy, providing feedstock for the production of liquid fuels, chemicals and advanced materials such as natural fibre composites for industry. The emergence of green industries provides expanded opportunities for the rural sector beyond traditional forestry and the supply of wood. Biological science has the ability both to make incremental efficiency improvements and to bring about radical change in a wide range of sectors. This includes use of enzymes, fermentation and organisms for processes and products in the energy, chemical, pharmaceutical, food, textile, and pulp and paper industries. Above all, biological and material science working with agriculture has the greatest potential in the energy, natural fibre composite and starch sectors. Much of this potential is already being realized, especially considering the rapid growth of the biofuel sector. Currently, ethanol is being produced from easily fermentable agricultural feedstock such as sugar cane, sugar beet, cereal grains and cassava. Biodiesel is produced from vegetable oil (typically rapeseed, soybean and palm oil) using a process of chemical modification. The expansion of liquid biofuel has been rapid – doubling from 68.3 million tonnes in 2006 to 130 million tonnes in 2011 – and is currently drawing upon feedstock from over 45 million ha of land. The emerging bio-based economy is based on energy efficiency, renewable feed stocks in polymer products, industrial processes that reduce carbon emissions and recyclable materials. Natural fibres exemplify these attributes.

Oil crops have occupied a large portion of areas under bioenergy crops (in 2005-2010). They were followed by corn and sugar cane, while wheat and cassava were grown as bioenergy crops on only a very small area. (Chart 86)

In Africa, Democratic Republic of the Congo, Ethiopia, Kenya, Nigeria, South Africa and Tanzania were the largest producers of biofuel, with over 13 500 Kt in 2005-2009. Angola, Cote d'Ivoire, Mozambique and Sudan produced between 6 500 and 13 500 Kt. Production was between 1 500 and 6 500 Kt in Benin, Central African Republic, Egypt, Ghana, Togo, Tunisia, Zambia and Zimbabwe. Some countries, such as Algeria, Botswana, Libya, Morocco and Namibia, had a very low biofuel production, below 500 Kt. (Map 59)

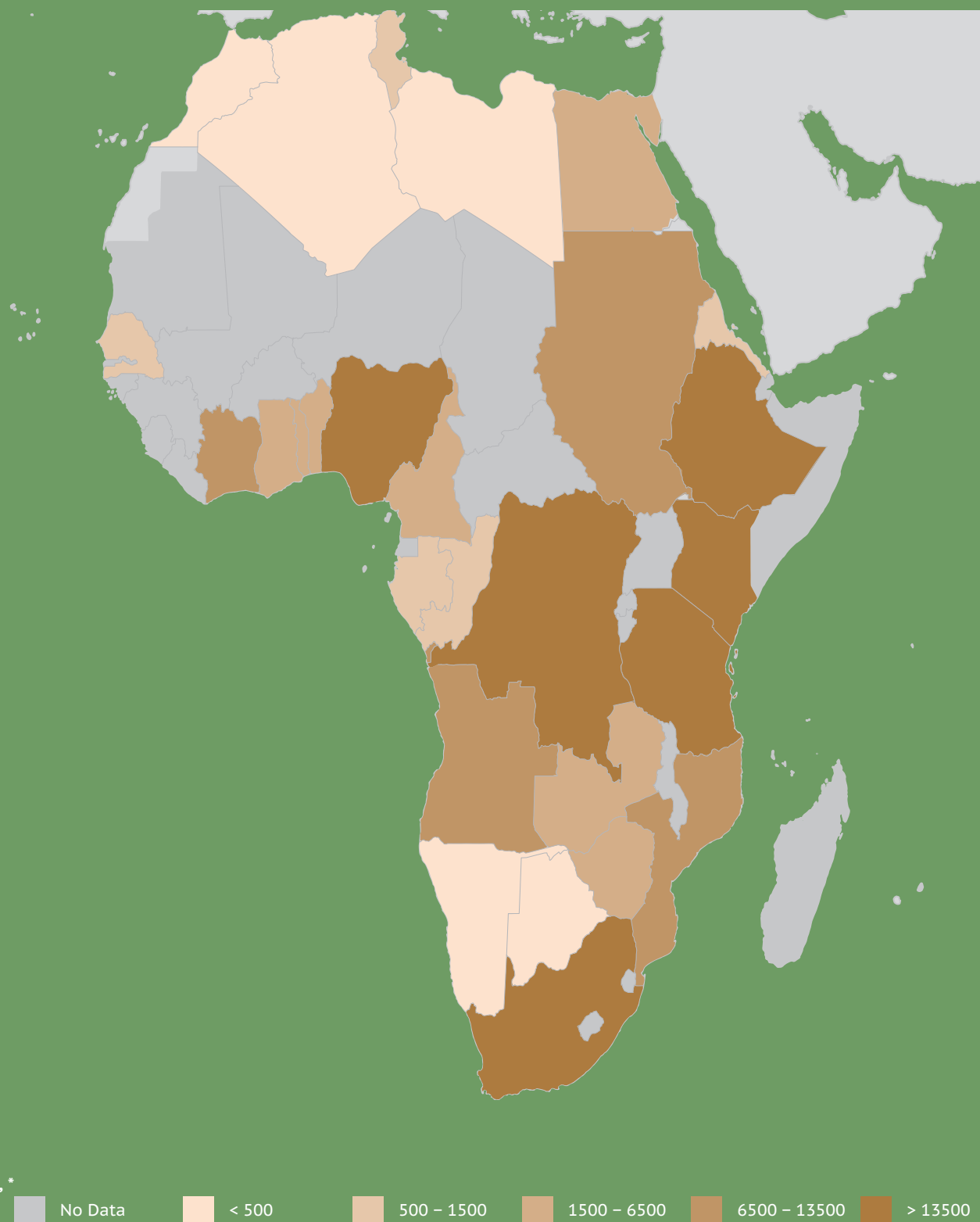
CHART 86: Area under bioenergy crops (2005-2010)



Source: Based on IEA biofuel production data

Metalink: P4.ENV.FAO.BIO.BF.HA, p. 236

MAP 59: Biofuel production (kt, 2005-2009*)



Source: Energy Balances of OECD Countries and Energy Balances of Non-OECD Countries, 2011 editions
 Metalink: P4.ENV.IEA.BIO.BF.QP, p. 236

Worldwide biofuel production has been growing significantly; it rose from 850 000 Kt in 1990 to about 1 150 000 Kt in 2009. (Chart 87)

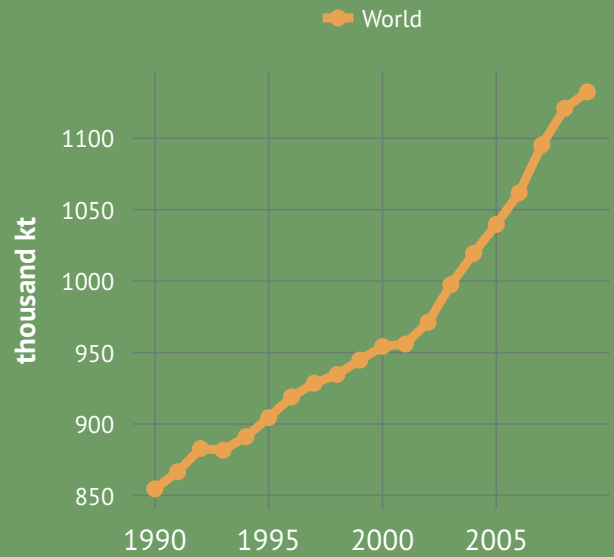
At the global level, natural fibre production was at less than 25 million tonnes in 1990; it reached 30 million tonnes in 2003, remained constant between 2003 and 2007, then dropped to about 25 million tonnes in 2010. In contrast, in Africa, natural fibre production has been very low as it was only 2 million tonnes in 1990 and remained almost constant until 2010. (Chart 88)

