DP IB Geography: SL

Your notes

Characteristics of Extreme Environments

Contents

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Global Distribution of Cold & High-Altitude Environments

What is an extreme environment?

- Extreme environments are places that are considered **inaccessible** and **very hard** for human life to **survive** in
- Some areas can **provide** opportunities for development and economic activity
  - They can have rich mineral deposits such as oil, gas, gold, etc.
  - However, exploiting these resources is costly
- Population densities are low in these areas
- Harsh conditions make it difficult to obtain and maintain energy and food supplies
- Many Indigenous peoples are abandoning traditional lifestyles
- Examples of extreme environments include:
  - Deep ocean trenches
  - Hyper-arid deserts (cold or hot)
  - Salt lakes
  - Volcanoes
  - Mountain plateaus, etc

Distribution of cold and high-altitude environments

- These environments include:
  - **Polar** regions
  - **Glacial** areas
  - **Periglacial** areas
  - **High mountains** in **non-tropical latitudes**
- Cold areas are mostly **found** at **high latitudes (66°** north and south of the equator), such as the polar regions and arctic tundra

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- These areas are also known as cold deserts because of:
  - Low levels of precipitation
  - Poor soil conditions
  - Low levels of vegetation
- Cold environments are also found at **high altitude,** such as the Himalayas and the Andes

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Distribution of cold and high-altitude environments

- The distribution of cold environments can be divided into polar, glacial, periglacial and high-mountain areas
- **Polar** environments are found where levels of solar radiation are very low
  - Located in high-latitudes within the Arctic and Antarctic circle (from 66.5° to 90° N and S)
  - They are the coldest places on Earth
  - Examples include the Poles, Greenland and northern Canada
- **Glacial**
  - Found at higher latitudes and altitudes, with high levels of precipitation
  - Found at the edges of polar ice sheets and mountain glaciers
  - Ice remains throughout the year
  - Examples include the Andes, Himalayas and Franz Josef Glacier, New Zealand
- **High-mountain** (non-tropical)
  - Also referred to as **alpine**
  - Found at **high latitudes and altitudes of over 3 000 m,** where snow and ice remain throughout the year with a cooler climate and seasonal coverage of snow at lower altitudes
  - Examples include the Himalayan and Tibetan mountain ranges in Asia, the Rockies and the Andes in the Americas, and the New Zealand Alps
- **Periglacial or tundra** environments are found at the fringes of permanent glaciated areas
  - Either at high-altitude mountain regions or high-latitude polar regions
  - Mainly located in the northern hemisphere due to a lack of land mass in the southern hemisphere
  - These areas account for a third of the Earth's surface

Global Distribution of Hot Arid Environments


Your notes

- **Hot desert and semi-desert areas** stretch across **30% of Earth's land surface**
- They are home to approximately 20% of the world's population
- Deserts have high levels of **aridity**
- They are defined as:
  - **Semi-arid** areas receive between 250 and 500 mm of precipitation per year
  - **Arid** regions receive 25–250 mm per year
- **Four main factors influence distribution:**
  - **Arid** areas are located along the **mid- and low-latitudes of the Tropic of Cancer and the Tropic of Capricorn**
    - These are **stable**, **subtropical high-pressure areas**
    - **Semi-arid** areas lie along the **margins** of these **arid** areas; for example, the Sahara desert is an arid area and the Sahel would be classified as a semi-arid area
  - **Continentality**
    - The further the distance from the sea, the more moisture is lost before reaching the area, such as the Turkestan desert situated in **central** Asia
  - **Rain-shadow**
    - Some areas are located in the shadow of **mountain ranges**, such as the Atacama Desert, which is alongside the Andes
    - Precipitation falls on one side of the mountain, keeping the adjacent side dry
  - **Cold ocean currents**
    - **Cold ocean currents** limit the amount of moisture held in the air
    - Usually located on the **western coasts,** such as the Namib desert, Africa, this is due to the cold Benguela Current running up the west coast of Africa

