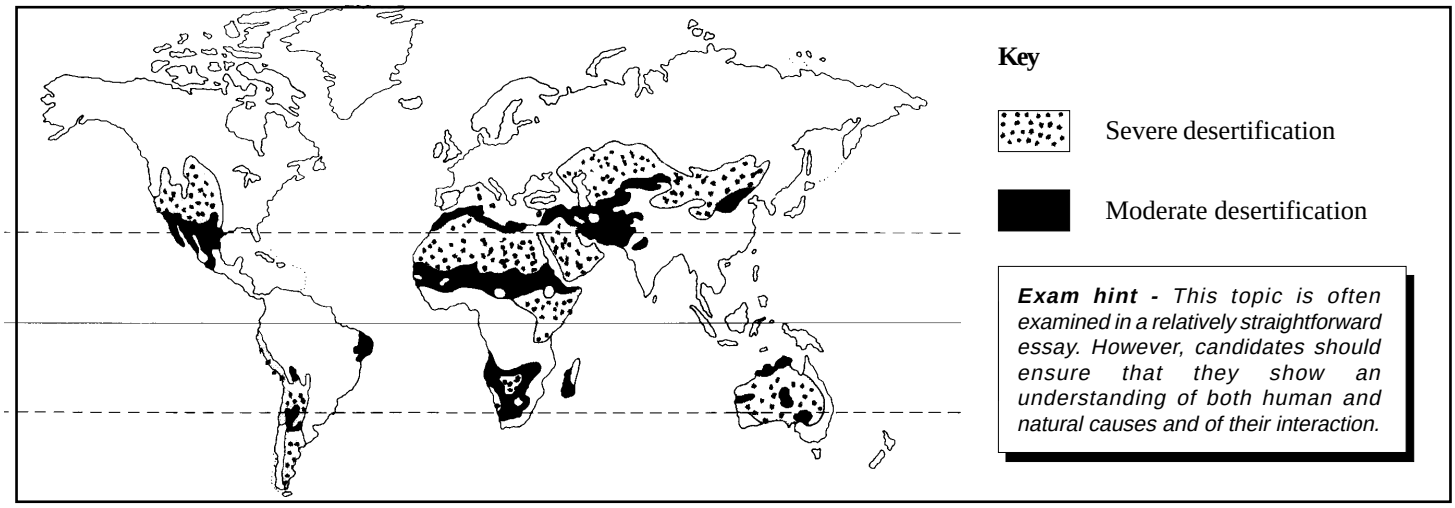
Geo Factsheet

Number 28

Desertification - Causes & Control

Desertification can be defined as the diminution or destruction of the biological potential of the land, often resulting in 'desert'-like conditions. Many observers believe that desertification is caused by a combination of both physical and human factors. This Factsheet will summarise these factors and outline some of the techniques which have been used to try to prevent or slow down the process.

Fig 1. Map of Arid and Semi-arid Climates of the World



Exam hint - *This topic is often examined in a relatively straightforward essay. However, candidates should ensure that they show an understanding of both human and natural causes and of their interaction.*

What is Desertification?

Desertification can be defined as 'land degradation in drylands resulting from human actions'. In other words, desertification is the loss of soil and its productivity in the arid and semi-arid regions of the world (defined as having less than 250 mm of rainfall per year) mainly due to its overuse by man. By undermining food production and contributing to malnutrition and famine, desertification can have devastating consequences.

The extent of the problem:

- 20 million km^2 of land are degraded every year and this affects over 280 million people (Table 1).
- More than 110 countries have drylands potentially at risk from desertification, with the possibility of affecting 900 million people. Those already suffering include Africa (both North and South), China, Pakistan, Australia and North America. Desertification does not differentiate between developing and developed countries.
- The problem does not just occur on the fringes of natural deserts, but in any dry area.
- The United Nations claim that $45 billion will be needed every year for the next twenty years to reclaim degraded land.

Table 1. Areas and Numbers of People Affected by at Least Moderate Desertification by Region

	Affected Area (1,000 sq km)	% Total	Affected Population (millions)	% Total
Africa	7,409	37	108.00	38
Asia	7,480	37	123.00	44
Australia	1,123	6	0.23	0
Med. Europe	296	1	16.50	6
N. America	2,080	10	4.50	2
S. America & Mexico	1,620	8	29.00	10
Total	***20,008***	***100***	***281.23***	***100***

The symptoms of desertification include soil erosion, loss or degradation of vegetation, desiccation of the soil profile, lowering of the water table, dune formation or reactivation and salinisation.

