



## Environmental issues in the Sahel

### Introduction

The Sahel is a region of Africa to the south of the Sahara Desert. It is experiencing many of the changes associated with hot semi-arid environments, including over-cultivation, over-grazing, soil erosion, salinisation and desertification. This Factsheet will examine the characteristics, causes and consequences of each environmental issue.

The Sahel region of Africa includes parts of Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, and Sudan. Technically it is contained within the 250mm and 750mm isohyets (lines of equal annual precipitation) and can be regarded as a fragile environment. The eight countries within its boundaries are some of the poorest countries of the world and, therefore, struggle to deal with this enormous range of environmental problems.

### Over-grazing

#### 1. Characteristics

Overgrazing occurs when the number of grazing livestock in an area exceeds carrying capacity. Carrying capacity is the number of animals that can be supported without causing long-term ecological damage.

#### 2. Causes

Parts of the Sahel have been used by nomadic pastoralists for millennia without over-grazing being a problem. Why is over-grazing a problem today?

- Sedentarisation of agriculture - the replacement of nomadism by sedentary agriculture has increased year-round pressure on land. In Mauritania, for example, much of the land formerly used by nomads has been enclosed for cultivation of cash crops (e.g. groundnuts). Nomads are forced to spend the whole year on marginal land.

- Increasing numbers of livestock - as the demand for meat has increased, livestock ranches have been developed on marginal land. According to the United Nations, in recent years the total number of grazing animals in the Sahel was more than double the region's carrying capacity.

Degradation by grazing is most concentrated around points used heavily by animals, such as boreholes.