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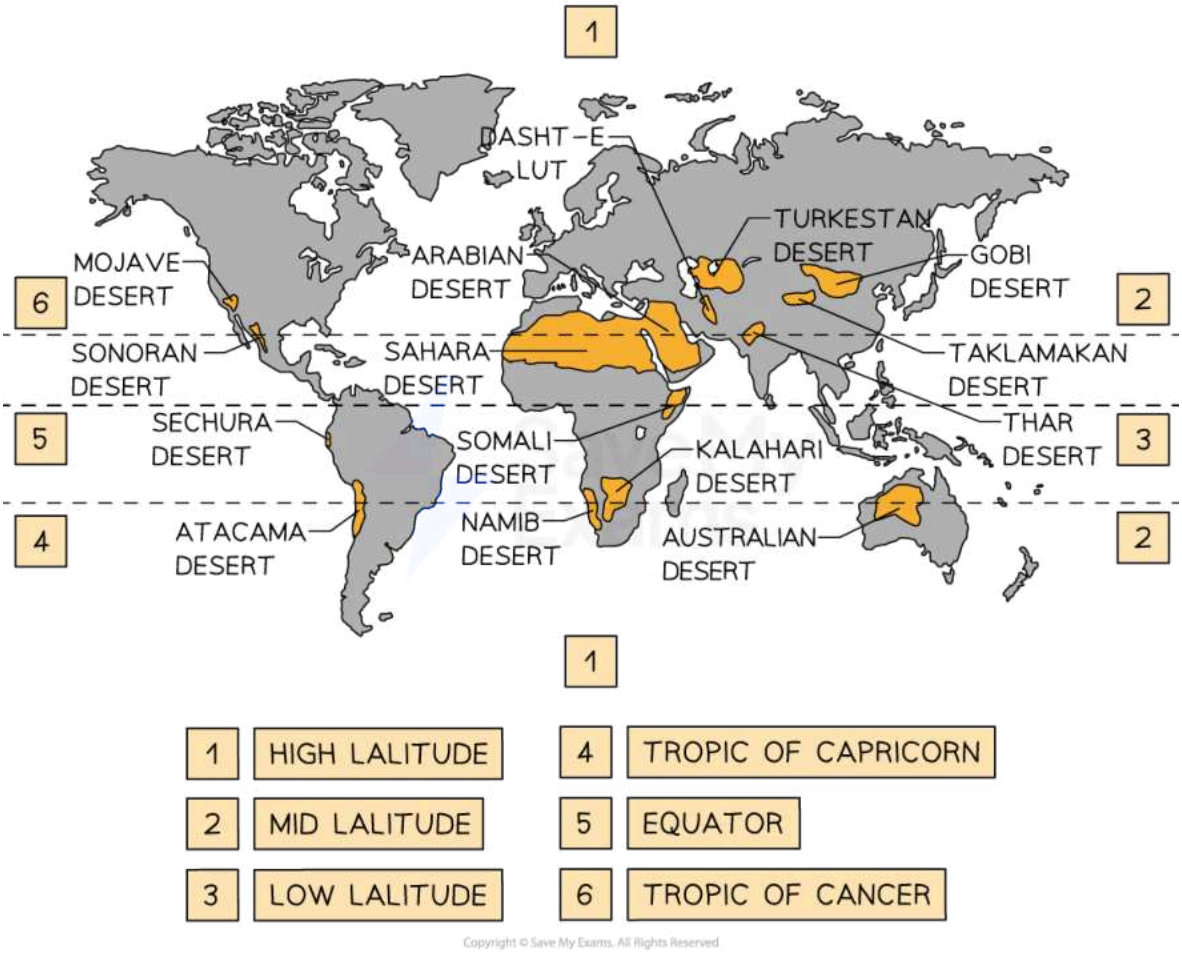

Distribution of arid and semi-arid regions; note that most semi-arid regions fringe arid areas

Examiner Tips and Tricks

When asked to describe the distribution, patterns, or features, make sure you give an overview of common locational features and not a list of locations.

Simply stating that hot deserts lie along the tropics without giving the extent, example, or noting semi-arid regions will only gain you 1 mark at most.

