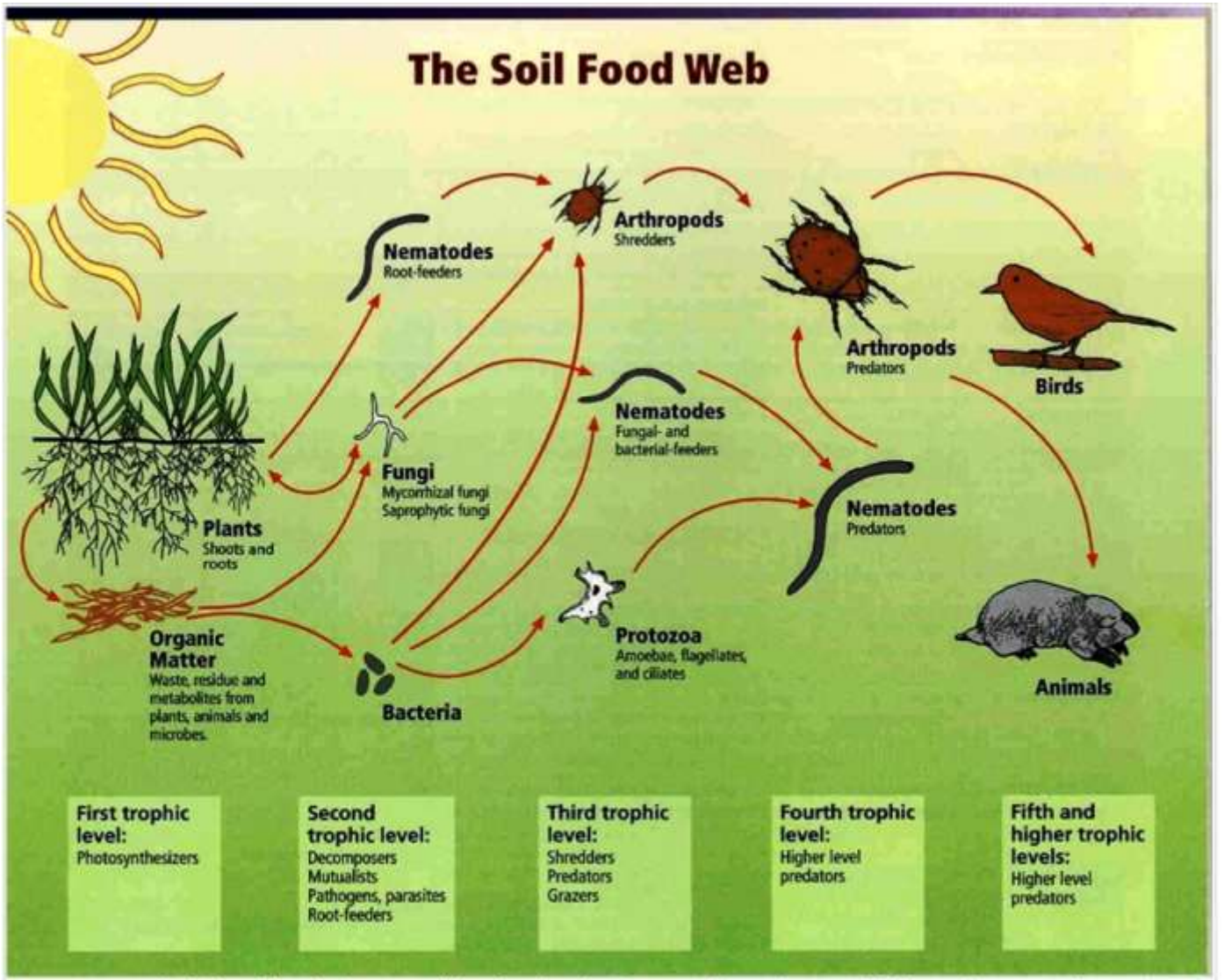
5.3 – Soil degradation and conservation

IB ESS

Study guide

Soil ecosystems change through succession. Fertile soil contains a community of organisms that work to maintain functioning nutrient cycles that are resistant to soil erosion.



Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html.