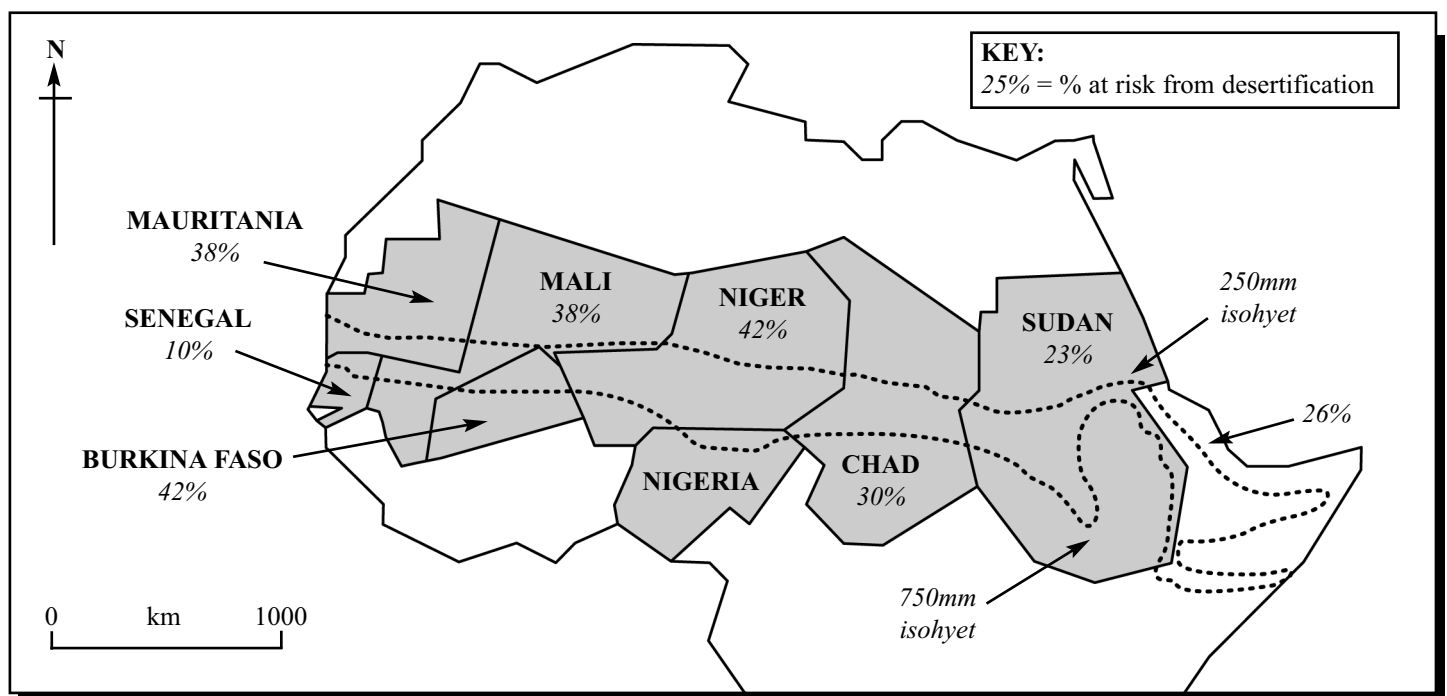
#### 3. Consequences

- Removal of ground cover - livestock eat grass and leaves, so making the soil more susceptible to erosion by wind and water;
- Trampling of vegetation - this destroys ground cover and compacts the soil, making it tougher for roots and rain-water to penetrate;
- Grazing changes the species composition of vegetation - for example, the valuable fodder grass *Cock's Foot* has become less common in grazed areas throughout the Sahel.
- Reduction in plant biomass and primary productivity - this is most severe around boreholes. In one study of vegetation around a borehole in Niger, it was shown that dry-matter biomass declined from 100 kg ha<sup>-1</sup> to 8 kg ha<sup>-1</sup> in eight years.

Virtually all Sahel range-land is at least moderately degraded. 650,000 km<sup>2</sup> of land once suitable for agriculture or intensive grazing has been lost over the last 50 years. However, grazing has some benefits. Grazed areas receive a high nutrient input through animal wastes. In any case, vegetation shortage may lead to higher rates of mortality among livestock.

**Exam Hint: Weaker candidate blame over-grazing on ignorant nomads. Stronger candidates make it clear that nomadic farming systems have been disrupted by recent socio-economic changes.**

Fig 1. Location of the Sahel Region within Northern Africa.



## Over-cultivation

### 1. Characteristics

Over-cultivation occurs when the crop yield taken from land exceeds carrying capacity.

### 2. Causes

- Expansion of cash crops - growing the same crops on the same piece of land for many years has depleted the soil of nutrients.
- Shorter fallow periods - this leads to nutrient depletion and reduced yields.
- Use of agricultural machinery - heavy machinery compacts the soil and makes it more vulnerable to erosion by wind and water.
- Increased use of marginal land - steep and arid land is used for crops. In Niger, for example, millet fields have appeared 100km north of the official limit to cultivation.

### 3. Consequences

- Reduced soil nutrient content - 90% of soils in the Sahel are deficient in phosphorus. Several years of arable monoculture exacerbates nutrient deficiencies, and forces farmers to apply expensive artificial fertilisers.
- Accelerated soil erosion - associated with periods when crop cover is low or when land is compacted by machinery.
- Salinisation and waterlogging - associated with inefficient irrigation practices (see below).

## Accelerated soil erosion

### 1. Characteristics

Soil erosion is the removal of topsoil by water or wind. In the Sahel, soil erosion usually starts with deforestation and is accelerated by burning. Sheet erosion by running water follows, followed by gully erosion. On slopes this may lead to landslides in the short rainy summers. In the dry winter, widespread wind erosion is a major issue.

### 2. Causes

- Deforestation - the long-term clearance of forests by humans. Trees are cut down to provide fuel wood and to increase the amount of land available for cultivation. In the Sudan, for example, there are now few trees within 90km of Khartoum city centre. In Burkina Faso, demand for wood now far exceeds natural regenerative capacity. It is estimated that while the Sahel can provide food for 3.9 million people, it can only provide fuel in the form of firewood for 300,000.
- Over-grazing - which produces bare patches of land, especially around boreholes, roads and settlements.
- Over-cultivation - which leads to nutrient depletion and reduces the binding of soil particles.
- Use of dung for fuel - where wood is in short supply, cattle dung is used for fuel. This removes a nutrient supply from farmland, and thus encourages a loss of soil structure.
- Cultivation of steep slopes - vegetation clearance on steep slopes has increased the susceptibility to erosion by running water.

**Exam Hint: Population increase does not necessarily accelerate soil erosion. Larger populations can plant more trees and change cultivation techniques, thus reducing the rate of erosion.**

### 3. Consequences

- Loss of soil depth - in south-east Nigeria, for example, over 20% of agricultural land has been destroyed by landslides, sheet and gully erosion.
- Loss of soil fertility - associated with a reduction in net primary productivity and loss of organic matter and nutrients
- Reduction in available soil moisture.
- Breakdown of soil structure.

## Salinisation

### 1. Characteristics

Salinisation is an increase in the salt concentration in topsoil to concentrations which are harmful to plants. Note that there are different types of salinity - common salt (sodium chloride) is not the only soil contaminant.