Regarding the share of food “crop” usage in the world bio-based economy, products can be classified as follows: palm oil fruit, sugar cane, maize, coconut, soybean and cassava. For food and feed, wheat was the most widely used, followed by soybean, cassava, maize, sugar cane, palm oil fruit and coconut. With respect to material production, coconut was the most used, followed by wood, palm oil fruit, maize, cassava, sugar cane, soybean, and wheat. (Chart 89)

In 2010, Democratic Republic of the Congo, Mozambique and Zimbabwe have produced more global jute and hard fibre (each producing more than 3 500 000 tonnes) than the other African countries, Egypt and Sudan each produced between 1 100 000 and 3 500 000 tonnes. Production from Mali was between 750 000 and 1 100 000 tonnes, more than Angola, Ethiopia and Nigeria, which produced between 500 000 and 750 000 tonnes each. However, Cameroon, Central African Republic, Madagascar, and South Africa recorded the smallest production of jute and hard fibre (less than 500 000 tonnes in 2010). (Map 60)

Ensuring the sustainable development of bio sectors becomes challenging when one tries to capture potential benefits for rural development, climate and non-food security. For instance, the rapid growth and sheer scale of the biofuel sector has potentially negative implications for all four dimensions of food security (availability, access, stability and utilization) as it may result in increased competition for land and water resources, leading to higher and less stable food prices. At the same time, however, it may create new employment and income-generating opportunities, especially in countries with abundant marginal land and climates conducive to feedstock production, where such land would be too costly to bring into food cultivation. Such opportunities exist, for example, in countries of Latin America, Southeast Asia and sub-Saharan Africa.

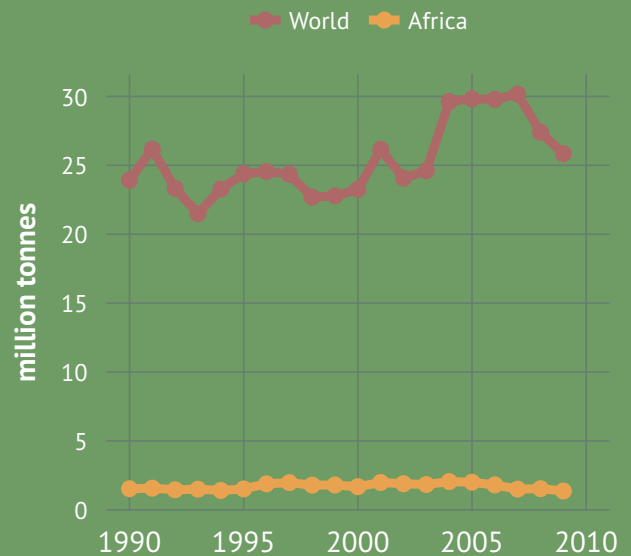
CHART 87: Biofuel production (1990-2009)



Source: Energy Balances of OECD Countries and Energy Balances of Non-OECD Countries, 2011 editions

Metalink: P4.ENV.IEA.BIO.BF.QP, p. 236

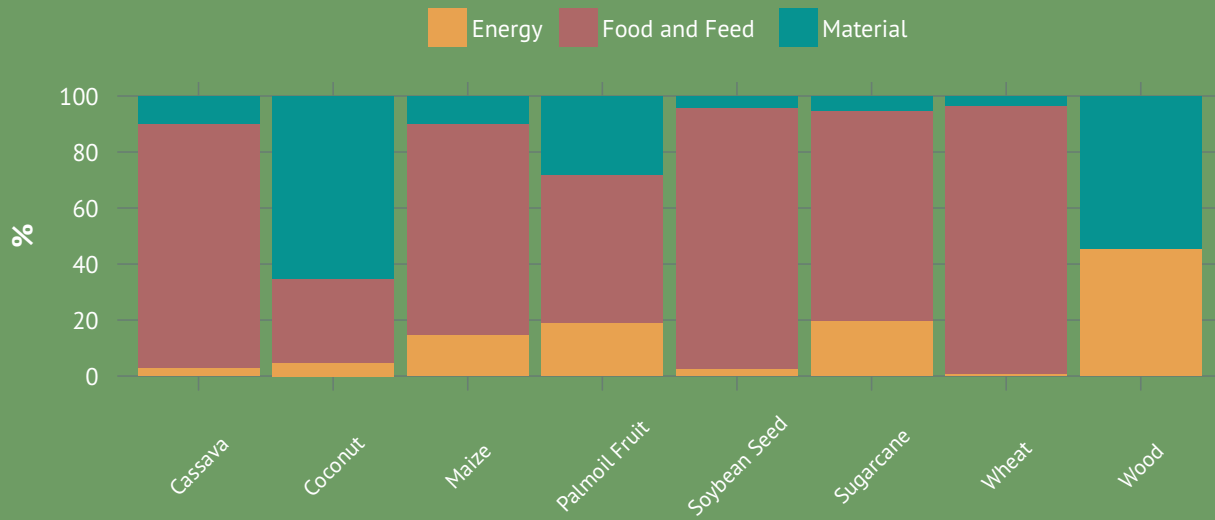
CHART 88: Natural fibre production (1990-2010)