Explain the relationship between soil ecosystem succession and soil fertility

First, lichens, which grow on rock, appear in a destroyed region. The lichens help break down the rock. Then, as lichens die and decompose, and weathering breaks apart rock, soil begins to form. As soil becomes richer, small plants like mosses and ferns appear, and the lichens start to disappear. The soil continues to become richer as plants continue to die and decompose, and flowering plants and grasses appear, bringing insects to the region. In time, shrubs and small trees cover the region, creating a suitable habitat for reptiles, birds, and mammals. As the shrubs and trees grow, smaller plants die from lack of sunlight and add more organic material to the soil. Eventually, the shrubs and trees die because taller trees cover the region. This all happens gradually over a long period of time.

image from ecology-project.weebly.com

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Discuss the influences of human activities on soil fertility and soil erosion

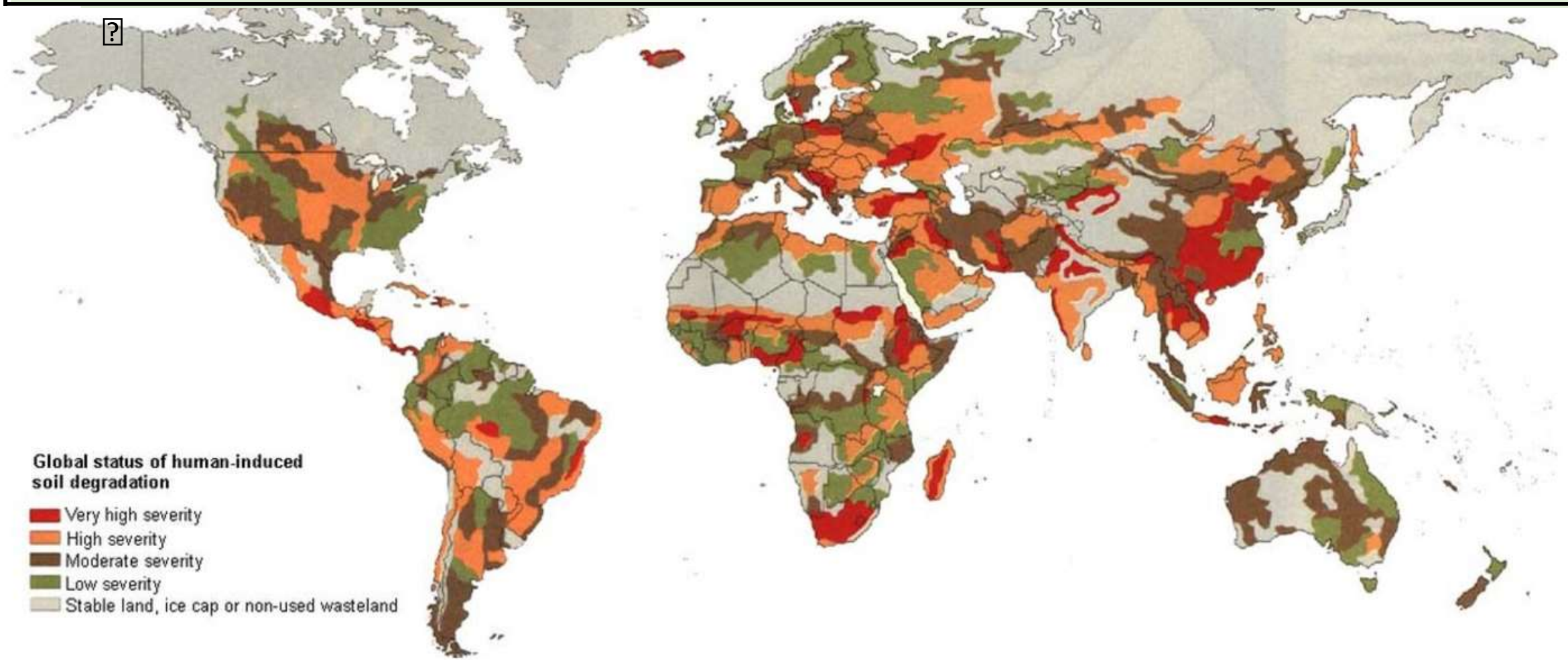
Soil is a non-renewable resource that once it is eroded it is not renewed. Soil erosion is the permanent change of the main characteristics of soil that could see it lose its fertility, pH, colour, humus content or structure. Soil erosion occurs naturally by wind or harsh climatic conditions but human activities include overgrazing, overcropping and deforestation.