Where potential evapotranspiration exceeds precipitation, evaporation of water from the soil surface brings water upwards from below by capillary action. Dissolved salts, brought to the surface, are deposited when the water evaporates.

Good quality irrigation water contains only 100ppm of salt, yet will leave behind 314 kg of salt per hectare per year. Poorer quality irrigation water, which may contain 500 ppm of salt, can leave up to 5000kg of salt per hectare per year.

### 2. Causes

- Irrigation - if excess water (more than the crops can absorb) is applied, surface water is left on the soil surface.
- Poor drainage - if the soil becomes waterlogged, salt accumulates and poisons crops. In arid areas, the water table may rise, bringing salt-containing water from deep underground.
- Deforestation - this increases soil surface temperature because there is no longer absorption and reflection of insolation by the forest canopy, and therefore promotes evaporation.

**Exam Hint: Irrigation does not necessarily lead to salinisation. Remember that the excess surface water is the major problem.**

### 3. Consequences

- Toxic soil - sensitive crops will not tolerate salinity above 1000 ppm. Even salt-tolerant crops, like dates, will not tolerate salinity above 6000 ppm.
- Increased pH - basic compounds (e.g. sodium carbonate) can accumulate in salinised soils. High pH (alkaline) reduces crop yield as it inhibits plant enzymes.
- Loss of soil structure - salts react with clay minerals to create impermeable soils.
- Reduced potability of water supplies - salinity is a major determinant of water potability. The upper limit of suitability is 700ppm. Sea water contains approximately 3500ppm of salt.
- Accelerated salt weathering.

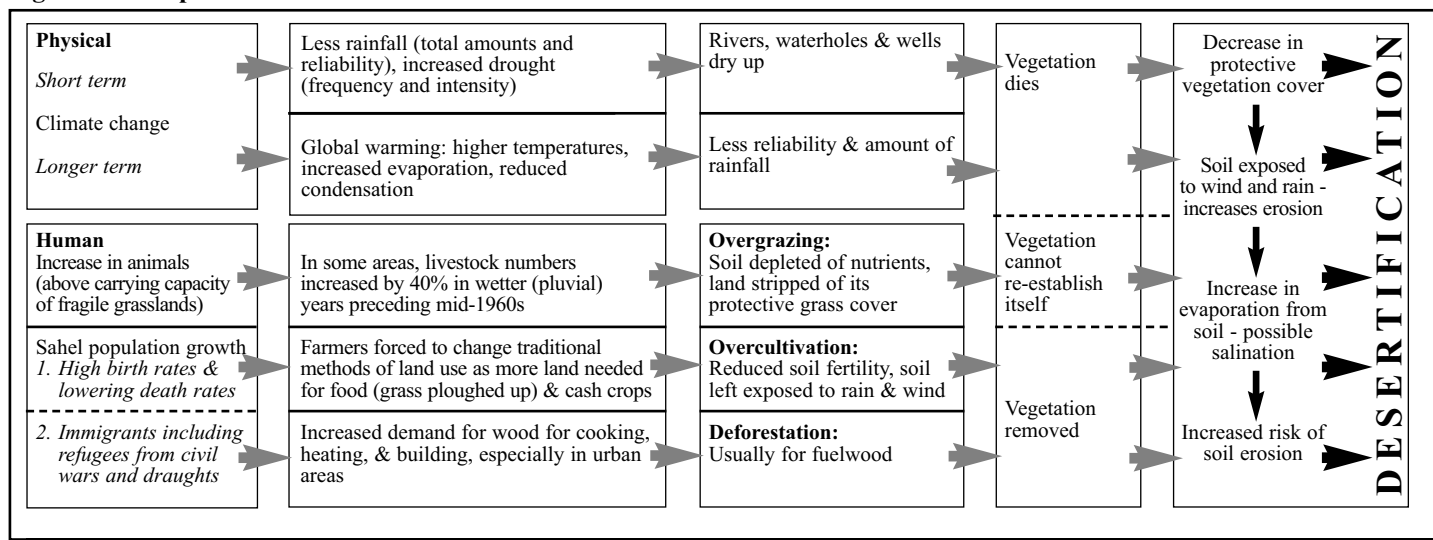
## Desertification

### 1. Characteristics

Desertification is one part of the wider process of land degradation. Land degradation is a loss in the utility of land, implying a reduction in biological productivity.