What Causes Desertification?

A combination of **natural** and **socio-economic** processes are responsible for the degradation of soils.

Natural processes

There are **three** main climatic factors that influence the onset and continuation of desertification processes:

1. The occurrence of **droughts** (periods of below-average rainfall), which can last for years.
2. High temperatures which cause a high rate of **evapotranspiration (**the loss of moisture from the Earth's surface by a combination of direct evaporation and transpiration from plants) and therefore a high rate of moisture loss from soils.
3. Infrequent and often intense periods of rainfall which compacts soils, increasing their erodibility.

Socio-economic processes

There are four main **human** actions which accelerate desertification - overgrazing, overcultivation, deforestation and poor irrigation.

1. **Overgrazing**. This occurs where herd sizes exceed the **carrying capacity** (the number of cattle that can graze an area sustainably i.e. without long term damage occurring). If this capacity is exceeded:

(a) Vegetation changes, e.g. drought-resistant species replace edible species.

(b) Soil quality is reduced, e.g. grazing animals compact and break down the soil structure, increasing its vulnerability to erosive processes.

(c) The health of livestock and their productivity decreases.

(2) Overcultivation. May occur when increasing food production is needed:

(a) To support increasing populations.

(b) When rural people are encouraged to grow 'cash crops' for sale in city markets and for export.

A common feature of all cash crops is that they are extremely demanding in their nutrient requirements. If farmers lack natural or artificial fertilisers or are unable to allow sufficient fallow periods, fertility will rapidly decline. Such a process has been repeated in many African countries - in **Chad** the area under cotton was forcibly tripled by Government order and in **Niger** huge increases in the cultivation of groundnuts (peanuts) led to rapid decline in yield and fertility.

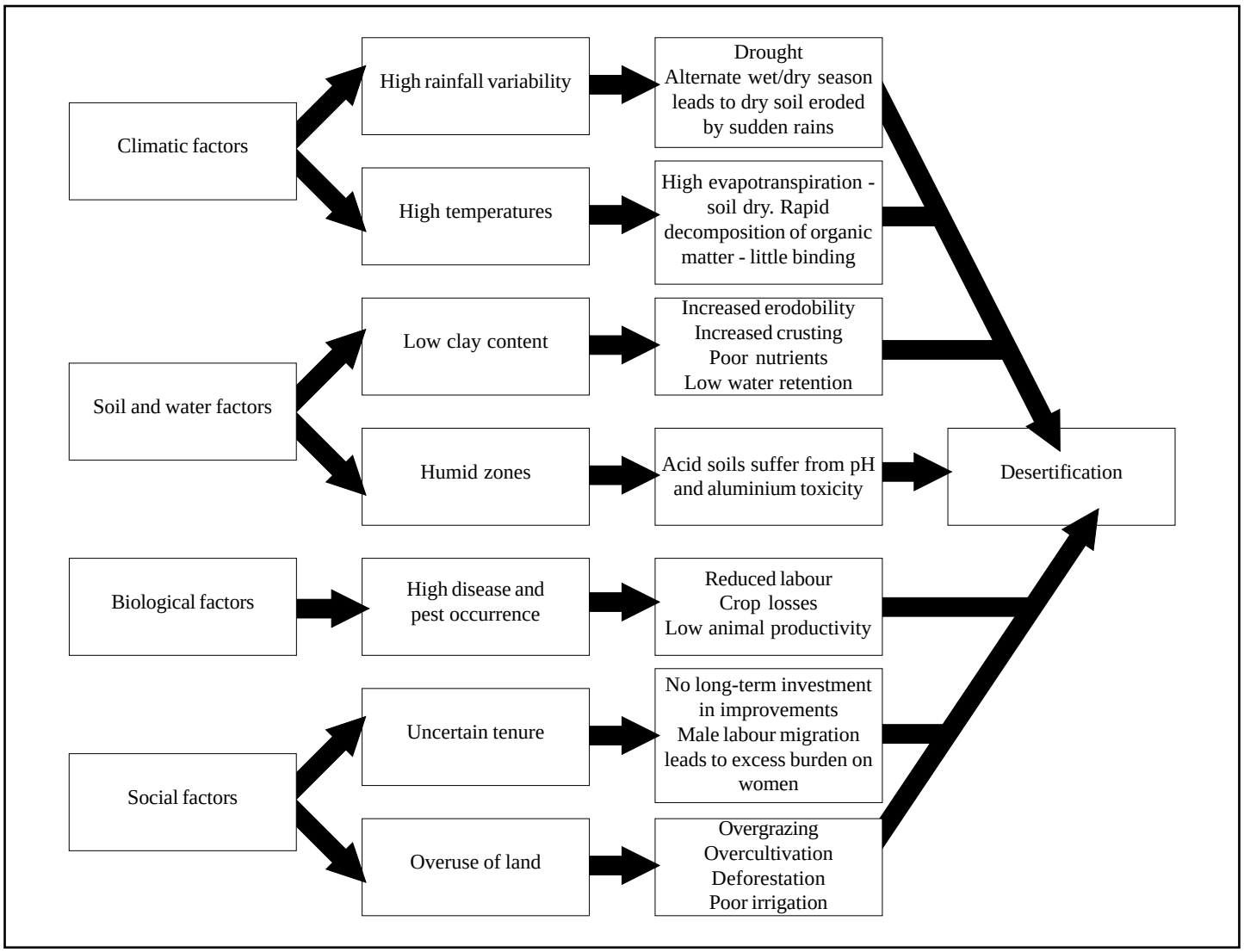
Declining fertility may lead people to cultivate marginal areas i.e. those which are inherently incapable of sustaining food production e.g. steep slopes which are highly erodible or areas which receive irregular and/or insufficient rainfall. Soil fertility will inevitably fall if vulnerable lands are left fallow (uncultivated) for shorter and shorter periods of time. Nutrient contents fall and soil structure deteriorates. This leads to reduced crop yields and vegetation cover, leaving soils exposed to erosion by wind and rain.