Source: Statistics Division

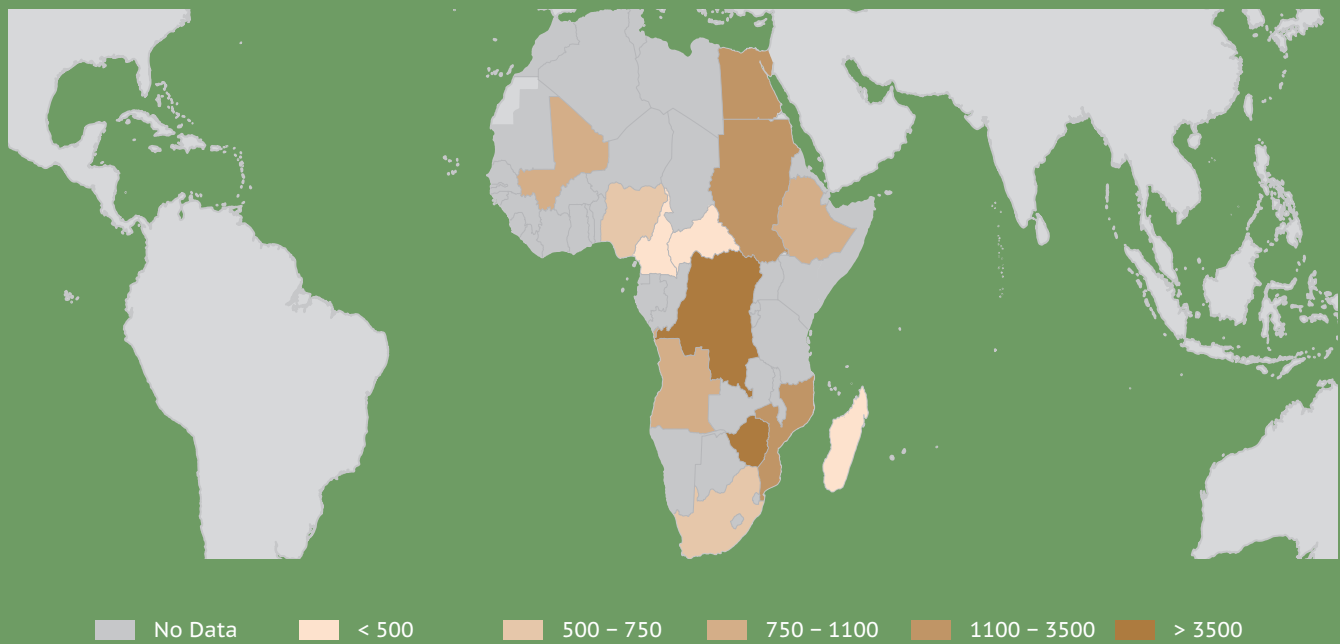
Metalink: P4.ENV.FAO.BIO.NF.QP, p. 243

CHART 89: Share of food crop usage in world bio-based economy (2009)



Source: Statistics Division
 Metalink: P4.ENV.FAO.BIO.FD.FDSTK, p. 249

MAP 60: Jute and jute-like fibre production (thousand tonnes, 2010)



Source: Statistics Division (FAOSTAT)
 Metalink: P4.ENV.FAO.BIO.CT.QP, p. 242

TABLE 44: Land indicators

	Forest area		Carbon content in topsoil	Carbon stock	Land use change		
	p.a. growth	total	weight	in living forest biomass	p.a. growth		
	%	thousand ha	%	giga-tonnes	cropland %	pasture %	forest %
	1990-2009	2009	2005-2010	2010	1990-2009	1990-2009	1990-2009
NORTH AFRICA	0.2	7 849	0.6	315	0.3	0.2	0.2
Algeria	-0.6	1 501	0.8	70	0.5	0.3	-0.6
Egypt	2.4	69	0.4	7	1.8		2.4
Libyan Arab Jamahiriya	0.0	217	0.5	6	-0.3	0.1	0.0
Morocco	0.1	5 121	0.8	223	-0.2	0.0	0.1
Tunisia	2.0	940	0.7	9	0.1	1.3	2.0
WEST AFRICA	-1.1	74 361	0.8	6 082	1.5	0.2	-1.1
Benin	-1.2	4 611	0.8	263	2.5	0.0	-1.2
Burkina Faso	-1.0	5 709	0.8	292	2.7	0.0	-1.0
Cape Verde	2.0	85	1.2	5	2.0	0.0	2.0
Cote d'Ivoire	0.1	10 403	0.9	1 842	1.0	0.1	0.1
Gambia	0.4	478	0.9	32	4.2	-2.8	0.4
Ghana	-2.0	5 055	0.9	381	2.9	-0.1	-2.0
Guinea	-0.5	6 580	1.3	619	0.3	-0.0	-0.5
Guinea-Bissau	-0.5	2 032	1.1	96	2.2	0.0	-0.5
Liberia	-0.6	4 359	1.1	585	1.1	0.0	-0.6
Mali	-0.6	12 569	0.7	282	6.0	0.8	-0.6
Mauritania	-2.7	247	0.9	7	-0.1	0.0	-2.7
Niger	-2.4	1 216	0.6	37	1.6	1.4	-2.4
Nigeria	-3.1	9 451	0.8	1 085	0.8	-0.3	-3.1
Senegal	-0.5	8 513	0.8	340	1.2	-0.1	-0.5
Sierra Leone	-0.7	2 746	1.2	216	3.6	-0.0	-0.7
Togo	-4.1	307	0.9		0.4	0.0	-4.1
CENTRAL AFRICA	-0.3	254 909	1.1	32 186	0.2	0.0	-0.3
Cameroon	-1.0	20 136	1.1	2 696	0.1	0.0	-1.0
Central African Republic	-0.1	22 635	0.9	2 861	0.1	0.3	-0.1
Chad	-0.6	11 604	0.9	635	1.4	0.0	-0.6
Congo	-0.1	22 423	1.5	3 438	0.4	0.0	-0.1
Democratic Republic of the Congo	-0.2	154 446	1.1	19 639	-0.3	0.0	-0.2
Equatorial Guinea	-0.7	1 638	1.0	203	-0.7	0.0	-0.7
Gabon	0.0	22 000	1.0	2 710	0.2	-0.0	0.0
Sao Tome and Principe	0.0	27	2.8	4	1.6	0.0	0.0
EAST AFRICA	-0.7	131 790	1.3	4 666	1.5	-0.2	-0.7
Burundi	-2.6	174	1.0	17	-0.2	0.4	-2.6
Djibouti	0.0	6	0.5		3.7	1.4	0.0
Eritrea		1 536	0.6				
Ethiopia		12 437	0.9	219			
Kenya	-0.3	3 478	0.9	476	0.5	0.0	-0.3
Rwanda	1.5	425	8.3	39	1.5	-2.6	1.5
Somalia	-1.0	6 824	0.5	394	-0.1	0.0	-1.0
Sudan (former)	-0.5	70 003	0.7	1 393	2.4	0.3	-0.5
Uganda	-2.3	3 076	1.1	109	1.4	0.0	-2.3
United Republic of Tanzania	-1.1	33 831	1.6	2 019	0.7	0.0	-1.1
SOUTHERN AFRICA	-0.5	208 178	0.9	12 448	0.9	0.2	-0.5
Angola	-0.2	58 605	0.6	4 385	1.2	-0.0	-0.2
Botswana	-0.9	11 588	0.6	646	-2.7	0.0	-0.9
Comoros	-6.4	3	1.6		1.1	0.0	-6.4
Lesotho	0.5	44	1.3	2	0.3	0.0	0.5
Madagascar	-0.4	12 610	1.1	1 626	0.3	0.6	-0.4
Malawi	-0.9	3 270	1.3	144	2.4	0.0	-0.9
Mauritius	-0.5	35	1.9	2	-0.8	0.0	-0.5
Mozambique	-0.5	39 233	0.8	1 692	1.9	0.0	-0.5
Namibia	-0.9	7 364	0.3	210	1.1	0.0	-0.9
Seychelles	0.0	41		4	-1.5		0.0

TABLE 44: Land indicators (continued)