The 1977 United Nations Conference on Desertification defined it as “the diminution or destruction of the biological potential of the land that can lead ultimately to desert-like conditions.” By 1990, the UN defined it as “land degradation in arid, semi-arid and dry sub-humid areas resulting mainly from adverse human impact.” Fig. 1 shows the percentage of population in the Sahel at risk from desertification.

Desertification is sometimes inaccurately portrayed as the advance of mobile sand dunes. Although some dunes can move (e.g. barchans can move 30m per year) it is more common for desertification to occur in isolated pockets around boreholes, settlements and roads.

**Fig. 2 The complex causes of desertification**

As can be seen from Fig. 2 the causes of desertification are complex – with both physical and human factors combining to increase the risk of desertification.

## 2. Causes

- Drought - precipitation in the Sahel has decreased since the 1960s. During 1920-39 the 200mm isohyet passed through Khartoum in Sudan, but by 1965-84 the isohyet had shifted 200km to the south. There are fewer heavy-rainfall events. Lake Chad, the largest lake in the Sahel, has contracted in size from 23500km<sup>2</sup> in 1963 to 2000 km<sup>2</sup> in 1985. Global climate change is predicted to lead to further reductions in precipitation.
- Direct human activity - over-grazing, over-cultivation, accelerated soil erosion and salinisation (all discussed above) have contributed to land degradation. Where the vegetation cover is lost, there is more evaporation and the soil is exposed to erosion by wind and rain. It is estimated that over-grazing is the main cause of desertification for 65% of affected land in the Sahel.
- Indirect human activity - social changes like the expansion of cash-crop cultivation, sedentarisation of nomadic pastoralists and the loss of indigenous traditions for coping with droughts (e.g. long fallow periods) have led to practices which encourage desertification.
- Rising population from natural increase (average 2-3% per annum) and in-migration of refugees from wars in Liberia, or Sierra Leone, has led to increased demands for food and fuel wood.

**Exam Hint: When describing the causes of desertification, you should refer to all the issues described in this Factsheet.**

## 3. Consequences

- Decreased organic matter in soil because less litter is produced. This reduces the soil nutrient content and the water-holding capacity of the soil. Nutrient recycling is slower because there is less biological activity.
- Soil surface crusting by rainsplash erosion may increase runoff by 40% in high-rainfall events.
- Decreased shading of the soil surface increases temperature so that more evaporation occurs.
- Decreased plant cover decreases the roughness of the soil surface, thus reducing wind turbulence and increasing wind speed. Since soil particles are less well connected, dust storms become more frequent.
- Loss of crop yield, leading to food deficit and malnutrition. Refugees from desertified land migrate into cities. For example, one sixth of the population of Mali and Burkina Faso has emigrated from degraded land.
- Desertification has played a part in armed conflict in arid lands, having contributed to political instability, starvation and social breakdown in places such as Somalia.

## Practice questions

- Explain what is meant by the term “desertification”. (15 marks)
  - Using an area you have studied, examine the extent to which desertification is caused by human activity. (30 marks)
- A clear definition is required which includes the main features and causes of desertification. You should place desertification within the wider issue of land degradation, discuss the reduction in land utility and productivity, and locate it within hot arid and semi-arid environments. You might discuss the two views of desertification: first, the idea of the advancing desert front, and second, the idea of pockets of degradation around areas of human activity.
  - A well-located answer is required. You should respond explicitly to the words “to what extent”. Start by discussing the direct and indirect human causes (over-grazing, over-cultivation, soil erosion, salinisation and social changes), then describe climatic factors (e.g. the drought of the 1970s and 1980s). The examiner will be looking for inter-relationships between the different processes that you have discussed. Your conclusion should bring together both parts of the essay and answer the question given in the title. Your own version of a diagram such as Fig 2 is well worth learning.

## Further research

Thomas, DSG and Middleton, NJ 1994: *Desertification: exploding the myth*. A very detailed book that looks at the history, causes and controversies of desertification. Chapter 5 examines the physical causes (over-cultivation, over-grazing, soil erosion, etc.) and Chapter 6 examines the social causes.

## Useful websites

<http://www-sul.stanford.edu/depts/ssrg/africa/guide.html>

The Africa South of the Sahara site - contains many helpful articles.

<http://grid2.cr.usgs.gov/geo1/ch/toc.htm>

The UN Global Environment Outlook Report 1997 contains a section on environmental issues in Africa, including a large amount of useful data.

## Acknowledgements;

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