

Land and food

The Earth could, in theory, support far more than its present population, but the distribution of good soils and favourable growing conditions does not match that of the population. The problem is being exacerbated by increasing land degradation all over the world. The problem is particularly serious where – due to environmental and socio-political factors – local food production cannot provide an adequate diet or even enough for bare survival.

Of a total of 1 900 million hectares of degraded land on the planet (UNEP-ISRIC 1991), the most serious problems occur in Asia and the Pacific (with 29 per cent of the world's total degraded land) and Africa (with slightly more than 26 per cent). Latin America and the Caribbean take third place, with approximately 16 per cent, followed by Europe (slightly more than 8 per cent) and North America (5 per cent) (UNEP-ISRIC 1991).

Latin America and the Caribbean have the world's largest reserves of cultivable land. The agricultural

potential of the region is estimated at 576 million hectares (Gómez and Gallopín 1995; UNEP-ISRIC 1991). During 1980–94, the area under cultivation and permanent pasture increased and the forested area decreased (FAO 1997a, 1997b).

However, land degradation in Latin America and the Caribbean affects 16 per cent of the land area. The impact is higher in Meso-America (reaching 26 per cent of the total, or 63 million hectares) than in South America (where it affects 14 per cent of the total, or almost 250 million hectares) (UNEP-ISRIC 1991).

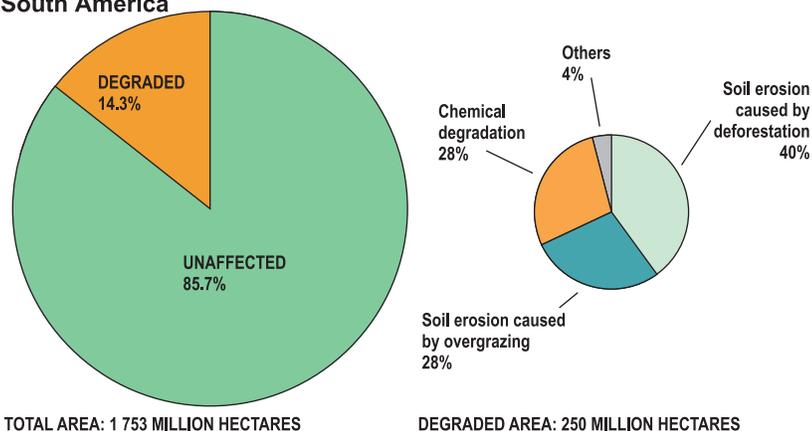
Soil degradation varies according to land use and location, but is more severe in cultivable land than in pastures or forests (Oldeman 1994). In South America, soil degradation affects 45 per cent of cropland, 14 per cent of pastures and 13 per cent of forests and woodlands. In Meso-America it affects 74 per cent of cropland, 11 per cent of permanent pastures and 38 per cent of forests. In general, soil degradation is more severe in arid lands under agricultural use. An estimated 70 per cent of these particularly vulnerable lands in Latin America and the Caribbean suffer from moderate to extreme degradation (UNEP 1997).

Original agricultural productivity losses caused by soil degradation also vary according to sub-regions. Recent estimates indicate that soil degradation in Central America is responsible for 37 per cent of losses, while global losses in South America have almost reached 14 per cent, slightly higher than losses in Asia (Oldeman 1998, quoted by Scherr 1999).

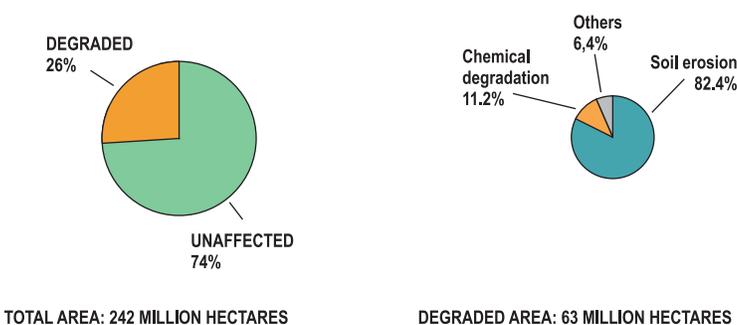
Erosion – by deforestation or overgrazing – and chemical degradation are among the main causes of soil degradation. In general, erosion is the main threat. Estimates indicate that there are 170 million hectares of eroded land in South America (68 per cent of the total affected land) and approximately 52 million hectares in Meso-America (82 per cent of the total affected land). Chemical degradation (basically loss of nutrients), on the other hand, affects 70 million hectares in South America and 7 million hectares in Meso-America (28 and 11 per cent of affected land respectively) (UNEP-ISRIC 1991).