	Forest area		Carbon content in topsoil	Carbon stock	Land use change		
	p.a. growth	total	weight	in living forest biomass	p.a. growth		
	%	thousand ha	%	giga-tonnes	cropland %	pasture %	forest %
	1990-2009	2009	2005-2010	2010	1990-2009	1990-2009	1990-2009
South Africa	0.0	9 241	0.6	807	0.4	0.1	0.0
Swaziland	0.9	559	1.7	22	-0.1	-0.1	0.9
Zambia	-0.3	49 635	1.6	2 416	0.8	0.6	-0.3
Zimbabwe	-1.7	15 951	0.5	492	1.9	1.0	-1.7
AFRICA	-0.5	677 898	0.9	55 736	1.1	0.1	-0.5
ECOWAS	-1.1	74 114	0.8	6 075	1.5	0.3	-1.1
SADC	-0.4	396 453	1.0	34 106	0.7	0.1	-0.4
COMESA	-0.4	327 971	1.0	26 611	1.4	-0.1	-0.4
UMA	0.0	8 026	0.8	315	0.1	0.2	0.0
ECCAS	-0.2	313 688	1.0	36 588	0.3	0.0	-0.2
IGAD	-0.6	97 360	0.9	2 591	1.7	-0.3	-0.6
CEMAC	-0.3	100 436	1.0	12 543	0.5	0.0	-0.3
UEMOA	-0.6	45 361	0.8	3 152	2.0	0.7	-0.6
CEN-SAD	-0.6	196 741	0.8	12 085	1.4	0.3	-0.6
ASIA Developing	0.3	565 849	1.3	34 883	0.4	1.6	0.3
LAC	-0.5	959 538	1.9	97 511	0.6	0.2	-0.5
DEVELOPED REGIONS	0.0	1 801 480	2.5	79 558	-0.8	-1.6	0.0
WORLD	-0.2	4 038 719	1.5	270 265	0.0	0.0	-0.2

TABLE 45: Forestry indicators

	Forest characteristics			Primary designated functions of forest				
	primary forest	other naturally regenerated forest	planted forest	production	protection and conservation	social services	multiple use	other or unknown
	thousand ha	thousand ha	thousand ha	%	%	%	%	%
	2010	2010	2010	2010	2010	2010	2010	2010
NORTH AFRICA	0	5 914	2 002	14.1	48.5	0.0	37.5	0.0
Algeria	0	1 088	404	35.0	65.0		0.0	0.0
Egypt	0	0	70	2.0	52.0	0.0	46.0	0.0
Libyan Arab Jamahiriya	0	0	217	0.0	100.0	0.0	0.0	0.0
Morocco	0	4 510	621	21.0	12.0	0.0	67.0	0.0
Tunisia	0	316	690	24.0	45.0	0.0	32.0	0.0
WEST AFRICA	3 145	67 817	2 515	31.5	24.3	0.1	12.6	32.0
Benin	0	4 542	19	31.0	28.0		40.0	0.0
Burkina Faso	0	5 540	109	11.0	6.0		84.0	0.0
Cape Verde	0	0	85	80.0	20.0	0.0	0.0	0.0
Cote d'Ivoire	625	9 441	337	89.0	11.0		0.0	0.0
Gambia	1	478	1		21.0	0.0	5.0	73.0
Ghana	395	4 285	260	23.0	8.0	1.0	0.0	68.0
Guinea	63	6 388	93	2.0	55.0	0.0	7.0	36.0
Guinea-Bissau	0	2 021	1	29.0	67.0	3.0	0.0	0.0
Liberia	175	4 146	8	25.0	4.0	0.0	0.0	71.0
Mali	0	11 960	530	47.0	38.0	0.0	15.0	0.0
Mauritania	0	221	21	0.0	27.0	0.0	73.0	0.0
Niger	220	836	148	1.0		0.0	81.0	0.0
Nigeria	0	8 659	382	29.0	28.0	0.0	0.0	43.0
Senegal	1 553	6 456	464	60.0			22.0	0.0
Sierra Leone	113	2 599	15	9.0	7.0	0.0	0.0	84.0
Togo	0	245	42	68.0	32.0	0.0	0.0	0.0
CENTRAL AFRICA				30.6	15.9	0.2	5.4	47.9
Cameroon				73.0	20.0	1.0	6.0	
Central African Republic	2 370	20 233	2	21.0	1.0	0.0	78.0	0.0
Chad	184	11 324	17	90.0		0.0	0.0	0.0
Congo	7 436	14 900	75	88.0	4.0	0.0	7.0	0.0
Democratic Republic of the Congo			59	5.0	17.0	0.0	0.0	78.0
Equatorial Guinea	0	1 626		5.0	36.0	3.0	53.0	3.0
Gabon	14 334	7 636	30	45.0	18.0		36.0	0.0
Sao Tome and Principe	11	16	0					
EAST AFRICA	14 691	108 783	7 546	26.7	22.6	1.8	36.5	13.5
Burundi	40	63	69	9.0	0.0	0.0	0.0	91.0
Djibouti	0	6	0	0.0	0.0	0.0	100.0	0.0
Eritrea	0	1 498	34	2.0	6.0	0.0	1.0	91.0
Ethiopia	0	11 785	511	4.0	0.0	0.0	96.0	0.0
Kenya	654	2 616	197	6.0	94.0	0.0	0.0	0.0
Rwanda	7	55	373	74.0	12.0	0.0	14.0	0.0
Somalia	0	6 744	3		0.0	0.0	100.0	0.0
Sudan (former)	13 990	49 891	6 068	50.0	20.0	0.0	0.0	30.0
Uganda	0	2 937	51	12.0	36.0	15.0	0.0	37.0
United Republic of Tanzania	0	33 188	240	71.0	6.0	0.0	24.0	0.0
SOUTHERN AFRICA	5 720	198 158	3 074	26.1	18.5	0.1	36.3	19.0
Angola	0	58 352	128	4.0	3.0	0.0	0.0	93.0
Botswana	0	11 351	0	0.0	0.0	0.0	100.0	0.0
Comoros	0	2	1	33.0	67.0	0.0	0.0	0.0
Lesotho	0	34	10	24.0	0.0	0.0	76.0	0.0
Madagascar	3 036	9 102	415	26.0	39.0	0.0	34.0	0.0
Malawi	934	1 938	365	37.0	23.0	0.0	0.0	40.0
Mauritius	0	20	15	30.0	61.0	7.0	2.0	0.0
Mozambique	0	38 960	62	67.0	33.0	0.0	0.0	0.0
Namibia	0	7 290		0.0	9.0	0.0	22.0	69.0
Seychelles	2	34	5	1.0	21.0	0.0	14.0	64.0
South Africa	947	6 531	1 763	19.0	10.0	0.0	71.0	0.0

TABLE 45: Forestry indicators (continued)

	Forest characteristics			Primary designated functions of forest				
	primary forest	other naturally regenerated forest	planted forest	production	protection and conservation	social services	multiple use	other or unknown
	thousand ha	thousand ha	thousand ha	%	%	%	%	%
	2010	2010	2010	2010	2010	2010	2010	2010
Swaziland	0	423	140	25.0	0.0	0.0	0.0	75.0
Zambia	0	49 406	62	24.0	22.0	0.0	17.0	37.0
Zimbabwe	801	14 715	108	10.0	8.0	0.0	82.0	0.0
AFRICA	47 947	437 154	15 326	30.0	17.0	0.6	17.0	35.0
ECOWAS	3 145	67 596	2 494	31.8	24.2	0.1	11.9	32.4
SADC	5 720	231 344	3 372	28.4	15.9	0.0	25.6	30.1
COMESA	19 464	144 491	8 760	13.8	30.9	1.2	31.3	22.8
UMA	0	6 135	1 953	24.7	44.3	0.0	31.1	0.0
ECCAS				25.5	13.1	0.2	4.3	57.0
IGAD	14 644	75 477	6 864	15.3	27.4	2.3	41.6	14.0
CEMAC	24 324	55 719		71.4	14.4	0.5	14.0	0.1
UEMOA	2 398	41 041	1 650	43.3	21.4	0.1	36.5	0.0
CEN-SAD	20 354	164 973	10 350	26.2	33.9	0.1	20.8	21.0
ASIA Developing	104 944	348 573	112 332	35.8	35.8	0.9	26.4	1.3
LAC	663 075	226 028	18 154	14.5	23.5	8.7	23.0	32.3
DEVELOPED REGIONS	514 589	1 165 193	117 804	34.9	27.9	3.7	29.4	5.7
WORLD	1 358 851	2 181 405	263 970	30.0	20.0	4.0	24.0	23.0