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Relief & Climate Characteristics of Cold & High-Altitude Environments

- Around the world, cold environments vary
  - For instance, polar regions are considered to be dry (**arid**) but some areas can be **hyper-arid**
  - At the upper latitudes, the sun does not rise or sink for several months of the year

Polar

- **Climate**
  - Harsh, covered in snow and ice
  - Long winters and short summers
  - Snow storms and cold winds for most of the year
  - The **Arctic's** mean temperature range is -28 °C to 4 °C
  - Average annual precipitation of approx. 100mm
  - The **Antarctic's** mean temperature is -55 °C in some places
  - Coastal areas are milder, with an annual average of -10 °C
  - The annual average precipitation is 200 mm
- **Relief**
  - The **Arctic** is a frozen ocean mostly surrounded by land
    - It has pack and drift ice
    - Rugged shores
    - Flat coastal plains
    - Rolling hills
    - Mountains surpassing 6 000 m above sea level
    - The Arctic has **moderate** relief
  - The **Antarctic** is an area of land surrounded by oceans

- Covered in a thick ice sheet
- The Transantarctic mountain range divides the continent east and west, with peaks above 4 000 m
- West Antarctica has the highest mountain (Mt Vinson) at 4892m above sea level
- Antarctica has the highest average surface **elevation** of all the continents, at around 2000m above sea level
- The highest elevation is over 4 000 m
- Therefore, Antarctica has a **rugged** relief


Your notes

High-mountain (non-tropical)

- **Climate**
  - Cool climates with some snow coverage but not all year
  - Seasonal temperatures range from –10 °C in winter to 20 °C in the summer months
  - Precipitation in high mountains depends on aspect
    - **Windward** sides receive large amounts of precipitation, with snow in the winter months
    - **Leeward** sides are in the rain shadow and, therefore, drier and protected from strong winds
    - On average, **temperatures decrease** with **elevation** at roughly 10 °C per 1000 m, so high mountains will be much colder than lower-altitude environments
- **Relief**
  - Some mountain environments may have a wide **diurnal range**
  - Some mountain areas are dry because they are in the rain shadow, while others are wet with high rates of rainfall
  - Mountains may appear as a single feature or in a range
  - They can be formed through folding, such as the Andes, or through volcanic eruptions (Mount Elbrus, Caucasus)
  - They usually have steep slopes, with **scree** at their bases, alternating between valleys, hills and peaks
  - They can be classified as **rugged** relief

Glacial

- **Climate**

- Characterised by permanently low temperatures, but may rise above 0 °C with seasonal temperature variations
- Cold climates in high latitudes and altitudes
- Ice remains throughout the year
- High precipitation but limited liquid precipitation provide inputs into the glacial system
- Little seasonal temperature variation

- **Relief**
  - Can be covered in **u-shaped valleys** along with **steep, eroded mountain peaks**
  - **Or deep valleys** with **sediment deposits**
  - Soil exposure is less due to snow cover
  - If sea invades the deep valley, it becomes a **fjord**
  - Can be classified as **rugged** relief


Your notes

Periglacial

- **Climate**
  - Cool climates with some snow coverage but not all year
  - Seasonal temperatures range from –10 °C in winter to 20 °C in the summer months
  - **Mean average temperature** between -1 °C and -3 °C
  - Precipitation in alpine mountains depend on aspect
    - Windward sides receive large amounts of precipitation, with snow in winter months
    - Leeward sides are in the rain shadow and, therefore, drier and protected from strong winds
    - **Mean** annual precipitation less than **1 000 mm**
- **Relief**
  - Found mainly in the northern hemisphere
  - Lack permanent ice cover, but experience freezing temperatures most of the year
  - Have a layer of permafrost beneath the active soil layer
  - Can be classified as **moderate** relief with significant elevation changes and a mix of landforms

