CAIE Geography Pre-U

1A: Hot Arid and Semi-Arid Environments

Essential Notes

Definitions, classification and distribution

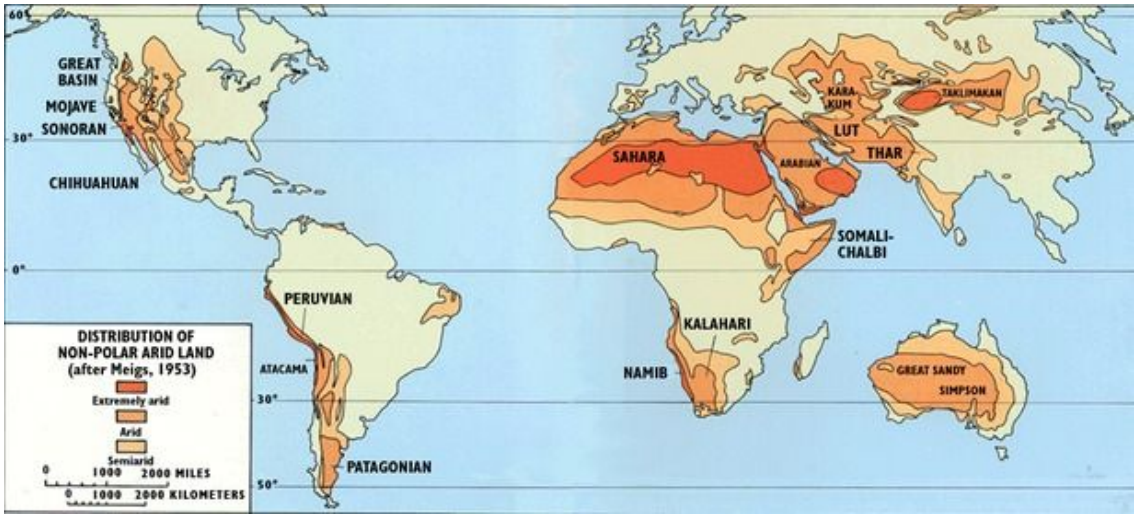
Meaning of aridity and the aridity index

Aridity is the lack of moisture, especially having insufficient rainfall to support most trees or woody plants. It is extremely dry, has low precipitation, and high rates of **evapotranspiration**.
The **aridity index** is the average annual precipitation divided by the annual potential evapotranspiration(the amount of evapotranspiration that would occur if there was sufficient water).
It is divided into three categories:

- **Hyper arid**
- **Arid**
- **Semi-arid**

Global distribution of hot arid and semi-arid areas

Mainly located on the west side of continents and mainly either along the **tropic of Cancer or the tropic of Capricorn**.



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Definition of desertification and the global distribution of desertified and desertifying areas

Desertification is the process of land **degradation** in arid and semi-arid regions as a result of various factors both climatic and from human activities.
Areas that are most at risk of desertification are those that surround existing deserts. Some of the most common causes are:

- Overfarming
- Removal of plants/deforestation
- Overgrazing
- Climate change
- Lack of precipitation
- Natural disasters

Past changes in the extent of aridity

Pluvials are periods marked by increased rainfall whereas **interpluvials** are those marked by decreased rainfall.

The **tertiary period** occurred 66 million to 2.6 million years ago and the **quaternary period** is the current and most recent period.

Scientists know that levels of aridity have changed due to various sources of evidence including:

- **Archaeological**
- Observing the **landscape and formations**
- **Biological** evidence
- **Ocean sediments** can be analysed

Scientists predict that in the future, arid and semi-arid areas will become more prevalent and extensive.