Land areas and degradation

South America



Meso-America



Source: UNEP / ISPRIC, 1990 and Oldeman, 1994.

In South America, the principal cause of erosion is deforestation (affecting approximately 100 million hectares, or 40 per cent of the total affected land). Second in importance is overgrazing (70 million hectares, or 28 per cent of the total affected land). On the other hand, the main cause of soil degradation in Meso-America is poor agricultural practices.

Expansion of permanent pastures into previously forested areas is still the main cause of deforestation in the Brazilian Amazon (Nepstad *et al.* 1997) although much of this land is initially used as cropland. Soybean production, mainly for export, has been the main driving force of the agricultural frontier expansion in northern Argentina, eastern Paraguay and central Brazil (Klink *et al.* 1995). Farming technology has improved agricultural yields throughout the region, but the environmental costs have been very high. The impact of agrochemical contamination on

soil and water and, as a consequence, on human health, is a major concern. For example, during the 1980s Central America increased production by 32 per cent and its cultivated area by 13 per cent, but doubled its consumption of pesticides (FAO 1997a), which casts doubt on the efficiency of such an effort.

In addition, stock farming (basically cattle and sheep) has led to overgrazing and subsequent desertification, particularly in Argentinian Patagonia where an estimated 35 per cent of the total area (80 million hectares; almost 5 per cent of the South American territory) suffers from desertification (Winograd 1995).

In Central America, steep slopes, intense rainfall and poor agricultural practices have made erosion the principal cause of the loss of agricultural potential. Severe inequality in land distribution associated with insecure land tenure is also leading to the over-exploitation of resources for short-term benefits (Fearnside 1993; Jones 1990).

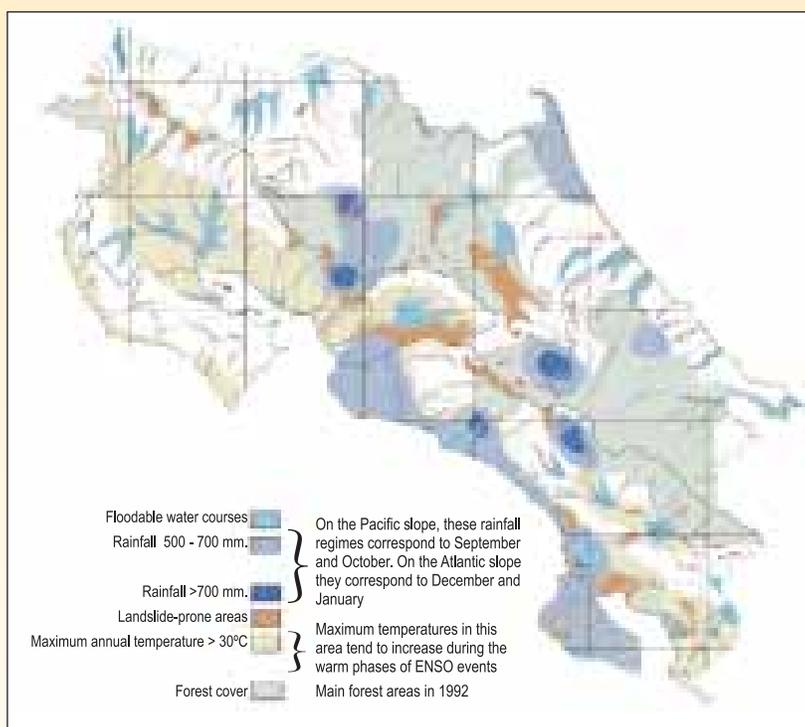
In general, if appropriate soil conservation measures are not adopted (including the implementation of new criteria for crop selection), the degradation of arable land will continue, endangering food production, affecting food security, and producing still other important environmental and economic impacts.

Soil degradation factors in Costa Rica

Excess precipitation and surface run-off are important factors in the transportation and loss of fertile soil material. Surface run-off is influenced by orography, and river beds are the first natural channels to receive excess water not absorbed by the soil. As river volumes rise there is an increased risk of spillage overflow, especially in short watersheds with steep inclines.

