Name: _____

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Class: _____

IB ESS

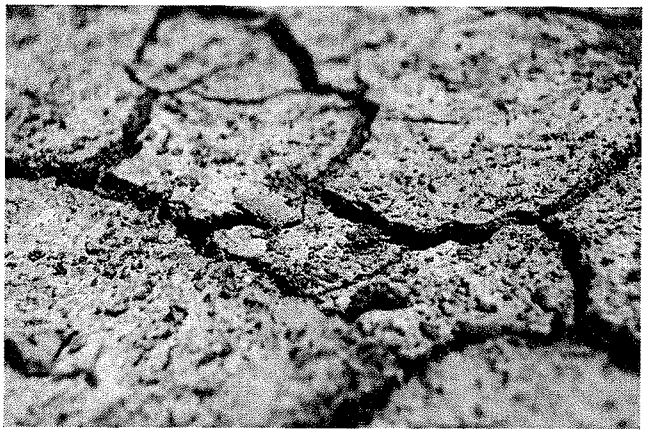
5.3 Soil Degradation and Conservation

Significant ideas:

Fertile soils require significant time to develop through the process of succession.

Human activities may reduce soil fertility and increase soil erosion.

Soil conservation strategies exist and may be used to preserve soil fertility and reduce soil erosion.



Soil Fertility and Succession

1. Outline how soil fertility changes through succession. Link to 2.4

(Consider the changes in organisms present, nutrient cycling, and soil erosion.)

Initially soil is little more than mineral particles, nutrient poor and with an erratic water supply.

Stage 1: simple soil starts from windblown dust and mineral particles

Stage 2: invertebrate species begin to live in soil increasing organic matter (humus) content and water holding capacity. Weathering enriches the soil with nutrients.

Stage 3: small plants (grasses + ferns) new species colonize, soil continues to increase in organic matter content, water holding capacity and nutrient content.

Stage 4: larger herbaceous plants can grow in the deeper and more nutrient-rich soil.

Stage 5: Climax community dominated by shrubs and trees.

Soil Degradation

1. Explain how the following human activities can affect soil fertility.

Deforestation Removal of forest increases soil erosion. The leaves of forest trees both deflect and slow down the progress of rain drops which helps stop them removing soil particles. The root systems of forests help to bind the soil together and give it stability.

Intensive grazing

Overgrazing of grasslands leaves bare patches where roots no longer hold the soil together. When this is combined with the actions of rain and wind the bare patches become bigger and soil is removed from the area.

Urbanization

Land in cities is paved and built upon so removing it removes a source of agricultural land and increases run-off which erode soil elsewhere many cities have expanded into prime agricultural land.

Irrigation

In many irrigation systems a major part of the water evaporates before reaching the crops. The minerals dissolved in the water remain in the top layer of the soil and form a hard salty crust (salinization) land is now unsuitable for growing crops.

Monoculture farming

The same nutrients are depleted from the soil leading to soil exhaustion. High yielding varieties of crops require large amounts of nutrients to go and have a greater impact.

2.

a) Describe the processes of soil erosion: sheet wash, gullying and wind erosion.

Sheet wash: large areas of surface soil are washed away during heavy storm periods and in mountainous areas moving as landslides

Gullying: channels develop on hillsides following rainfall. Over time these channels become much deeper (increasing water flow)

Wind erosion: on drier soils high winds continually remove the surface layer.

b) For each of the above processes, outline how farming (or other human practices) may result in soil erosion.

Sheet wash could result from total removal of crops after harvest.

Gullying could result from growing crops in rows with uncovered soil in between, especially if the crops are grown on a slope and the rows are in the direction of the slope

Gullying could also result from plowing in the direction of the slope as this leaves ready made channels.

Wind erosion will result from removal of crops.

3. Which farming practices tend to reduce soil fertility more: industrialised commercial farming or small-scale subsistence farming? Explain your answer.