Overgrazing occurs when farmers stock too many animals such as sheep, cattle or goats on their land. The animals damage the soil surface by eating the vegetation and either digging into wet soil or compacting dry soil with their hooves.

Overcropping is when the land is being continuously under cultivation and is not allowed to lie fallow between crops. This constant farming of the land reduces the soils ability to produce valuable humus for soil fertility as it is constantly being ploughed or stripped for crop growth. The soil becomes drier and less fertile.

Deforestation is the cutting down of large areas of forests leaving an open, exposed landscape. Deforestation occurs for many reasons such as the sale of wood, charcoal or as a source of fuel, while cleared land is used as pasture for livestock, plantations of commodities, and settlements. The removal of trees without sufficient reforestation has resulted in damage to habitat, biodiversity loss and aridity (drying of soil).

Human activities which can reduce soil fertility include deforestation, intensive grazing, urbanization, and certain agricultural processes (irrigation, monoculture etc.)



This shows that the soil degradation's damage is world wide and occurs over 15% of the world's total area.

Soil degradation is the decline in quantity and quality of soil. It is also erosion by wind and water, biological degradation (loss of humus and plant or animal life), physical degradation (loss of structure, changes in permeability), chemical degradation (acidification, declining fertility, changes in pH, salinity)

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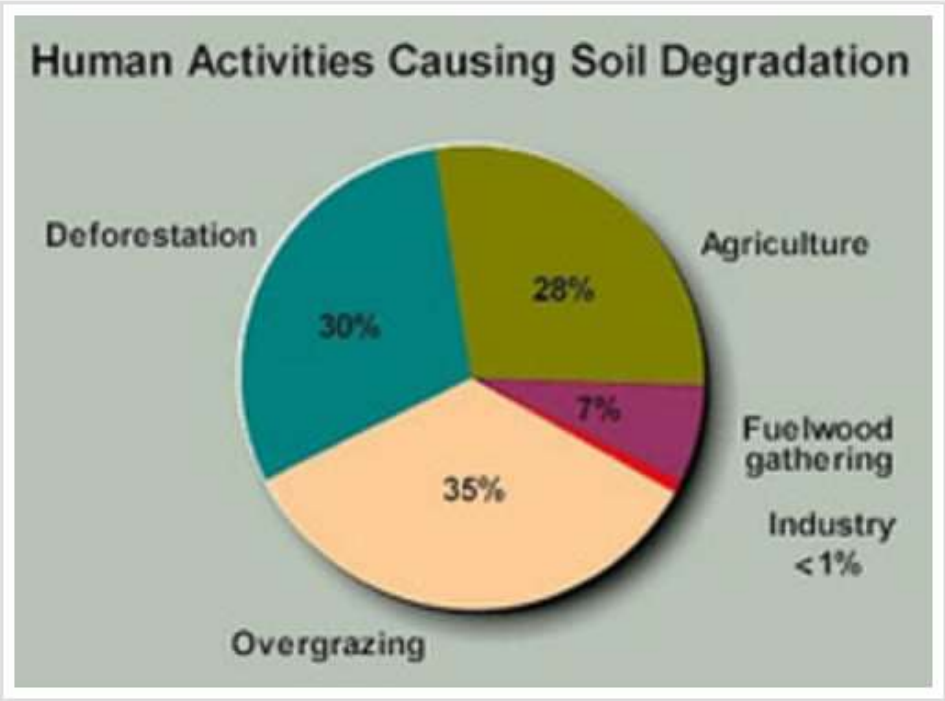
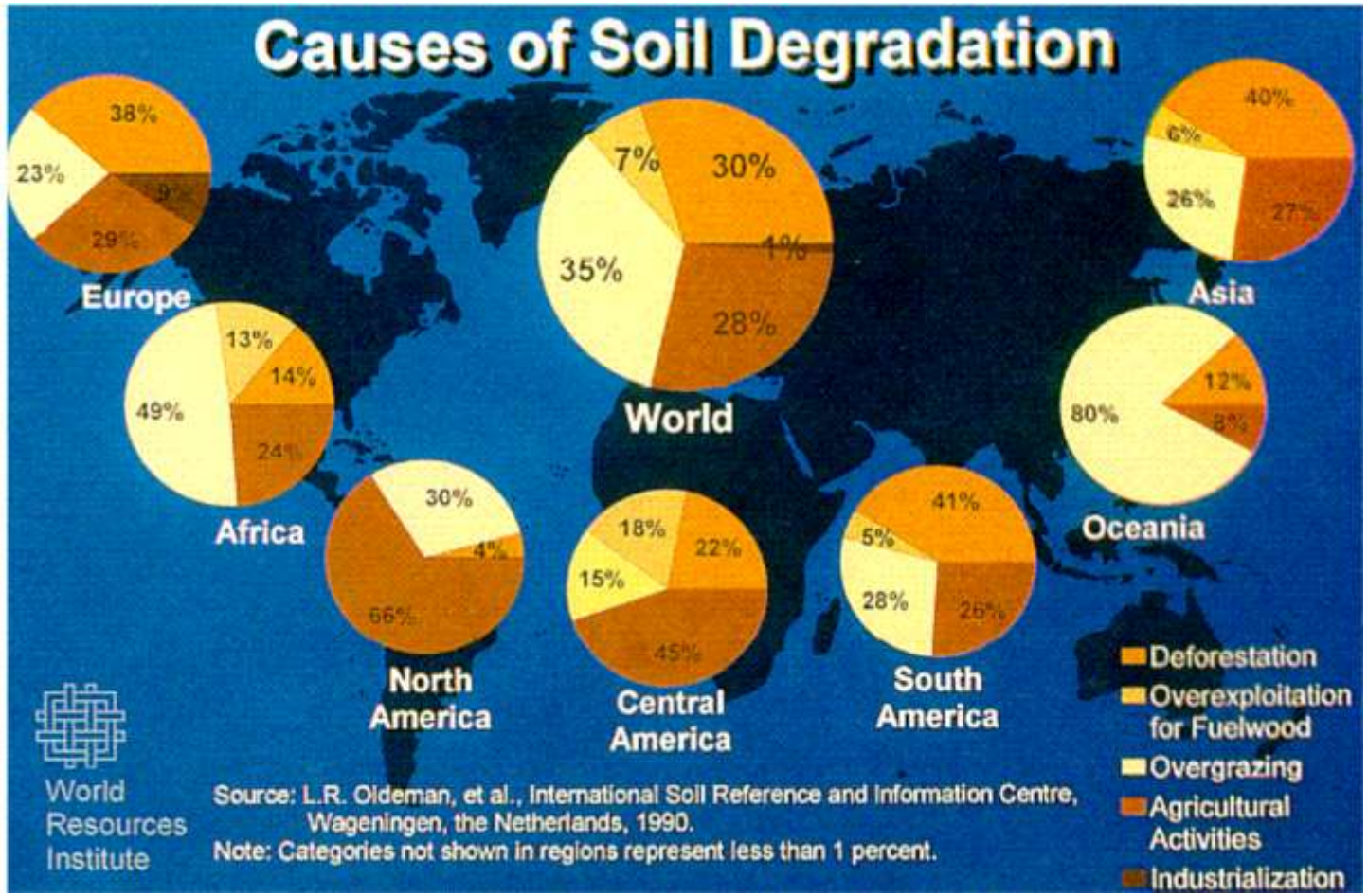