(3) Deforestation and excessive fuelwood cutting. Forest is cleared for agriculture or fuelwood. This leads to reduced shade and greater desiccation of the soil, a lowered water table and an increase in the use of dung (otherwise used as fertiliser) as a fuel source. The resulting loss of organic matter reduces both the 'stickiness' of the soil peds and the water-holding capacity of the soil; its erodibility therefore increases.

(4) Inappropriate irrigation practices. Fertility is reduced through **salinisation** (the build up of salt around the roots of plants) and **waterlogging** (caused by poor drainage and the formation of an impermeable salt crust on the soil surface).

The combination of these and other biological, soil and water factors are summarised in Fig 2.

Fig 2. Summary of the Causes of Desertification



> ***Exam hint -*** *Pass grade responses will provide reasonable* ***descriptions*** *of the processes involved. A-C grade responses will show a thorough understanding of the interaction of natural and socio-economic factors and will provide* ***explanations*** *of several interactions.*

These practices are not carried out in ignorance; often, villagers fully understand the potentially harmful consequences of overcultivation, overgrazing and deforestation. However, lack of ownership of land or uncertainty of whether they will even be allowed to cultivate an area from one year to the next (uncertainty of tenure) and lack of government financial assistance or technical aid means that villagers often feel they have little long-term security or stake in the land. Such insecurity does not encourage sustainable agriculture.

However, not all researchers believe that desertification has been accelerated by human activities such as overgrazing. Such sceptics point out that the United Nation's own estimates of desertification have an accepted margin of error of 10%. The spread of deserts along the edges of the **Gobi** in **China** and the **Kalahari** in **southern Africa** fall within this margin of error. Desertification, it is argued, is much more a consequence of natural climatic variability and, as many studies have shown, desert margins naturally oscillate by tens of kilometres over periods of a decade. Other researchers have explained the importance of the difference between a meteorological drought (a period of abnormally low rainfall) and an agricultural drought (a reduction in soil moisture leading to a decrease in agricultural production). Even in areas of the **Sahel** (see Case Study below), some researchers believe that there is conflicting evidence about both rainfall and agricultural production and that the accuracy of scientific records is not sufficient to draw firm conclusions. It is becoming increasingly accepted however, that global climate change is increasing the likelihood and/or severity of drought.