Relief & Climate Characteristics of Hot Arid Environments

Climate


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- Hot, arid environments **share** a number of climatic **characteristics**
- Located in **zones of high atmospheric pressure** due to sinking, warm, dry air
- **Insolation** is **strong** because of a lack of cloud cover and the angle of the sun
- **Temperatures** are **high** with **large diurnal ranges (up to a 30 °C difference)**
  - **The diurnal range is less extreme (up to15°C) in semi-arid** regions
  - The **mean annual temperature** of most arid **margins** is **lower** by approximately 10 and 20 °C
  - Distance from the coasts: land heats and cools faster inland, providing a greater range of temperature
  - Height above sea level (elevation): the higher the region, the cooler it will be
  - Albedo effects temperatures: salt-encrusted, dried-out lakes reflect insolation, making the area cooler
- **Strong desert winds and sandstorms** are **common**
  - **Changes in temperatures** create steep pressure gradients that generate strong winds
  - Harmattan winds from the Sahara create powerful dust (loess) storms that blow over West Africa between Nov and April
  - Convection winds are typical late afternoon and evening
- **Precipitation** is usually **small**, **infrequent** but **intense**, resulting in **flash flooding**
  - The overhead sun (low latitude) provides intense convective activity that triggers **thunderstorms**
  - **Arid regions receive 25–250 mm of precipitation per year**
  - **Semi-arid** areas have seasonal rainfall between **250 and 500 mm** per year
  - Areas closer to cool ocean currents have lower temperatures and produce sea fog

Relief

- Deserts are considered active, mobile landscapes
- **Vegetation** is sparse, such as grassland, with few trees
  - However, irrigation schemes show that many hot deserts have potentially fertile soils
  - Allowing some areas to be **permanently or seasonally inhabited** by people
- Surfaces are hard (baked by the Sun) or have exposed rock

- Making infiltration rates poor and increasing surface runoff

- Relief can be divided into **3 types**:
  - **Hamada:** most of the sand has been removed, leaving behind a landscape of gravel, boulders and bare rock plateaus
  - **Reg:** hard, impermeable surfaces composed of rock fragments set in sand or clay
  - **Erg:** sandy deserts/sand seas, common only in about 30% of deserts. Their distribution appears to be climate-linked (i.e. less than 150 mm of rain)

Hamada desert	*Reg desert*	*Erg desert*

- Desert **landscapes** are **diverse** due to:
  - **Geological factors** (tectonics and rock type)
  - **Climate:** temperature, rainfall and wind
  - **Weathering** and **mass movement** processes
  - **Time**

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Your notes

Challenges for Human Habitation

- Extreme environments have **low population densities,** such as in central Australia, Iceland, northern Canada and Namibia
- People have to **adapt** to harsh environments such as insufficient heat in Iceland and Canada or water scarcity in places such as Australia and the Sahara
- These environments are outside what is known as the **'comfort zone for human habitation'**
  - Humans have a wide tolerance of temperatures
  - However, temperatures below -10°C or above 35°C are unsuitable in the long term
- Comfort zones can have **cultural biases**; for instance, the Inuit are more adapted to severe cold compared to other populations
- Challenges include:
  - **Limited** water, food and fuel
  - **Climate extremes**
    - Extreme temperatures can cause heat stroke or frostbite
    - The seasonal melting of permafrost can cause subsidence, which affects the structural integrity of buildings
    - Unpredictable and severe weather patterns, from heavy snowfall or rainfall to dust storms, cause damage to infrastructure and disruptions
    - The **lack** of **daylight** in polar regions affects physical and mental health
  - **Remoteness and inaccessibility**
    - Periglacial environments can be situated on steep or uneven terrain, making it difficult to build or access
    - Likewise, arid environments can be land-locked and located far from habitation
    - Infrastructure is limited and needs advanced engineering to overcome the demanding terrain, making it costly to build and difficult to maintain
    - The lack of basic infrastructure, such as healthcare and education facilities, increases the problems of living in these regions
    - Transportation is difficult, affecting the movement of people, goods, and services