TABLE 46: Water withdrawal

	Water withdrawal by sector			Water withdrawal		% of freshwater res withdr	% of freshwater resources withdrawn
	share of total			total	per capita	total	by agriculture
	agricultural	industrial	municipal	million m ³ /yr	m ³ /inhab/yr	%	%
	%	%	%	2005	2005	2005	2005
NORTH AFRICA							
Algeria	61	15	24	6 472	197	55.5	33.8
Egypt	86	6	8	68 300	920	119.2	103.0
Libyan Arab Jamahiriya	83	3	14	4 326	750	721.0	597.3
Morocco	84	4	12	13 115	432	45.2	38.0
Tunisia	82	4	14	2 640	266	57.5	47.1
WEST AFRICA							
Benin	45	23	32	130	17	0.5	0.2
Burkina Faso	63	2	35	1 087	77	8.7	5.5
Cape Verde	91	2	7	22	47	7.3	6.7
Cote d'Ivoire							
Gambia	24	26	50	82	55	1.0	0.3
Ghana	66	10	24	982	45	1.8	1.2
Guinea	83	3	14	1 641	182	0.7	0.6
Guinea-Bissau	76	6	18	190	139	0.6	0.5
Liberia	31	28	41	194	61	0.1	0.0
Mali	90	1	9	6 546	497	6.5	5.9
Mauritania	92	2	6	1 627	534	14.3	13.2
Niger	86	1	12	2 407	185	7.2	6.2
Nigeria	48	17	35	11 574	83	4.0	1.9
Senegal	93	3	4	2 221	204	5.7	5.3
Sierra Leone	68	11	21	517	100	0.3	0.2
Togo	34	3	63	223	41	1.5	0.5
CENTRAL AFRICA							
Cameroon	68	10	23	1 081	62	0.4	0.3
Central African Republic	1	16	82	73	18	0.1	0.0
Chad	48	26	26	397	41	0.9	0.4
Congo	4	26	69	92	26	0.0	0.0
Democratic Republic of the Congo	15	20	64	722	13	0.1	0.0
Equatorial Guinea	5	15	80	20	33	0.1	0.0
Gabon	34	9	57	149	109	0.1	0.0
Sao Tome and Principe							
EAST AFRICA							
Burundi	79	5	15	280	39	2.2	1.8
Djibouti	16	0	84	19	24	6.3	1.0
Eritrea	95	0	5	582	130	9.2	8.7
Ethiopia	86	1	13	6 065	82	5.0	4.3
Kenya	79	4	17	2 735	77	8.9	7.1
Rwanda	55	11	33	184	20	1.9	1.1
Somalia	99	0	0	3 298	394	22.4	22.3
Sudan (former)	96	1	3	37 513	977	58.2	55.9
Uganda	43	16	41	279	10	0.4	0.2
United Republic of Tanzania	89	0	10	5 184	134	5.4	4.8
SOUTHERN AFRICA							
Angola	27	31	42	769	47	0.5	0.1
Botswana	39	19	42	207	110	1.7	0.7
Comoros	47	5	48	10	16	0.8	0.4
Lesotho	20	40	40	50	24	1.7	0.3
Madagascar	97	1	2	14 768	826	4.4	4.2
Malawi	81	5	14	1 001	78	5.8	4.7
Mauritius	68	3	30	725	577	26.4	17.8
Mozambique	65	4	30	840	40	0.4	0.3

TABLE 46: Water withdrawal (continued)

	Water withdrawal by sector			Water withdrawal		% of freshwater res withdr	% of freshwater resources withdrawn
	share of total			total	per capita	total	by agriculture
	agricultural	industrial	municipal				
	%	%	%	million m ³ /yr	m ³ /inhab/yr	%	%
	2005	2005	2005	2005	2005	2005	2005
Namibia	71	5	24	300	144	1.7	1.2
Seychelles	7	28	66	14	163		
South Africa	57	7	36	13 677	286	27.4	15.7
Swaziland	94	2	4	1 068	967	23.7	22.3
Zambia	76	7	17	1 740	152	1.7	1.3
Zimbabwe	79	7	14	4 205	335	21.0	16.6
AFRICA							
ECOWAS							
SADC							
COMESA							
UMA							
ECCAS							
IGAD							
CEMAC							
UEMOA							
CEN-SAD							
ASIA Developing							
LAC							
DEVELOPED REGIONS							
WORLD	70	19	12	3 941 055	607	9.3	6.5

TABLE 47: Agricultural emissions and pollution

	Greenhouse gas emissions		Methane emissions		Nitrous oxide emissions	
	by agriculture	share of agriculture in total	total	by agriculture	total	by agriculture
	gigagrams	%	thousand kt	%	thousand kt	%
	2000-2010	2000-2008	2000-2005	2000-2005	2000-2005	2000-2005
NORTH AFRICA			135	20.6	33	75.3
Algeria	6 534.6	5.9	54	8.2	5	58.6
Egypt	31 799.0	16.5	47	31.7	19	80.0
Libyan Arab Jamahiriya			15	5.7	1	51.9
Morocco	20 927.5	35.0	11	51.7	6	82.6
Tunisia			8	25.5	2	66.4
WEST AFRICA				23.9		67.8
Benin			4	47.8	3	61.5
Burkina Faso						
Cape Verde						
Cote d'Ivoire	194 611.9	71.8	11	17.4	7	29.3
Gambia						
Ghana			9	39.5	5	70.5
Guinea						
Guinea-Bissau						
Liberia						
Mali						
Mauritania	5 667.5	81.6				
Niger	10 635.0	78.0				
Nigeria			130	19.8	22	77.3
Senegal	6 260.5	37.1	7	68.3	4	88.5
Sierra Leone						
Togo			3	39.8	2	67.5
CENTRAL AFRICA				25.7		38.3
Cameroon			19	42.4	9	75.9
Central African Republic						
Chad						
Congo	324.7	15.7	6	31.9	4	51.8
Democratic Republic of the Congo	34 582.7	75.2	56	23.1	55	31.3
Equatorial Guinea						
Gabon			8	1.1	0	23.3
Sao Tome and Principe						
EAST AFRICA				74.8		88.6
Burundi	25 917.3	97.9				
Djibouti						
Eritrea			2	73.2	1	90.9
Ethiopia			52	72.5	31	88.8
Kenya			22	65.5	11	88.8
Rwanda	958.4	40.2				
Somalia						
Sudan (former)			67	85.2	49	92.6
Uganda						
United Republic of Tanzania			32	63.2	22	78.8
SOUTHERN AFRICA				40.8		59.4
Angola			45	27.9	39	38.4
Botswana			5	84.1	3	92.0
Comoros						
Lesotho						
Madagascar	26 550.1	90.5				
Malawi						
Mauritius						
Mozambique			13	44.2	10	71.4
Namibia			5	94.9	4	94.3
Seychelles						
South Africa			64	31.4	24	59.8
Swaziland						
Zambia			19	59.3	25	71.7