Controlling factors: Climate and the hydrological cycle

Causes of aridity

- **Relief and the rain shadow effect**
- **Global atmospheric circulation**
- **Cold ocean currents**
- **Offshore winds**
- **Continentality**

Characteristics of typical desert climates

- **High temperatures and large diurnal ranges.**
- **Low rainfall levels** with some periods of very heavy rain.
- High levels of **evapotranspiration.**

The hydrological cycle and water balance in hot arid and semi-arid environments

Even when rain does fall in arid areas, the effectiveness of this precipitation is very low due to:

- Rapid rates of **evaporation and transpiration**
- Bare surfaces which limit **infiltration**
- Low **interception** rates

This can cause flash floods whilst also not providing enough water for plant growth.

The role of climate in influencing natural sources of water in hot arid and semi-arid environments

For aquifers to recharge, long steady periods of rain are more effective than short intense periods of rain. This allows the rainwater to infiltrate into the ground more effectively. Coastal mist and fog relies on the correct air masses to be present over the sea for it to form. Higher temperatures will cause greater evaporation of surface water as well as greater transpiration from plants. Higher temperatures can also make the surface harder and less permeable to water and so less water infiltrates into the aquifers.

Natural sources of water in hot arid and semi-arid environments

- **Aquifers** are underground sources of water as a result of permeable rock, rock that contains fractures or unconsolidated particles.
- **Coastal mist and fog** occur due to sinking air above a layer of moist air that has been formed over the sea. This causes a layer of mist or fog which can then travel over the land.
- **Dew** is water in the form of droplets that appear on exposed, thin objects in the evening or morning as a result of condensation.

Processes and landforms in hot arid and semi-arid environments

Weathering processes

Weathering is the process of breaking down a rock. It is the mechanism that leads to rock decomposition or degradation, and the production of sediment.
Low levels of precipitation with occasional flash flooding, low levels of plant protection, high temperatures and high diurnal ranges all increase the levels of weathering.

- **Frost shattering**
- **Thermal fracture**
- **Salt weathering**
- **Wetting and drying**
- **Chemical weathering**

Processes of erosion

Erosion is the wearing away and/or removal of rock particles and other materials by a moving force.

- **Deflation by the wind**
- **Abrasion/corrasion by the wind**
- **Abrasion by water**
- **Sheet runoff by water**

Processes of transportation

Factors influencing transportation include:

- Amount and type of vegetation cover
- Wind speed, duration and direction
- Degree of turbulence
- Nature and size of surface material

Types of wind transportation include:

- **Suspension**
- **Saltation**
- **Surface creep**

Types of water transportation include:

- **Suspension**
- **Solution**
- **Bedload saltation**
- **Bedload traction**

Landforms and landscapes of the past and present

Landscapes

- **Mountain deserts**
- **Stony deserts**
- **Sandy deserts**
- **Shield deserts**

Wind erosion landforms

Landform	Explanation
Deflation hollows	A large, enclosed, surface depressions that were created by the removal of loose particles by the wind in large quantities. They collect runoff and can form salt lakes.
Ventifacts	Cobbles or pebbles which have been shaped by sand carried in the wind. This causes it to have smooth sides that are separated by sharp edges.
Rock pedestals	Mushroom-shaped rocks that occur where an isolated rock has been eroded more rapidly at the base.
Zeugen	A narrow ridge of land that has a protective cap of rock above it. Due to the horizontal layering of rocks, there is increased **corrasion** at lower levels.
Yardangs	Sculptured rocks which are streamlined, steep-crested, linear ridges of clay, rock or silt. They are caused by **abrasion** and small amounts of **deflation.** The rock layers are arranged vertically forming parallel rills or troughs.