- **Developing and extracting resources** in extreme environments requires advanced, reliable and usually expensive equipment
  - Hot and arid environments offer little in the way of natural resources, such as clean water and fertile soil, to support humans
  - Water in cold environments can be frozen for most of the year
  - Any development in these fragile environments have significant ecological footprints, such as habitat damage and pollution
  - The harsh conditions increase the economic costs linked to resource development and extraction
  - Development projects are sensitive to fluctuations in global markets, making the feasibility of development in these areas an issue


Your notes

General Adaptations Made by People in Extreme Environments

Hot	Cold
Adaptations to **temperature** include painting buildings white to reflect the heat, having thicker walls and small windows to keep the heat out, air conditioning in the homes, wearing loose-fitting clothes and wearing head coverings	Adaptations to **temperature** include triple glazing in houses, wearing layers, wool, fur, etc. to keep warm and using geothermal power
Adaptations to **water scarcity** include building houses with flat roofs to catch water, drip irrigation to grow crops and nomadic farming to prevent overgrazing by herds	Adaptations to **frozen ground** include lifting houses above the ground, hunting rather than growing crops and building roads on gravel beds to stop them cracking
Travel is usual in the early morning or late afternoons to avoid direct sunlight, Long periods of rest during the day avoid exhaustion and limit dehydration. Seasonal mobility is a way of coping with limited amounts of water and a lack of pasture	**Travel** is migratory and follows the herding or hunting of caribou, moving north during the summer and south to the forest margins in winter. Fishing is also important as the availability of land for growing is too short

Coping in cold environments

Adaptation by People in Alaska

Farming techniques	Native Alaskans relied on hunting and fishing for food rather than farming the land because of permafrost and the very short growing season

Buildings	High-pitched, steep roofs allow snow to slide off. Triple glazed windows keep heat in. In areas of permafrost, houses are raised on stilts to prevent their heat from melting the frozen ground beneath, (which can cause the land to sink and subside)
Transport	Alaskan roads are built on 1–2–metre-thick gravel pads that stop heat transferring from vehicles to the soil beneath, which would cause permafrost to melt and roads to crack
Energy use	Energy use is high as there is little heat and limited sunlight for parts of the year. In parts of Alaska, geothermal heat provides energy and hot water
Clothing	Inupiat and Yupik people of Alaska wear coats made of caribou skin (with double fur lining). Now they also wear modern fabrics like fleece and Gore-Tex


Your notes

Coping in hot environments

Adaptation by Middle Eastern Bedouin

Farming techniques	Water in underground aquifers is accessed through boreholes, using hand-pumps or buckets to draw the water up. Only tribes that own the well are allowed to draw water from it. Where irrigation is not available, traditional nomadic pastoralism is still practiced; sheep and goats are moved to new grazing before they put too much stress on local vegetation
Buildings	Portable tents or shelters that give flexibility to move around with their animals. Bedouins that return to the same place every year for the winter months often build stone houses. Many Bedouin are now settled in permanent homes with flat roofs, thick walls, painted white walls, and small windows to keep the rooms within cool
Transport	Traditionally, camels have been used as desert transport. Now, people use 4×4s, although they can get stuck in sand
Energy use	Traditionally, energy use has been low due to high temperatures. In the Middle East where oil has been found, wealthy people use a lot of energy on air conditioning. Photovoltaic solar panels work very well in hot, sunny climates
Clothing	Middle Eastern Bedouin tribes favour loose-fitting clothing, often in blue to reflect sunlight. To avoid sunburn and protect from wind-blown sand, heads and faces are covered with head scarves called keffiyeh

Your notes

Changing Distribution of Cold Environments

- Glaciers and ice sheets **advance** (grow) in winter and **retreat** (shrink) in summer
- Glaciers are systems with inputs, outputs and stores
  - **Output** is through ablation (melting)
  - **Input** (accumulation) of snow
  - **Stores of glacial ice** form layer by layer each year over 20–30 years
  - **Equilibrium** of the glacier is achieved when input and output are balanced
    - There is no gain or loss of ice and the glacier remains the same size
- The **regime** of glaciers can be classified as follows:
  - **Steady**: accumulation = ablation
  - **Retreating**: ablation is greater than accumulation and occurs at lower elevations
  - **Advancing**: accumulation is greater than ablation and occurs at higher elevations
  - A glacier will advance if temperatures are 0 °C or below