Steep mountain slopes are also very susceptible to landslides caused by excessive rainfall. Soil erosion results from landslides and from gullies that develop when the ground cover on slopes is removed or degraded by over-grazing, wildfires or earthquakes. Gullies vary in size according to soil type, land gradient and the volume of water scouring their channels deeper.

Alterations in the ground cover, or lack of it, affect the capacity of the soil to retain water, which translates into an increase in surface run-off. Causes of alterations to the ground cover include the use of land for cultivation and cattle raising, the growth of urban areas and the pressure caused by increasing population.



High environmental temperatures may be another important element in the soil degradation process. High temperatures exacerbate the drying of vegetation in areas without forest cover, or with sparse ground cover or low moisture retention capacity. In these cases, the soil is more exposed to other weather factors such as solar radiation and winds, which contribute to the drying of the soil surface. Wind erosion compounds the problem by physically removing soil material. In addition, should environmental temperatures rise to unusually high levels, as is the case during some warm phases of ENSO (*El Niño* Southern Oscillation) events, the impact of this element may increase even further.

In several areas of the Central American Pacific Watershed, the combination of these factors determines the severity of soil degradation. The accompanying map shows these risk factors (flood-prone rivers, high precipitation, landslide areas, high temperatures and forest cover) for Costa Rica.

Source: CADETI-MINAE 1999.

Since 1994, FAO has carried out an action programme in 83 low-income countries with food deficits (FAO 1999a). These countries are home to nearly 824 million people – almost 14 per cent of the world's population – who suffer chronic food insecurity (that is, have insufficient calorie intake to satisfy their basic energy needs) (FAO 1999b). The group comprises 42 African countries, 24 from Asia, 7 from Latin America and the Caribbean, 7 from Australasia and the Pacific, and 3 from Europe (FAO 1999a).

According to a recent FAO study (FAO 1999b), between one-fifth and one-third of the population in five countries of the region suffer from inadequate

food intake. In ascending order they are Honduras, Bolivia, Dominican Republic, Nicaragua and Haiti. In Haiti, the proportion exceeds 60 per cent of the population. With the exception of Nicaragua, the situation improved in all these countries between 1990–92 and 1995–97. However, these numbers conceal significant local disparities between countries. In Venezuela, for example, the national average of food insufficiency does not exceed 15 per cent of the population, but in some eastern and southern states of the country the proportion of children suffering from inadequate nutrition reaches, respectively, 20 per cent and 36 per cent of the total.

Risks of intensive use of agrochemicals

Intensive use of agrochemicals – particularly nitrogenous fertilizers and pesticides containing environmentally persistent organic compounds – generate not yet fully understood but potentially very serious risks of soil degradation and environmental pollution.

Increased use of nitrogenous fertilizers in agriculture, in combination with extensive farming of legume species, causes the deposition of additional quantities of nitrogen into land and water ecosystems. If we include the impact of fossil fuels, human activities are currently making a larger contribution of fixed nitrogen to the global supply than natural processes and have at least doubled the amount of nitrogen available for absorption by plants. The increase in the use of nitrogenous fertilizers world-wide is causing a dramatic rise in the nitrogen levels in potable water sources, run-off water and agricultural waste, which in turn generates more eutrophication in water bodies (unusual plant growth and subsequent oxygen deprivation for other species). One consequence of this process is a loss of biodiversity as a result of some species adapting more rapidly than others to this new environment, to the detriment of less adaptable species.

A major problem is that persistent organic compounds do not degrade easily and last for many years in the environment. They have a tendency to accumulate at the higher levels of the food chain, in animal and human tissue, often a long way from their sources of origin. These compounds interact with hormones and the endocrine system, affecting reproductive and developmental processes and damaging the nervous and immune systems of humans and other animal species.

Brazil is one of the world's four biggest users of agrochemicals, consuming 2.33 kilograms of active ingredients per hectare in 1997, with a total consumption of 117 000 tonnes of active ingredients in 1998 and total billings of US\$2.18 billion in 1997. In 1997, areas in south and south-eastern Brazil used the largest amount of agrochemicals, with 33 per cent of total consumption concentrated in the state of São Paulo. Figures for that year indicate that herbicides contained the greatest amount of active ingredients (48 per cent), followed by fungicides (26 per cent), insecticides (15 per cent) and acaricides (9 per cent).