Industrialized commercial farming will reduce soil fertility more due to soil erosion, exhaustion and toxification. This type of farm tends to grow monocultures which deplete the soil of the nutrients (exhaustion) and crops are completely harvested at the same time increasing soil exposure to wind and water (erosion). Irrigation will be more intense leading to increased salinization of the soil and the over-use of pesticides would result in toxification.

Small scale subsistence farming tends to grow a variety of crops, harvested at different times with less use of irrigation and chemical pesticides.

Soil Conservation

1. Describe how soil conditioners can be used to improve soil quality.

Crushed limestone or chalk increases the pH and counters soil acidification. Helps clay particles stick together so they act more like sand (this helps with drainage, trapping air and aiding decomposition) Organic materials improve the texture of the soil and act as a supply of nutrients (these are released slowly)

2. Explain how the following techniques are beneficial in conserving soil quality:

Terracing

This reduces the steepness of the slope by replacing the slope with a series of horizontal terraces this traps soil and water in the terrace and reduces soil erosion.

Plowing

Breaks up soil structure and temporarily increases drainage - this makes a seed bed for sowing. Growing evidence states that plowing is bad for soil structure and microbial activity.

Contour farming

Plowing and cultivating along contour lines perpendicular to the slope. The furrows and ridges act as small terraces trapping soil and water and the water flow downhill reducing erosion.

3. Explain how improved irrigation technique may conserve soil quality.

Covering irrigation canals will prevent evaporation before the water reaches the land. Trickle flow irrigation (drip irrigation) consists of a network of pipes covering the field. The pipes have small openings next to the plant so the plants can absorb the drops of water before it evaporates. Both of these prevent salinization of the soil.

4. Explain how crop rotation may conserve soil quality.

Growing the same crop year after year on the same land leads to pest and disease build up and impoverishes the soil. Changing the crop grown would allow the nutrient levels to recover. Planting legumes, for example, between other crops would add nitrogen to the soil.

5. Describe what is meant by the term *marginal lands* and explain why their use must be considered carefully in order to conserve soil quality.

Marginal land is land that is found on the edge of cultivated areas and is often difficult to grow crops on. (OED). The soil is of poorer quality than the cultivated land and using it to grow crops would further deplete the nutrients and increase the size of the marginal land.

Soil Conservation – Case Study

Research soil management strategies for a **named** commercial farming system and a **named** subsistence farming system. Evaluate these strategies. Guinness + Walpole (2016)

Commercial farming system: Wheat in Canadian Prairies

A very productive area vital to the Canadian economy where the issue of soil degradation is taken very seriously

Traditional strategies: crop-fallow rotation, ripping, strip farming.

More recent management strategies include diversified crop rotations together with the use of minimum and zero-tillage practises.

Farmers who were already aware of soil erosion problems were willing to adopt these new measures as they were; suited to the soil and climate of the region, practical to implement, capable of producing the quality and quantity of the grain expected and able to maintain the quality of soil, water and air resources.

The approach is more costly due to high equipment costs involved in changing from traditional practises but this has been offset by the income generated from the higher-value crops. The mixed cropping system has also lowered disease and weed pressure, resulted in greater residual soil nutrients and moisture reserves and reduced soil losses

Subsistence farming: Arumeru, Tanzania The People Land management and Environmental Change (PLEC) project

Difficult environment where farmers struggle to make a living for themselves and their family. A variety of crops are grown and different soil conservation strategies used but the 3 basic principles of the project are: minimum soil disturbance, soil cover (permanent if possible) and crop rotation.

The objective is to enhance soil fertility by improving water retention, increasing soil organic matter and reducing soil degradation.

Conservation agriculture aims to increase farm production, household food security and farm income

There are many strategies in place. Farmers have responded to their soil problems with a mixture of management strategies that reflect the resources they have available, traditional knowledge and the awareness of new techniques provided by the PLEC.

The conservation agricultural practices are still at relatively early stages but the PLEC has concluded that there is enough evidence from successful implementation in other areas