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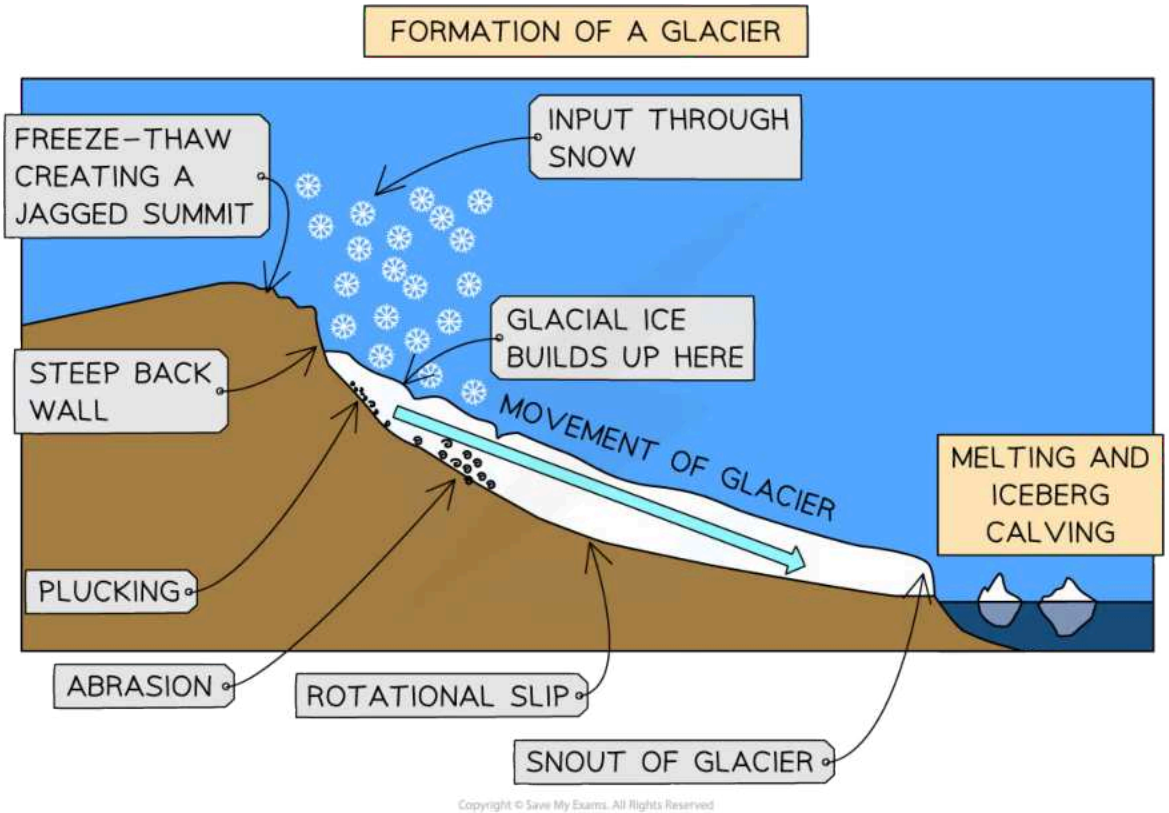
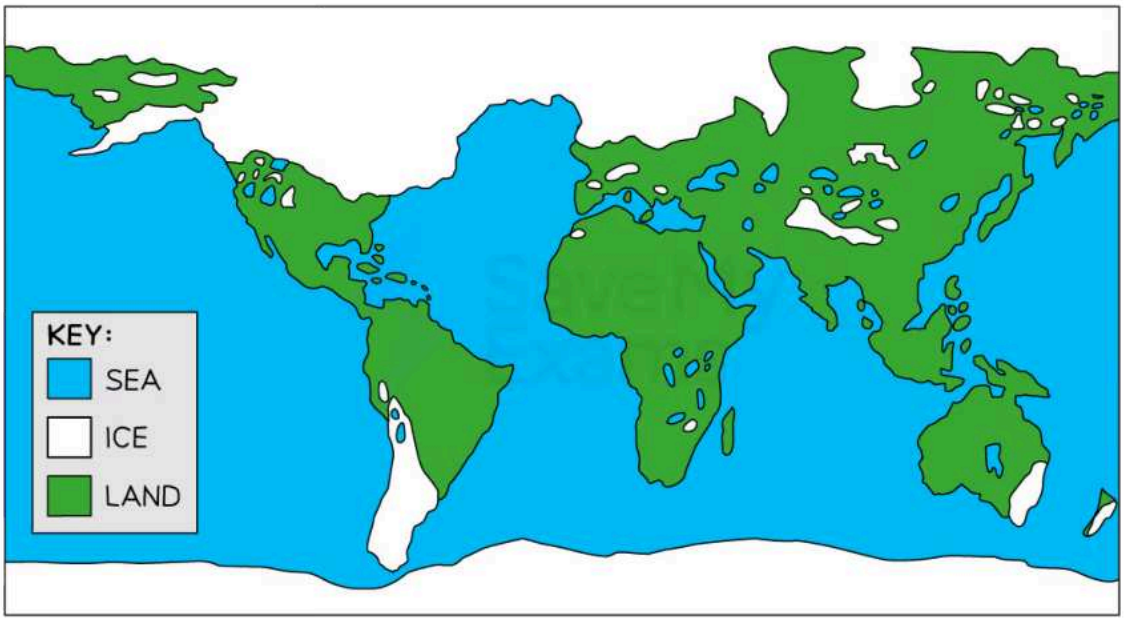