TABLE 47: Agricultural emissions and pollution (continued)

	Greenhouse gas emissions		Methane emissions		Nitrous oxide emissions	
	by agriculture	share of agriculture in total	total	by agriculture	total	by agriculture
	gigagrams	%	thousand kt	%	thousand kt	%
	2000-2010	2000-2008	2000-2005	2000-2005	2000-2005	2000-2005
Zimbabwe			10	73.3	6	85.2
AFRICA				39.6		66.9
ECOWAS				23.9		67.8
SADC				39.6		53.4
COMESA				54.6		70.5
UMA				14.7		69.0
ECCAS				26.4		38.3
IGAD				77.4		90.9
CEMAC				30.1		67.4
UEMOA				39.4		54.3
CEN-SAD				40.5		81.2
ASIA Developing			3 322	45.4	1 113	71.8
LAC				58.1		72.4
DEVELOPED REGIONS		12.8	2 062	31.6	925	56.5
WORLD			7 136	42.6	2 853	66.2

TABLE 48: Agricultural pollution

	Energy use in oil equivalent		Air pollution	Water pollution			
	by agriculture	share of agriculture in total	urban	food industry	paper and pulp industry	textile industry	wood industry
	kt	%	annual PM10[mg/m ³]	% of total BOD emissions	% of total BOD emissions	% of total BOD emissions	% of total BOD emissions
	2005-2009	2005-2009	PM10 2004	% 2000-2007	% 2000-2007	% 2000-2007	% 2000-2007
NORTH AFRICA		7.2	93.4				
Algeria			65.0				
Egypt	2 618.6	5.3	136.0				
Libyan Arab Jamahiriya	224.9	2.1	121.0				
Morocco	1 721.6	14.8	27.0	16.3	2.9	43.5	2.0
Tunisia	423.7	6.5	46.0				
WEST AFRICA			84.9				
Benin			51.0				
Burkina Faso			97.0				
Cape Verde			33.0				
Cote d'Ivoire	64.9	1.1					
Gambia			138.0				
Ghana	91.5	1.2	42.0	18.6	3.8	10.2	33.3
Guinea			63.0				
Guinea-Bissau			84.0				
Liberia			39.0				
Mali			102.0				
Mauritania			42.0				
Niger			86.0				
Nigeria			95.0				
Senegal	6.1	0.3	93.0	44.6	6.3	10.5	0.8
Sierra Leone			69.0				
Togo			45.0				
CENTRAL AFRICA			62.4				
Cameroon	4.4	0.1	86.0				
Central African Republic			24.0				
Chad			73.0				
Congo			74.0				
Democratic Republic of the Congo	0.1	0.0	57.0				
Equatorial Guinea			12.0				
Gabon	8.3	0.5	13.0				
Sao Tome and Principe			76.0				
EAST AFRICA			85.9				
Burundi			99.0				
Djibouti			68.0				
Eritrea			109.0	27.3	4.4	29.0	
Ethiopia			88.0	34.7	6.0	27.9	1.5
Kenya	110.4	0.9	38.0				
Rwanda			100.0				
Somalia			35.0				
Sudan (former)	54.1	0.5	219.0	57.5	1.9	8.0	1.7
Uganda			33.0	34.8	7.8	17.2	
United Republic of Tanzania	717.7	4.2	38.0	61.2	4.8	12.7	2.9
SOUTHERN AFRICA			54.0				
Angola	4.1	0.0	113.0				
Botswana	20.3	1.1	25.0	43.8	2.4	3.9	
Comoros			125.0				
Lesotho			94.0	2.6	0.5	93.5	
Madagascar			51.0	7.6	1.6	58.9	6.3
Malawi			88.0	82.1	1.4	7.5	1.1
Mauritius			47.0	14.7	3.6	63.9	0.7
Mozambique	7.2	0.1	44.0				
Namibia	223.4	13.9	50.0				
Seychelles							
South Africa	1 535.0	2.2	24.0	15.7	6.6	10.4	4.2

TABLE 48: Agricultural pollution (continued)

	Energy use in oil equivalent		Air pollution	Water pollution			
	by agriculture	share of agriculture in total	urban	food industry	paper and pulp industry	textile industry	wood industry
	kt	%	annual PM10[mg/m3]	% of total BOD emissions	% of total BOD emissions	% of total BOD emissions	% of total BOD emissions
	2005-2009	2005-2009	PM10 2004	% 2000-2007	% 2000-2007	% 2000-2007	% 2000-2007
Swaziland			71.0				
Zambia	39.7	0.7	71.0				
Zimbabwe	641.4	7.7	43.0				
AFRICA			79.1				
ECOWAS			85.5				
SADC			51.9				
COMESA			93.9				
UMA			52.0				
ECCAS			71.8				
IGAD			94.7				
CEMAC			70.8				
UEMOA			85.4				
CEN-SAD			95.0				
ASIA Developing			87.3				
LAC			46.1				
DEVELOPED REGIONS	59 540.2	2.3	30.0				
WORLD		2.0	72.2				