Water erosion landforms

Landform	Explanation
Wadis	Dry river beds which form temporary channels after periods of rain. They have steep sides and a wide floor. They are formed by **flash floods** which widen the **rills** and **gullies** then streams of water widen these **gullies** into **wadis**
Canyons	Desert gorges and are much deeper versions of wadis. They are formed by heavy rainstorm events which result in flash floods. High water erosion is combined with tectonic uplift to form canyons.
Mesas	Elevated areas of land with a flat top and sides that are steep. They are formed by a **tectonically uplifted** horizontally layered rock which then

	undergoes **weathering** and **erosion**. This is called **differential erosion**.
Buttes	Were once part of a **mesa** or a **plateau**. They are an isolated hill with vertical sides and a small flat top. A protective cap of resistant rock protects the underlying rock from erosion.
Pediments	Gently sloping erosional rock surfaces which forms an angle of less than 7°. They are found at the base of mountain ranges or cliffs and are formed by the parallel retreat of steep slopes of a mountain front.
Arroyos	Dry riverbeds or seasonally active creeks. They are filled with water after heavy rainfall and dry up during dry periods. They are formed by **flash flooding**.
Inselbergs	**Isolated relic hills** which are rounder versions of **mesas or buttes.** They are formed by deep **chemical weathering** which occurs in the rock and the material is then carried away by water. The rock is then isolated by **differential erosion**.
Surface crusts	Extensive areas of flat desert surfaces which are covered by a hard crust of fine material which reduces infiltration. It is formed wind **deflation** and the **selective sorting** of rock materials by the presence of subsurface water. Caused by **cycles of wet and dry periods**.

Wind deposition landforms

Dunes are formed by the deposition of fine materials. This occurs when the wind speed decreases so that it can no longer carry the material. This often occurs where there is vegetation, a rock or other obstacle which slows the wind on the leeward side.

Landform	Explanation
Barchan/crescent dunes	Relatively small individual crescent-shaped dunes which point downwind. They are formed due to a dominant wind direction and a limited supply of sand and are highly mobile.
Seif/linear/longitudinal dunes	Very large sand dunes which develop from **barchan/crescent dunes.** This is due to the elongation of one of the horns caused by a constant switching in the direction of the prevailing wind.
Transverse dunes	Look like ocean waves. They are formed by a steady trade wind in a constant direction. They are stabilised by vegetation.
Star dunes	Pyramidal in shape and the tallest of all the dunes. They are formed by strong winds which blow from multiple directions.
Draa dunes	Sequence of large **star dunes** which form a ridge.

Water transport and deposition landforms

- **Alluvial fans** are formed when water carrying sediment reaches a lowland plain or a basin. This causes the water to slow down and spread out.
- **Bajadas** are a series of **alluvial fans** that join together.
- **Playas** are salt lakes and are formed when **depressions** are occupied by shallow, ephemeral saline lakes with no surface outlet.
- **Salt flats** are flat expanses of ground which is encrusted with salt crystals and other minerals. It is formed when water from a salt lake evaporates.
- **Washes** are the drainage areas in desert terrains. They are dry beds of sandy soil and are some of the only areas in deserts where water is able to penetrate back into the **aquifers.**

Human activity and its impacts on hot arid and semi-arid environments

Human interaction with hot arid and semi-arid environments

Societies living in these environments have to deal with infrequent and unpredictable rainfall, poor soil quality, low levels of vegetation and grazing pastures. Many societies overcome this by adopting a **nomadic lifestyle**. This means they are always moving depending on the availability of water and pastures. Some societies have adopted a **semi-nomadic** way of life where they move with their flocks and herds but when it reaches harvest time they set up their tents near villages and take advantage of the high levels of supplies. However, due to decreased availability of water and increasing desertification, many people have undergone the process of **sedentarisation** where they settle down in villages, towns or cities.

The opportunities and constraints for human activity

- **Climate:** provides a continuous growing season due to high amounts of sunshine however there are low levels of water.
- **Alluvium deposits:** provide **nutrient-rich fine soils** which can warm up quickly, however, they are prone to wind erosion and also flash floods.
- **Hydroponics:** can be used as an alternative to regular farming due to lower use of water although it is very expensive.
- **Advanced irrigation systems:** these include **dams and irrigation channels** so water can be obtained where it is needed. However, the large surface area of water which is present due to dams increases the level of evaporation so a lot of water is wasted.
- **Natural water sources:** oases, aquifers and ephemeral rivers can provide water to the local populations, however, due to climate change and overuse these sources are becoming less abundant.
- **Desalination:** Mainly used in rich countries due to the high cost. Removes salt from seawater so it can be used.
- **Mining:** Arid and semi-arid environments can contain **rich mineral resources** which can provide jobs in desert areas and help to improve local services, infrastructure and amenities. However, it uses a large volume of water, removes vegetation and waste produced can contaminate the area and natural water sources.
- **Tourism** provides economic benefit to the area and country whilst encouraging the improvement of infrastructure. These environments, however, are very fragile and have a