Case Study: The Sahel

The Sahel is a ***transition zone*** *between the Sahara Desert in the north and the savannahs in the south.*

Since the 1940s, 650,000 km² of The Sahel region in West Africa, south of the Sahara Desert (Fig 3), have turned to desert. Reasons for this include:

- *This region has been going through a long lasting decline in precipitation over the last 50 years (Fig 4). Explanations for this gradual change have included changes in the ground's surface reflective properties and global climate (i.e. the 'enhanced greenhouse effect').*
- *Farmers who traditionally rotated crops were forced to stop allowing their soil's vital fallow period. Population pressure has been the main force behind this, and the 'carrying capacity' of the land has therefore come under strain as land is not recovering.*
- *Farmers have been forced onto marginal, less fertile land.*

Population growth in the region has often been identified as the underlying cause of factors such as overgrazing, overcultivation and deforestation. The population of ***Ethiopia****, for example has increased by nearly 300% since 1950 and similar increases have affected countries such as* ***Somalia****,* ***Sudan*** *and* ***Niger****. Since rainfall is always erratic in the region, the actual areas which can be used for non-irrigated cultivation vary annually. Severe drought in the late 1960s/ early 1970s, along with poor land use, led to the deaths of between 50,000 and 250,000 people, 3.5 million cattle, sheep goats and camels.*

Fig 3. The Sahel region extends across Africa along the southern edge of the Sahara.

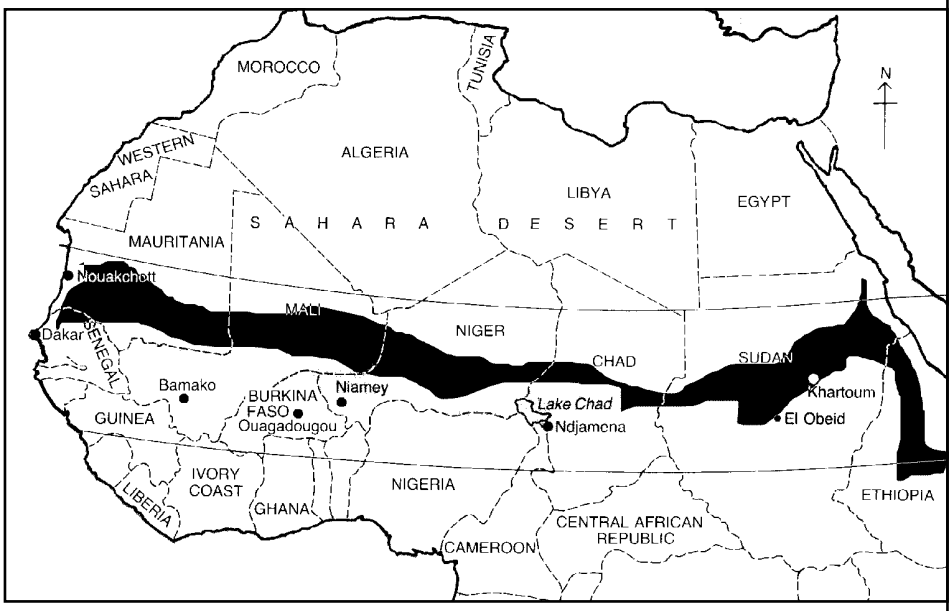
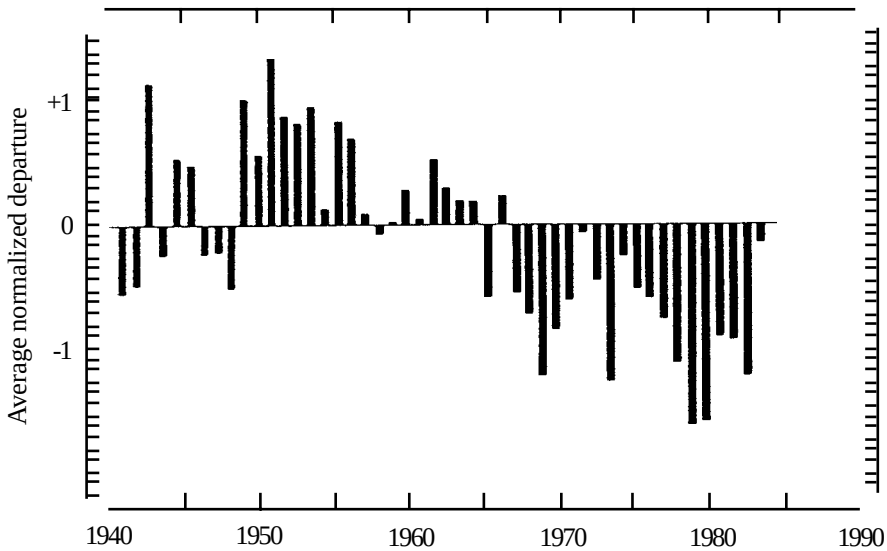