Source: UNEP 1999a; IBAMA 1999a.



Losses due to desertification

Desertification is caused by climate variation and human activities, which upset the balance of soil, vegetation, air and water. This rupture causes the reduction, or even destruction, of the biological potential of soils, the degradation of living conditions and the expansion of deserts. Desertification is a particularly significant threat to arid, semi-arid and sub-humid dry areas of the world, where social and economic pressures, ignorance, wars and droughts lead to over-exploitation of the land (UNSCDD 1999; UNEP 1999a). Arid soils are especially vulnerable because of their very slow rate of recovery from disturbances. Because water availability is limited in arid climates, soil formation is slow and at the same time highly susceptible to erosion processes.

In Latin America and the Caribbean, soil degradation attains the category of desertification mainly in Chile, Peru and Mexico. According to some estimates, desert areas in those countries cover a total of about 252 million hectares (1.3 per cent of the region's territory) (Brzovic 1996). But arid and semi-arid areas also occur in Argentina, Brazil and Bolivia, and together with Chile, Peru and Mexico, represent 97.3 per cent of the total area in this condition – 457 million hectares, equivalent to 23 per cent of the region's territory.

By the mid 1990s, it was estimated that 20 per cent of the agricultural land in South America was threatened by desertification (INTA-GTZ 1995). Around 70 per cent of Argentina's land (some 200 million hectares) is in arid and semi-arid regions, and at risk of desertification. Estimates indicate that desertification covers an area of more than 21.5 million hectares (7.5 per cent of the total territory) (SAGyP-CFA 1995; INTA-GTZ 1995). In Chile, the desertification process is esti-

mated to affect about 47.3 million hectares, equivalent to 62.6 per cent of the national territory. The areas worst affected are those with the greatest flora and fauna conservation problems, where about 1.5 million people (13 per cent of the national population) live in rural poverty (CONAF 1999).

It has been estimated that total losses due to desertification in Latin America and the Caribbean could approach US\$975 million per year. If losses caused by drought are added to those of desertification, annual losses could exceed US\$4.8 billion (FGEB 1994). About US\$13 billion could be needed to restore degraded soils in order prevent these losses (FGEB 1994). However, given the lack of comparability in the current data, and existing doubts about the socio-economic benefits of initiatives against desertification, many policy-makers are reluctant to allocate funds for land restoration work.

The social cost of desertification may be even higher. Desertification and its disruption of agricultural production destroy the social fabric of a country. Millions of people are forced to migrate in search of better job opportunities and living conditions. This migration from the country to the cities (in many cases, to other countries) often leads them to settle on the fringes of urban areas, thus perpetuating and aggravating the urban poverty cycle. When only the men migrate, leaving their wives and children behind, the latter become even more vulnerable, since community and government authorities often do not recognize women as legitimate counterparts. Therefore, desertification not only exacerbates poverty but also aggravates social disruption and political instability.



According to FAO, food insecurity in these and other countries is caused (among others) by environmental factors that generate a poor capacity to produce food reserves or a variable production capacity that does not guarantee food on a regular basis. Environmental factors include dry or cold weather, poor soils, erratic rainfall patterns, steep slopes and severe land degradation (FAO 1999b). Low agricultural productivity due to limitations of institutional, technologic and sectoral policies, and scarce and insecure income in rural and urban areas, are other contributing factors (FAO 1999a).

In addition to its impact on food security, land degradation has other important environmental and economic effects that produce insecurity problems (Scherr 1999). In economic terms, land degradation

affects agricultural value added, stability and prices. In turn, this can have a negative impact on agricultural income and on economic growth as a whole, where the economy depends on agriculture to a significant extent. Where degraded land is a critical asset for subsistence-level producers, the social consequences can be very severe, especially for those who have no other productive options. Finally, a nation's long-term wealth and productivity options can be affected, threatening the resources and food security of future generations.

Sedimentation and the release of greenhouse gases are two of the environmental consequences of land degradation (Scherr 1999). According to several estimates, the release of carbon dioxide due to land degradation in particular corresponds to 10–30 per

Large and small farmsteads in Panama: their role in soil degradation

Degraded surfaces have increased at an alarming rate in Panama. Between 1970 and 1987, the increase was close to 60 per cent, its impact covering 27 per cent of the country's total land area. This trend continues, and is particularly acute in the highly eroded area of eastern Chiriqui, the northern area of Veraguas y Cocolé and the extreme west of the province of Panama.