Past and present cold environments

- Evidence from current landforms shows the Earth has had **interglacial** (warm) and **glacial** (cold) periods
  - Glacial periods saw **glacial advance and expansion and sea levels dropped**
  - An interglacial saw **glacial retreat, contraction and sea level rise**
- About 21 000 years ago, there was the last glacial maximum (the ice age), and cold environments covered more than 30% of the Earth's surface.
- At this point, the **Earth's average temperature was 6 °C** (average now is 14–15 °C)
- The **climate** was **drier** because most of the water on Earth's surface was ice, resulting in less precipitation
- **Sea levels dropped,** and **shorelines extended farther out**, creating more land (water was trapped in ice sheets)
- The **polar ice sheets covered much of the UK** and most of **southern Europe was periglacial**

- **Currently**, the Earth is in an **interglacial** period, with **glaciers retreating**

Distribution of ice in the past



The extent of global ice during the last ice age

(Pleistocene epoch)

Changing Distribution of Hot Arid Environments

- The **distribution** of **hot arid and semi-arid lands has changed over time**
- **Changing climates** have changed the **extent** and **distribution** of hot deserts
- A large percentage of the world was **wetter after** the **last ice age** and this **reduced** the amount of land covered in **desert**
  - Canyons formed when the climate was wetter (interglacial period ≈8 000 years ago) and present-day landforms such as pedestals
- Until about 5 000 years ago, there were only **narrow strips of hot deserts** to be found on the **west coasts of South America** and **Africa**
- Gradually, these areas of **desert increased** in size, but **new** hot deserts also **began** to form
- The **Sahara** region was **not** always a **desert**