Fig 4. Rainfall Trends in the Sahel Region 1941-1988



Desertification has been successfully tackled in many areas of the world. However, there have been more failures than successes (see Box and Table 2).

Reasons for the Failure of Measures to Combat Desertification

- Lack of technical knowledge and the use of non-local techniques. For example, in the **Eastern Refugee Reforestation Project, Sudan** in the 1980s, only 28% of the windbreaks planted were successfully established, mainly due to incorrect seeding, lack of herbicides to prevent competition from weeds and the damaging effect of heavy rains.
- Governments being centralised in their approach to measures while poor people living in marginal, 'less visible' areas were overlooked.
- Radical proposals required major governmental policy changes which proved difficult to impose.
- Measures did not take local cultural and socio-economic needs into account when they have been carried out, alienating local communities. For example in **Niger** in the early 1970s, the increased sinking of wells led to tribes from outside the region bringing their herds to use the new resource. This led to overgrazing.
- Aid from donor countries was not directed properly.
- The use of resources was not planned well enough, leaving many projects unfinished.
- After initial treatment and when symptoms disappeared, interest in dealing with the problem waned while the underlying problem still existed.

However, there have been many successes; In **West Africa** in the 1980s. Kad trees (a type of Acacia, suited to drier climates), were used to revitalise cropland and pasture in a number of ways:

- By buffering winds, preventing wind erosion of the soil
- Fixing nitrogen, a vital plant nutrient, which other plants can then use
- Providing a plentiful supply of fuelwood

Table 2. Desertification Control Measures

Area to be Addressed	Suggested Measures for Improvement
Crop Production	(a) Develop drought resistant crop varieties (b) Increase the use of organic fertilisers (c) Improve cropping and irrigation systems
Livestock Management	(a) Improve the quality of animals by disease control and selective breeding (b) Reduce livestock populations to below carrying capacity (c) Improve rangelands by reseeding, allowing regeneration time and planting new fodder crops (d) Improve infrastructure by digging wells and improving roads to markets (e) Introduce regional livestock raising schemes, self-regulated by Pastoral Associations
Forestry Management	(a) Protect existing trees (b) Plant specially designed and managed fuelwood forests (c) Improve household stoves to reduce wood consumption (d) Introduce other energy sources, such as solar and wind power
Water and Land Management	(a) Improve irrigation schemes by redesign (b) Use measures which increase water harvesting, such as lines of stones (d) Increase incidence of windbreaks
Socio-economic Factors	(a) Guarantee tenure or ownership of land (b) Use education to expand local awareness of desertification and to inform people of the skills to combat it (c) Provide buffer stocks of food and resources for people involved in schemes which may, in the short term, reduce the output of their land (d) Improve health services

In **Burkina Faso, West Africa** in the early 1990s, walls of stones, known as 'magic stones' were placed in fields to trap soil that would otherwise have been washed away. Crop yields have since increased by 50%.

In **Northern China**, a 'Great Green Wall' has been planted to hold off the advancing desert and stabilise eroded uplands. The **San Bei** forest belt will eventually cover 3.5 million km^2. Built by local communities and assisted by government, this 'wall of trees' protects 80,000 km^2 of valuable cropland. In 1990, the annual grain harvest was up by 13%.

In **Rajastan, India** since the 1980s, Acacia trees have been used to stabilise 600 km^2 of sand dunes.

The most important point is that techniques suggested for improving land use must be economically attractive to people in affected areas as well as being compatible with their cultures. Social needs therefore have to be included in policies.

Acknowledgements;

This Geo Factsheet was researched and written by Samantha White

***Geo Press**, 10 St Paul's Square, Birmingham, B3 1QU*

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