image from www.uwec.edu

Human activities such as overgrazing, deforestation, unsustainable agriculture and irrigation cause processes of degradation. These include soil erosion, toxification and salinization. Desertification (enlargement of deserts through human activities) can be associated with this degradation.



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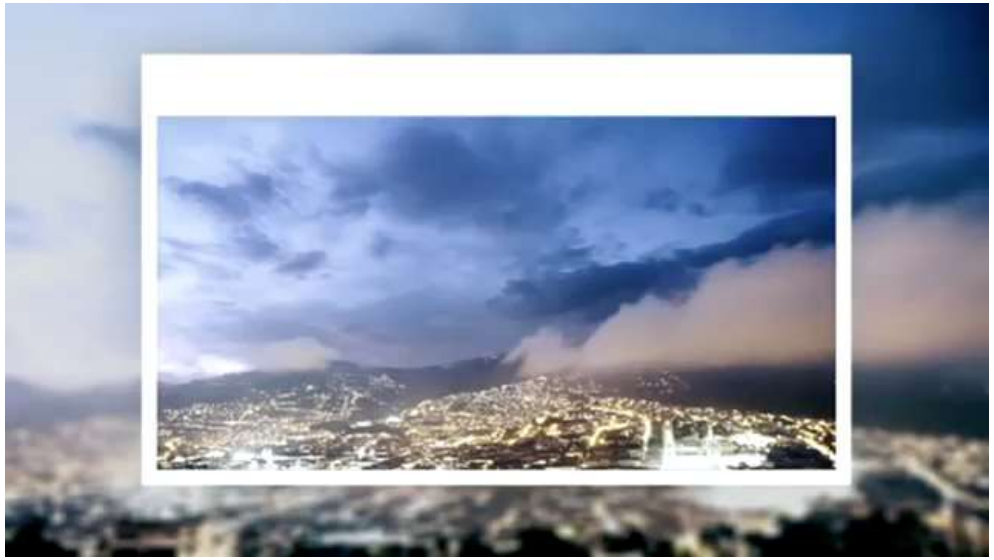
	Processes	Consequence
Overgrazing	Grazing by livestock at high density remove vegetation cover	Increase in soil erosions by wind and water and can lead to desertification
Deforestation	Removal of forest cover	Increase in soil erosion
Unsustainable agriculture		Use of chemicals could damage the soil microorganisms
Irrigation	Remove upper soil horizons	Stress for plants and can damage agricultural productivity
Erosion	Wind and water can remove upper layers of the soil, removing organic material, minerals and nutrients	Impact on water quality-can cause flood Impact on air quality-dust
Desertification	Enlargement of deserts	Can cause crop failure and lead to malnutrition and famine

Many forms and causes of degradations

A significant amount of chemical and energy input is required in commercial and industrialized food production systems. This is achieved through the application of synthetic chemicals, genetically modified organisms, and a number of other industrial products. This method usually alters