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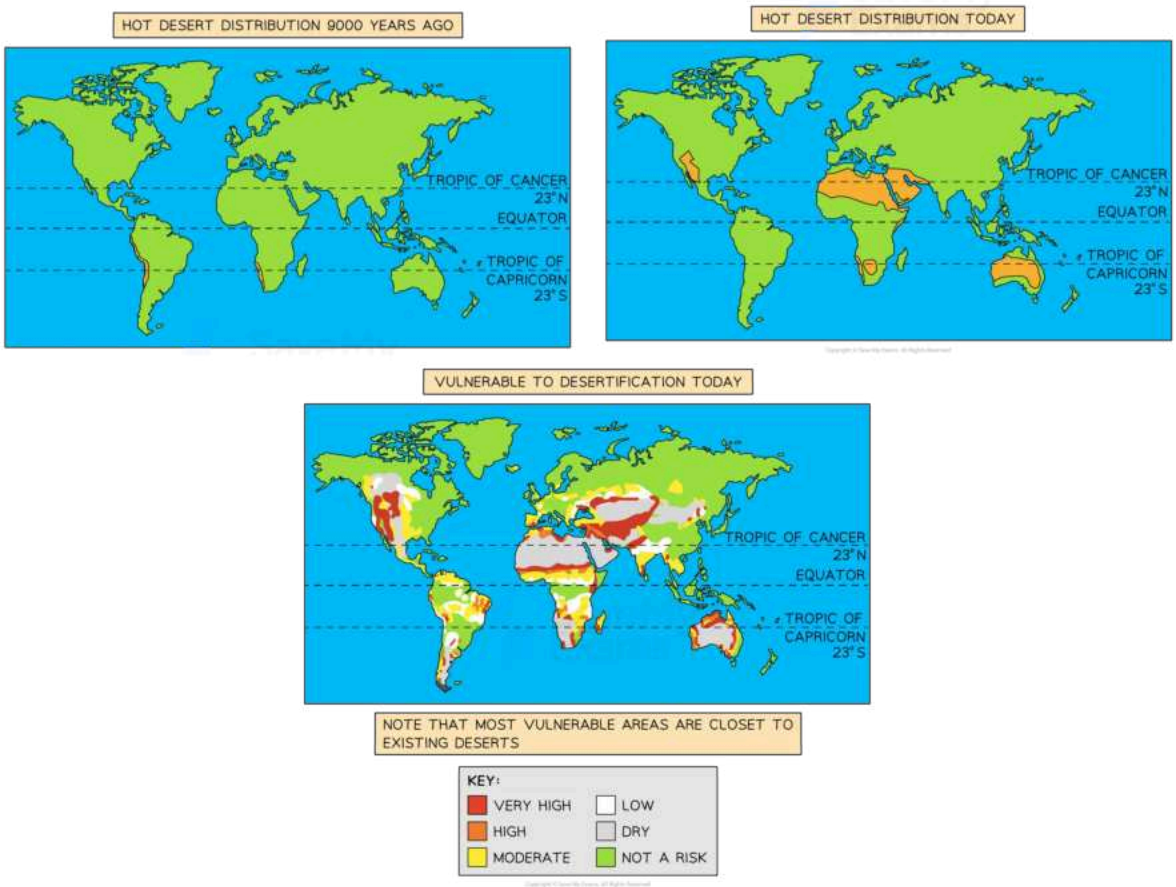
- Between 11 000 and 5 000 years ago, the area was known as the Green Sahara with lakes, lush vegetation and animals of the savanna biome such as elephants and lions
- These are **natural climatic variations** forming hot deserts; however, human activity has influenced the extent and distribution of these drylands

Your notes



Over time, the distribution of drylands has increased through human activity. Note that the most at-risk areas already fringe the driest areas.

Pleistocene pluvials

- The **end** of the Pleistocene corresponds with the end of the **last glacial period (approximately 11 700 years ago)**
- A **pluvial** refers to the **characteristic of rainfall (higher)**
- Events that happened a long time ago frequently have an impact on the evolution of arid and semi-arid landforms

The Changes to Hot Desert Climate Over Time

5 000 years ago to the present day	Over Asia and Africa, the monsoon rains began to lessen, and so began arid conditions. 3000 years ago, conditions were similar to today.
About 8 000 years ago	During this interglacial period, conditions were warmer and more humid. Forests thrived and were widespread in warm and wet conditions. Aridity fell dramatically, with many of the present-day deserts being grasslands.
Last glacial maximum **20 000 years ago**	During the last glacial maximum, aridity was widespread, with cold deserts in the north. In the south, deserts existed in similar locations to the present day but were more extensive.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