TABLE 49: Conservation and renewable feedstocks

	Nationally protected area	Organic agriculture	Production					
	share of total area	% of total area	biofuel			natural fibre		recovered paper
			kt	kt	p.a. growth	thousand tonnes	p.a. growth	thousand tonnes
	%	%	2000	2009	%	2009	1961-2009	2010
2000-2009	2009			2000-2009				
NORTH AFRICA	3.0	0.2	2 910.8	3 566.6	2.3	112	-2.4	487 000
Algeria	6.3	0.0	76.5	57.2	-3.2	0	-7.6	32 000
Egypt	5.9	1.5	1 325.1	1 567.3	1.9	110	-2.4	380 000
Libyan Arab Jamahiriya	0.1		139.6	168.0	2.1			
Morocco	1.5	0.0	436.0	480.1	1.1	2	-0.4	35 000
Tunisia	1.3	1.7	933.6	1 294.0	3.7	1	2.5	40 000
WEST AFRICA	10.4	0.1	88 058.2	111 530.8	2.7	625	4.8	14 000
Benin	23.8	0.0	1 445.0	1 995.6	3.7	92	11.1	
Burkina Faso	14.2	0.1				183	12.0	
Cape Verde	2.5							
Cote d'Ivoire	22.6	0.1	4 223.6	7 780.4	7.0	53	7.5	6 000
Gambia	1.5					0	<i>Inf</i>	
Ghana	14.7	0.2	5 315.2	6 456.0	2.2	8	<i>Inf</i>	
Guinea	6.8					11	10.3	
Guinea-Bissau	16.1					2	<i>Inf</i>	
Liberia	1.8							
Mali	2.4	0.1				73	7.5	
Mauritania	0.5							
Niger	7.1	0.0				2	2.0	
Nigeria	12.8	0.0	74 154.7	91 907.2	2.4	178	2.6	8 000
Senegal	24.1	0.3	1 163.6	1 208.5	0.4	6	8.2	0
Sierra Leone	4.9	2.1				5	-0.5	
Togo	11.3	0.1	1 756.1	2 183.1	2.4	13	3.2	
CENTRAL AFRICA	12.9	0.0	22 255.3	27 735.2	2.5	96	0.7	
Cameroon	9.2	0.0	4 984.7	4 436.5	-1.3	60	4.1	
Central African Republic	17.7					3	-2.3	
Chad	9.4					20	0.4	
Congo	9.4		587.6	716.9	2.2			
Democratic Republic of the Congo	10.0	0.0	15 758.4	21 473.1	3.5	13	-2.0	
Equatorial Guinea	19.2					0	-0.7	
Gabon	15.1		924.6	1 108.7	2.0			
Sao Tome and Principe		6.4						
EAST AFRICA	9.3	0.3	52 690.4	72 806.0	3.7	273	-1.3	46 500
Burundi	4.8	0.0				1	-2.2	
Djibouti	0.0							
Eritrea	5.0		507.7	561.3	1.1			
Ethiopia	18.4	0.4	17 423.9	30 052.0	6.2	41		2 500
Kenya	11.8	0.0	11 245.0	14 233.7	2.7	29	-1.7	38 000
Rwanda	10.0	0.2				0	-100.0	
Somalia	0.6					2	1.8	
Sudan (former)	4.2	0.3	11 055.9	10 754.4	-0.3	62	-1.3	6 000
Uganda	10.3	1.6				23	-2.2	
United Republic of Tanzania	27.5	0.2	12 457.8	17 204.6	3.7	115	-1.6	
SOUTHERN AFRICA	15.2	0.0	36 278.8	42 849.5	1.9	255	0.8	1 176 398
Angola	12.4	0.0	5 538.2	7 150.4	2.9	2	-7.0	
Botswana	30.9		542.6	483.2	-1.3	1	-0.9	
Comoros	0.0	0.8				0	-100.0	
Lesotho	0.5	0.0						
Madagascar	3.1	0.0				23	-0.2	2 200
Malawi	15.0	0.0				27	4.3	
Mauritius	4.5	0.0				0	-5.6	3 000
Mozambique	15.8	0.0	6 417.6	7 987.8	2.5	60	-0.2	5 000
Namibia	14.9	0.0	172.9	205.7	1.9	2	<i>Inf</i>	
Seychelles	42.0							0
South Africa	6.9	0.1	12 872.4	14 428.8	1.3	13	0.6	1 090 198

TABLE 49: Conservation and renewable feedstocks (continued)

	Nationally protected area	Organic agriculture	Production					
	share of total area	% of total area	biofuel			natural fibre		recovered paper
	%	%	kt	kt	p.a. growth %	thousand tonnes	p.a. growth %	thousand tonnes
	2000-2009	2009	2000	2009	2000-2009	2009	1961-2009	2010
Swaziland	3.0	0.0				0	-3.9	6 000
Zambia	36.0	0.0	5 144.1	6 357.0	2.4	44	<i>Inf</i>	
Zimbabwe	28.0	0.0	5 591.0	6 236.6	1.2	83	8.8	70 000
AFRICA	11.1	0.1	202 193.4	258 488.2	2.8	1 363	0.3	1 723 898
ECOWAS	11.1	0.1	88 058.2	111 530.8	2.7	625	4.8	14 000
SADC	16.7	0.0	64 494.9	81 527.2	2.6	383	-0.4	1 176 398
COMESA	11.2	0.3	68 190.8	91 403.4	3.3	456	-0.8	507 700
UMA	2.0	0.1	1 585.6	1 999.3	2.6	2	-0.5	107 000
ECCAS	11.9	0.0	27 793.4	34 885.6	2.6	99	-0.7	
IGAD	7.2	0.3	40 232.6	55 601.4	3.7	157	-1.0	46 500
CEMAC	13.3	0.0	6 496.9	6 262.1	-0.4	84	1.8	
UEMOA	15.2	0.1	8 588.3	13 167.6	4.9	424	8.3	6 000
CEN-SAD	8.2	0.1	113 701.2	140 589.7	2.4	854	0.6	513 000
ASIA Developing	9.6	0.2	514 021.4	551 414.6	0.8	19 253	2.4	64 663 116
LAC	15.7	1.2	90 732.1	123 613.2	3.5	1 782	-0.0	9 787 000
DEVELOPED REGIONS	14.1	1.5	147 342.5	198 962.5	3.4	3 452	-0.1	131 830 091
WORLD	12.3	0.7	954 280.6	1 132 462.3	1.9	25 849	1.1	208 004 105

TABLE 50: Forestry production

	Production of selected forest products					
	industrial roundwood		woodfuel		total roundwood	
	thousand m ³	p.a. growth	thousand m ³	p.a. growth	thousand m ³	p.a. growth
		%		%		%
2010	1961-2010	2010	1961-2010	2010	1961-2010	
NORTH AFRICA	1 077	1.5	29 235	0.8	30 312	0.8
Algeria	103	-0.4	8 176	2.2	8 279	2.1
Egypt	268	3.2	17 511	1.1	17 779	1.2
Libyan Arab Jamahiriya	116	3.5	952	2.5	1 068	2.5
Morocco	372	0.7	411	-5.1	783	-3.9
Tunisia	218	3.0	2 185	1.1	2 403	1.2
WEST AFRICA	17 311	1.8	176 919	1.4	194 230	1.5
Benin	427	2.5	6 275	0.5	6 702	0.6
Burkina Faso	1 171	3.7	12 785	1.5	13 956	1.7
Cape Verde			193	1.8	193	1.8
Cote d'Ivoire	1 469	-0.1	8 947	0.7	10 416	0.6
Gambia	113	6.2	694	2.5	807	2.7
Ghana	1 250	-0.9	37 791	3.7	39 041	3.2
Guinea	651	1.9	11 959	0.6	12 610	0.7
Guinea-Bissau	132	0.7	2 600	3.9	2 732	3.6
Liberia	480	2.4	7 008	3.1	7 488	3.1
Mali	413	1.7	5 326	1.5	5 739	1.5
Mauritania	3	0.0	1 836	2.1	1 839	2.1
Niger	701	3.6	2 857	0.6	3 558	0.9
Nigeria	9 418	2.9	63 215	1.1	72 633	1.3
Senegal	794	2.2	5 427	1.3	6 221	1.4
Sierra Leone	124	0.5	5 582	-0.0	5 705	0.0
Togo	166	1.5	4 424	0.5	4 590	0.5
CENTRAL AFRICA	14 536	2.0	98 538	2.4	113 074	2.4
Cameroon	2 175	2.2	9 906	0.8	12 081	1.0
Central African Republic	648	2.2	2 000	0.5	2 648	0.8
Chad	761	1.8	7 070	2.0	7 831	2.0
Congo	2 426	3.2	1 336	1.0	3 762	2.1
Democratic Republic of the Congo	4 592	2.1	76 602	3.0	81 194	2.9
Equatorial Guinea	525	1.1	447	0.8	972	1.0
Gabon	3 400	1.4	1 070	2.3	4 470	1.6
Sao Tome and Principe	9		107	1.7	116	1.9
EAST AFRICA	14 967	2.7	237 920	2.0	252 887	2.0
Burundi	883	7.5	9 846	2.1	10 729	2.3
Djibouti	0		356		356	10.2
Eritrea	1		1 264		1 265	
Ethiopia	2 935		101 274		104 209	
Kenya	1 246	2.1	26 400	2.4	27 646	2.4
Rwanda	1 212	6.6	5 000	1.2	6 212	1.6
Somalia	110	2.0	12 532	3.2	12 642	3.2
Sudan (former)	2 173	1.8	18 776	1.4	20 949	1.4
Uganda	4 093	3.4	39 636	2.1	43 729	2.2
United Republic of Tanzania	2 314	2.2	22 836	1.3	25 150	1.4
SOUTHERN AFRICA	25 398	2.6	74 005	2.4	99 403	2.4
Angola	1 096	1.1	4 009	2.6	5 105	2.2
Botswana	105	2.5	683	0.4	788	0.5
Comoros	25		266	3.8	291	4.0
Lesotho			2 092	0.7	2 092	0.7
Madagascar	281	-0.8	13 100	3.7	13 381	3.4
Malawi	1 400	4.7	5 405	1.1	6 805	1.5
Mauritius	5	-2.9	9	-3.1	14	-3.1
Mozambique	1 416	1.1	16 724	1.9	18 140	1.8
Namibia			822	1.8	822	1.8
Seychelles	10		3		13	
South Africa	18 888	2.9	12 000	5.8	30 888	3.6
Swaziland	330	1.8	1 063		1 393	4.8
Zambia	1 325	3.1	9 119	2.1	10 444	2.2