the natural environment, deteriorates soil quality, and eliminates biodiversity. The goal of commercial and industrialized food production systems is to maximize the potential yield of crops.. In maintaining a conventional system, biodiversity, soil fertility, and ecosystems health are compromised.

Sustainable agriculture is a more holistic approach to farming than conventional in that it relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects Sustainable agriculture is a natural way to produce food and has a number of social, economic, and environmental benefits.



Commericial industrialised food production systems generally tend to reduce soil fertility more than small-scale subsistence farming methods

Reduced soil fertility may result in soil erosion, toxification, salination and desertification

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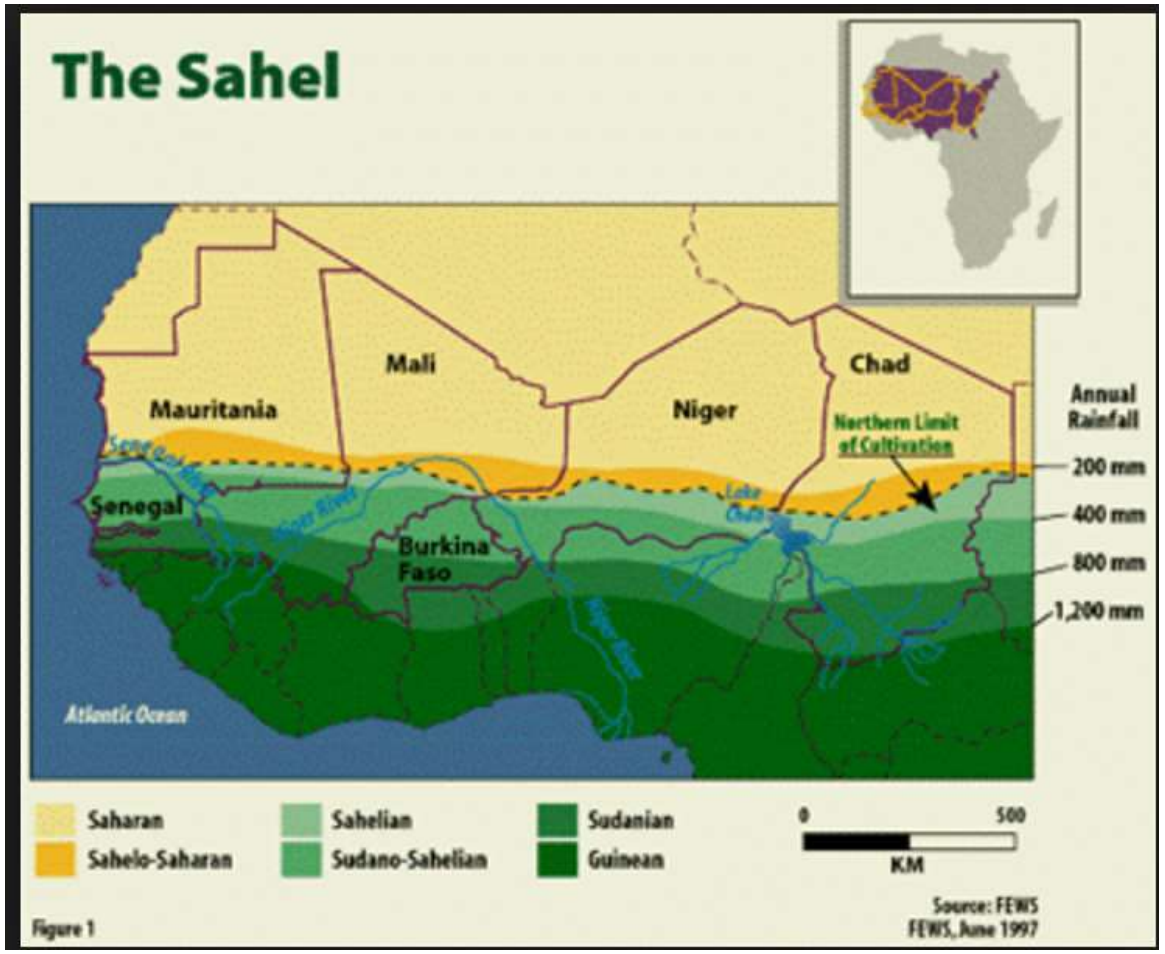
Many poor farming and forestry operations encourage erosion. Erosion accelerates when sloping land is ploughed and when grass is removed from semi-arid land to begin dry-land farming. It accelerates when cattle, sheep and goats are allowed to overgraze and when hillside forests are felled or cut indiscriminately. While there are isolated instances of deserts being reclaimed by irrigation or of new forests being planted, man, in the majority of instances, degrades the soil when he begins agricultural operations.