low **carrying capacity** and are very vulnerable to human activity. Local cultures may also become **commercialised** for the tourism industry.

- **Renewable energy:** If just **0.3% of the Sahara desert** was used for a solar plant, it would provide all of Europe with clean renewable energy. This is difficult though because windblown sand covers the panels and transmission lines will be hard to build.

The contribution of humans to desertification

- **Overgrazing**
- **Overcultivation**
- **Vegetation clearance/deforestation**
- **Water collection and storage**
- **Salinisation**
- **Mineral extraction** requires lots of water and vegetation also needs to be removed
- **Population pressures**
- **Poverty** increases the percentage of people that farm on already fragile lands.
- **Policy errors**
- **Climate change**
- **Urban development**

Consequences

- **Rates of soil degradation and soil erosion** increase as a result of human activity. **Feedback mechanisms:** Increased atmospheric dust due to increased wind erosion of dry soil leads to increased frequency of dust storms but also increases the **greenhouse effect** and so increases global warming. Human activity also leads to **denudation** which is the wearing away of the earth's surface. This increases **albedo** which is the ratio between incoming radiation and the amount reflected.
- **People:** Increased frequency of food shortages and famine. This will increase the levels of **migration** which can also increase social tensions in the recipient country. There will also be an increased **dependency** on food aid and food imports which undercut local prices and as a consequence a decrease in agriculture. There will also be a loss in **traditional skills** as people are forced to settle in cities.

Management

The issues associated with settlement, transport and infrastructural development

- **Contour bunds** are constructed ridges of earth or rocks that slow down the flow of water. This allows more water to infiltrate into the ground but also prevents minerals from being washed away.
- A **Zai** is a technique where pits are dug in the earth and filled with organic matter. They trap water and nutrients. The matter is also carried by termites down into the ground which increases stability and fertility of the soils.
- **Prioritising areas for restoration.**
- **Outplanting** involves growing plants in nurseries or greenhouses before planting them in the desert.
- **Planting trees** to hold the soil together to prevent soil erosion.

- **Building high tech transport systems in cities** reduce congestion and so decreases the release of **greenhouse gases**, decreases both global warming and the **urban heat island effect**.
- **Solar power** and **wind power**

Issues associated with economic development

Places like **Dubai** rely heavily on **oil** for their economic development. However, oil reserves in Dubai will be **exhausted by 2025** and this is similar in many other oil-rich nations. To combat this, many countries are actively trying to **diversify their economy** by investing in tourism, IT and banking.

Water supply is a huge issue in arid and semi-arid areas. The United Arab Emirates (UAE) now has the highest water consumption per person in the world. Many of these countries, due to large amounts of wealth, rely on **desalination** plants to provide their water.

The role of sustainable development

Sustainable development needs to be able to balance economic, social and environmental needs.

- **Sustainable tourism** involves encouraging continual **investment** and maintenance of local jobs, **conserving** the ecosystems and landscape and protecting and **improving local customs, cultures and livelihoods**.
- **Conservation projects** such as the Eden Foundation in Niger benefit both the local people and the environment. They are planting trees and bushes which grow naturally in dry conditions and also provide food for the local people.
- **Sustainable mineral extraction** requires **environmental assessments** as well as recycling water, ensuring no waste leakage and working to protect the **cryptobiotic soils.**
- **Sustainable agriculture** requires sourcing a **sustainable water source** and implementing sympathetic farming techniques to help **sustain soil quantity**.