Land tenure is the main factor in soil degradation. In Panama, as in many other countries in the region, unequal soil distribution and shortcomings in the ownership regime prevail. About 46 per cent of land users (mainly in the provinces of Veraguas, Panama and Darién) do not have deeds, 19 per cent are under a mixed regime, and approximately 1 per cent lease their land, while only 34 per cent have any form of ownership title.

Plots of less than five hectares – *minifundia* – occupy only 4.2 per cent of the land available for agriculture and cattle-raising, but represent 71.5 per cent of the total agricultural and cattle-raising activities in the country. Given their intrinsic limitations (poor soil quality, lack of working capital, and inappropriate technologies), small farmsteads do not yield sufficient quantity or quality of produce to provide a dignified livelihood. This forces producers to over-exploit the land in certain regions, causing rapid soil deterioration and the opening of new satellite farms (*trabajaderos*) in mountainous or marginal areas. At the same time, many farmers are forced to look for temporary employment or enter into share-cropping contracts. When these possibilities yield no results, farmers migrate to the cities or the agricultural frontier. Exploitation of new croplands generates further deforestation, erosion and loss of fertile soils, as well as a greater need for new agricultural and cattle raising land, thus aggravating the poverty cycle.

In 1990, large-scale farming units – *latifundia* – with areas of 200 hectares or more, represented 37 per cent of the land being used for agriculture and cattle-raising, while only contributing 0.98 per cent of the total farming and cattle-raising benefits to the country. Among these are the few agro-industrial production centres linked to high-technology agricultural production and cattle-raising activities: the rest have



little or no production due to the low level of land utilization, inadequate local labour availability, and reduced financial resources (as is the case of extensive cattle-raising ventures and barren areas surrounding cities and towns in the countryside). Deforestation in these areas, and poor management practices (planting pastures and using slash-and-burn techniques to affirm the existence of an owner), turn these farms (deprived of the benefits of national economic growth) into a direct contributor to the gradual degradation of the country's natural resources.

Significant numbers of *minifundia* subsistence farms, as well as some extensive cattle-raising ventures, operate on land that should be used for protection instead of production. When the intensity of use exceeds the land's productive potential, these lands are over-exploited and the resource is placed under pressure. The result is deterioration and degradation of the physical and chemical properties of the soil, with accelerated compaction and erosion. Subsequent pollution and sedimentation of waterways and water bodies compromises the water regulation capacity of drainage basins, which in turn produces flooding and worsens seasonal droughts.

Source: ANAM 1999a.

cent of emissions produced by fossil fuels, while the release of nitrous oxide (N₂O) due to land degradation is among the main causes of greenhouse gas accumulation and stratospheric ozone depletion. Greenhouse gas emissions and ozone depletion have a negative effect on the process of climate change, thus increasing the threats to long-term food security. In addition, land degradation reduces protection and generates habitat changes, provoking genetic and biodiversity losses and aggravating other factors of food insecurity.

A Land Use Index for Central America

Decision-making and planning for sustainable development assume the design of strategies, the definition and implementation of policies, and the execution of actions. For this, it is necessary to use assessment and performance indicators to gain knowledge about the current situation and the direction in which the processes must go. It is essential therefore that the information tools used by planners and policy-makers take into consideration the spatial (where) and temporal (when) dimensions of the situation, as well as the process components (economic, social and environmental) and their interactions (why, who, how and how much).

The CIAT–World Bank–UNEP joint project on rural sustainability indicators seeks to develop and apply environmental, land quality and other indicators, and information tools, to allow the integration of environmental and sustainability considerations into planning and decision-making processes. By developing geo-referenced indicators and user-friendly interfaces, this project helps improve environmental management in the Central American countries.

Land use is one of the main factors related to development and the environment. The Land Use Index, applied in Central America as shown in the accompanying map, combines two indicators: current production systems (how land is being used) and 'potential' production systems (how land should be used in a technically advisable manner). According to the Index, almost half the land in the region (46 per cent) is being inadequately used. Approximately 25 per cent of the surface has a specific agricultural potential, but is being used for other purposes, while 14 per cent of the land has agricultural use but should be destined for other uses, such as forestry. Also, 7.5 per cent of the territory is being used inadequately (for example, as pasture rather than coffee plantations).