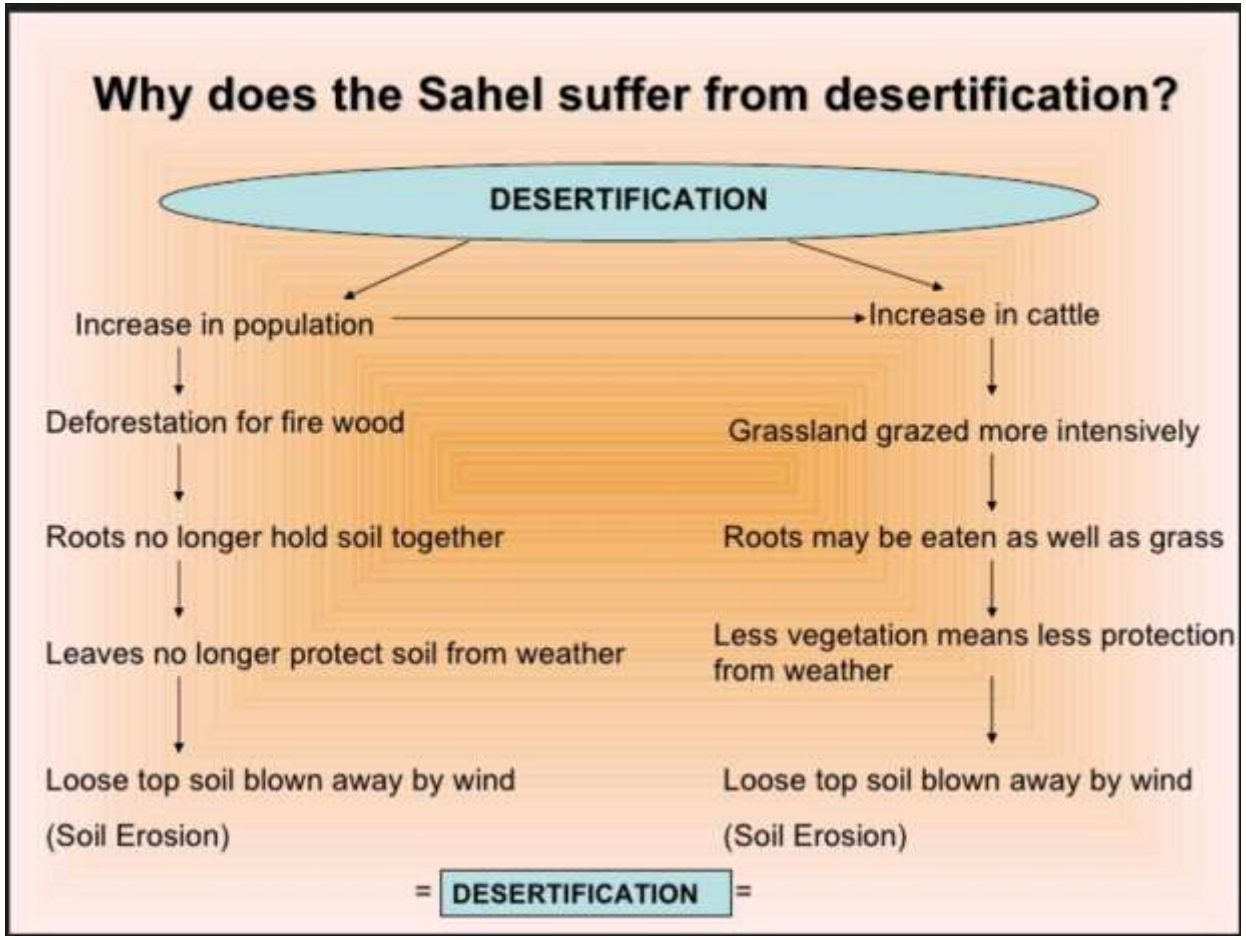
Poor management practices can also lead to low organic matter. This will result in poor water infiltration, poor water drainage, saturated soil, or compaction. These practices will limit the ability of water to infiltrate the soil causing an increase in the soil salinity and the soil's ability to buffer salt.