TABLE 50: Forestry production (continued)

	Production of selected forest products					
	industrial roundwood		woodfuel		total roundwood	
	thousand m ³	p.a. growth	thousand m ³	p.a. growth	thousand m ³	p.a. growth
		%		%		%
2010	1961-2010	2010	1961-2010	2010	1961-2010	
Zimbabwe	518	2.1	8 709	1.6	9 227	1.7
AFRICA	73 294	2.2	616 675	1.8	689 969	1.9
ECOWAS	17 308	1.8	175 083	1.4	192 391	1.5
SADC	32 279	2.5	173 177	2.4	205 456	2.4
COMESA	21 413	2.6	335 292	2.2	356 704	2.2
UMA	812	1.2	13 560	0.5	14 372	0.6
ECCAS	16 515	2.1	112 393	2.4	128 908	2.3
IGAD	10 558	2.5	200 238	2.1	210 797	2.1
CEMAC	9 935	2.0	21 829	1.2	31 764	1.4
UEMOA	5 273	1.4	48 641	1.1	53 914	1.1
CEN-SAD	23 258	1.8	266 556	1.5	289 814	1.5
ASIA Developing	250 841	2.3	764 934	-0.1	1 015 776	0.2
LAC	207 517	3.8	282 923	1.1	490 440	1.8
DEVELOPED REGIONS	995 731	0.3	197 054	-0.5	1 192 785	0.1
WORLD	1 533 819	0.8	1 867 470	0.5	3 401 289	0.6

TABLE 51: Forestry production: finished products

	Production of selected forest products							
	sawnwood		wood-based panels		paper and paperboard		wood pulp	
	thousand m ³	p.a. growth %	thousand m ³	p.a. growth %	thousand m ³	p.a. growth %	thousand m ³	p.a. growth %
	2010	1961-2010	2010	1961-2010	2010	1961-2010	2010	1961-2010
NORTH AFRICA	159	1.2	246	6.6	996	4.2	262	5.4
Algeria	13	-3.0	48		46	0.3		
Egypt	12		59	5.1	660	5.4	41	
Libyan Arab Jamahiriya	31	3.8			6	2.0		
Morocco	83	2.8	35	3.7	127	2.4	221	5.0
Tunisia	20	4.4	104		157	7.3		
WEST AFRICA	3 505	2.5	1 049	7.3	20		23	
Benin	84	4.9						
Burkina Faso	5							
Cape Verde								
Cote d'Ivoire	700	3.8	477	10.2				
Gambia	1							
Ghana	513	0.4	430	8.3				
Guinea	30	1.2	42					
Guinea-Bissau	16	1.4						
Liberia	80	1.2	0					
Mali	13	0.7						
Mauritania	14		2		1			
Niger	4							
Nigeria	2 002	3.5	97	3.3	19		23	
Senegal	23	0.3			0			
Sierra Leone	5	-1.3						
Togo	15	6.5	1					
CENTRAL AFRICA	1 416	2.5	445	2.4	6	4.8	0	
Cameroon	838	4.7	80	3.9	0		0	
Central African Republic	45	0.3	5					
Chad	2							
Congo	179	3.6	60	3.9	3			
Democratic Republic of the Congo	92	-1.8	4	-4.5	3	3.3		
Equatorial Guinea	4	-2.6	28					
Gabon	250	4.8	268	2.7				
Sao Tome and Principe	5							
EAST AFRICA	584	1.7	216	8.0	109	8.9	56	
Burundi	83							
Djibouti								
Eritrea								
Ethiopia	18		103		78			
Kenya	142	2.2	83		0	-100.0	0	
Rwanda	135		0					
Somalia	14	2.1	0					
Sudan (former)	51	1.9	2		3			
Uganda	117	2.2	24	4.0	3			
United Republic of Tanzania	24	-2.9	5	5.1	25		56	
SOUTHERN AFRICA	2 667	1.8	815	4.5	2 690	5.3	2 376	4.4
Angola	5	-5.2	11		0	-100.0	15	
Botswana								
Comoros								
Lesotho								
Madagascar	104	1.7	1		10		1	
Malawi	45	2.9	18					
Mauritius	2	-0.3	0		0		0	
Mozambique	198	1.0	1	-0.8	2			
Namibia								
Seychelles	1		0		0		0	
South Africa	1 876	1.8	690	4.1	2 516	5.3	2 298	4.5
Swaziland	102	2.5	8		49		15	0.9
Zambia	157	3.4	18		4			

TABLE 51: Forestry production: finished products (continued)

	Production of selected forest products							
	sawnwood		wood-based panels		paper and paperboard		wood pulp	
	thousand m ³	p.a. growth	thousand m ³	p.a. growth	thousand m ³	p.a. growth	thousand m ³	p.a. growth
		%		%		%		%
2010	1961-2010	2010	1961-2010	2010	1961-2010	2010	1961-2010	
Zimbabwe	177	2.4	68		109	5.2	47	5.2
AFRICA	8 332	2.2	2 771	4.8	3 821	5.0	2 717	4.6
ECOWAS	3 491	2.5	1 047	7.3	19		23	
SADC	2 783	1.3	824	3.7	2 718	5.4	2 432	4.5
COMESA	1 269	1.7	388	4.2	925	5.6	104	4.2
UMA	161	1.3	189	7.4	337	2.8	221	5.0
ECCAS	1 504	2.3	456	2.5	6	2.4	15	
IGAD	342	1.6	211	8.2	84	8.3	0	
CEMAC	1 318	4.0	441	3.2	3		0	
UEMOA	860	3.5	478	10.3	0			
CEN-SAD	3 911	2.5	1 336	7.2	973	4.8	285	5.6
ASIA Developing	84 886	2.8	137 460	11.2	148 318	8.0	18 109	6.5
LAC	42 969	2.6	16 654	7.1	19 694	5.0	20 960	7.3
DEVELOPED REGIONS	253 735	-0.2	121 986	3.3	229 835	2.5	128 815	1.6
WORLD	390 141	0.4	278 983	4.9	401 668	3.5	170 601	2.1