Desertification is the accumulated result of ill-adapted land use and the effects of a harsh climate. Human activities that represent the most immediate causes are:

- over-cultivation exhausts the soil,
- overgrazing removes the vegetation cover that protects it from erosion
- deforestation destroys the trees that bind the soil to the land and poorly drained irrigation systems turn croplands salty.
- the lack of education and knowledge
- the movement of refugees in the case of war, the unfavorable trade conditions of developing countries and other socio-economic and political factors enhance the effects of desertification.

Due to the lack of alternative survival strategies, farmers tend to relentlessly exploit natural resources (food crops, water for drinking and washing, firewood) to the point that they are often over-exploited and cannot regenerate naturally. Soil nutrients and organic matter begin to diminish as intensive agriculture removes quantities of nutrients greater than the soil's natural regeneration capacities. As a consequence, the soil is unable to recover, as it does during fallow periods, resulting is an ever-increasing spiral of environmental degradation and poverty, the principal causes of desertification.





Soil conservation measures exist such as: soil conditioners (for example, organic materials and lime), wind reduction techniques (wind breaks, shelter belts), cultivation techniques (terracing, contour ploughing, strip cultivation) and avoiding the use of marginal lands

Strategies for combating soil degradation is not so common or widespread and to reduce this risk farmers are encouraged and informed about the processes and conservation methods.

Farmers are in the need of beginning with extensive management practices like organic farming, afforestation, pasture extension, and benign (gracious) crop production. However to make this work policies need to be put into place.

Consider conservation measures:

- soil conditioners (for example, use of lime and organic materials)
- wind reduction techniques (wind breaks, shelter belts, strip cultivation)
- cultivation techniques (terracing, contour plowing)
- efforts to stop plowing of marginal lands
- Trickle drip is a slow release of water from pipes under the surfaces which can reduce the loss of evaporation

image from kids.britannica.com

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There are several methods farmers can use to reduce or prevent erosion.

- Mechanical methods are used to reduce water flow including bunding, terracing, and contour ploughing. The goal is to prevent and slow down the movement of rain water down the slopes.
- Vegetation cover methods use roots of crops to help bind the soil and decrease the action of wind and rain on the soil surface. Increased organic on the soil surface allows the soil to hold more water and reduce the mass, movement and erosion and stabilizing the soil structure.
- Soil husbandry is used to prevent damage to the soil structure. Care is taken to reduce the use of heavy machinery especially on wet soils and ploughing on soils that are sensitive to erosion.

The three main ways of managing salt-affected soils is by:

- flushing the soil with water and leaching the salt away
- using gypsum and calcium sulfates to replace sodium ions on the clay and colloids
- reduction in evaporation losses to reduce the upward movement of water in the soil

Both socio-economic and ecological factors have been ignored and integrated approach to soil conservation is needed, non-technological factors like population pressure, social structures, economy and ecological factors can determine the appropriate technical solutions.

CASE STUDY

Common measures to minimize wind erosion on light agricultural soils of Northern Europe

Table 3.12 comments on some measures to curb wind erosion.

TABLE 3.12 MOST COMMON MEASURES TO MINIMIZE WIND EROSION ON LIGHT AGRICULTURAL SOILS OF NORTHERN EUROPE

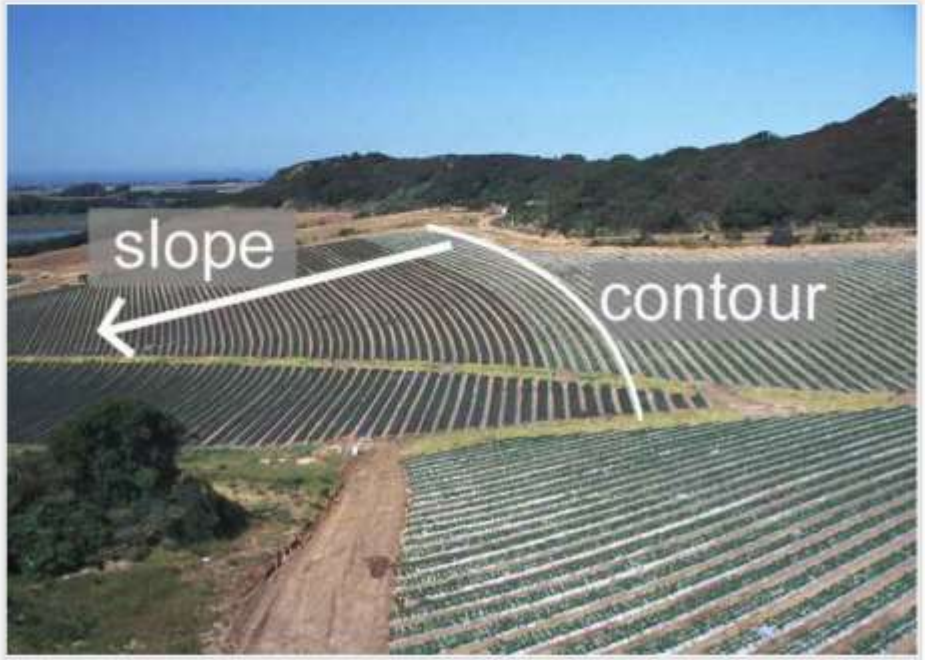
Measure	Comment
Measures that minimize actual risk (short-term effect)	
autumn sown varieties	need to be sown before the end of October to develop a sufficient cover
mixed cropping	after the main crop is harvested, second crop remains on the field
nursing or cover crop	more herbicides needed
straw planting	unsuitable on light sandy soils
organic protection layer (e.g. liquid manure; sewage sludge; sugar beet factory lime)	depends on availability, and regulations on the use of these products
synthetic stabilizers	unsuitable on peat soils
time of cultivation	depends on availability of labour and equipment
cultivation practice (e.g. minimum tillage; plough and press)	not suitable for all crop or soil types
Measures that lower the potential risk (long-term effect)	
smaller fields	increase in operational time and costs
change of arable land to permanent pasture or woodland	loss of agricultural production and farm income
marling (increasing the clay content to 8–10%)	suitable material should be available close by
wind barriers	high investment cost, and loss of productive land; takes several years before providing full protection; level of protection reduces with distance from the shelter

Evaluate soil management strategies in a named commercial farming system and a named subsistence farming system

The North American Prairies and commercial farming

The problems occurred were increasing salinity, soil erosion and loss of soil fertility. Farmers managed to reduce salinity and erosion, to reduce salinity summer fallowing or leaving bare soil for long periods were stopped or reduced. Snow fences or barriers enabled snowdrifts to pile up which provide water then they melt in.

And to reduce erosion is used Contour ploughing- along the contour lines instead of up and down slopes traps soil and water. Strip Cropping – growing as flax and tall wheatgrass at right angles to the wind.



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