Lesson 5

MOUNTAINS, RIVERS & DESERTS

Aim
Discuss the ecological features of mountains, rivers and deserts.

MOUNTAINS

The name mountain is usually applied to any region of land raised steeply above the surrounding terrain. The term is used loosely to describe an elevated portion of the earth's crust, and they can occur as a single peak or as continuous peaks. There is no proper way to define a "mountain", but any terrain with characteristics such as elevation, steepness, summit, volume, continuity and spacing may be used. Basically, a high ground over 300 metres may be called either a "hill" or a "mountain", and they can be formed by volcanic activity, erosion or by tectonic plates colliding.

Mountains are normally found in groups or ranges that consist of peaks, ridges and inter mountain valleys. Apart from certain mountains that occur individually, the smallest unit is the range, comprising either a single complex ridge or a series of ridges alike in origin, age and form. Other forms are:

- Several closely related ranges that are in parallel alignment or chainlike clusters are known as a "Mountain system".
- An elongated series of systems form a mountain chain.
- An extensive complex of ridges, systems and chains is known as a "belt" or "cordillera".

The Formation of Mountains

Geologists believe that most mountains are formed by movements in the earth's crust. The earth's crust is constantly undergoing changes by warping, fracture and weathering, producing an accumulation of effects, producing, this way, variations in elevation to which mountains are formed.

The plate tectonics model has helped explain many processes of mountain formation. Very briefly, this concept envisages the crust of the earth as made up of many plates that move about, at a rate of a few centimetres per year. This leads to collisions and the separation of continents, and the subsequent development of mountain belts.

Movements resulting in collisions between plates raise the crust by faulting, folding or arching up layers of rock strata.

In the simplest cases, mountains are due to actual building, because volcanic cones, such as Fuji, Egmont and Vesuvius, are the products of volcanic outbursts. Laccolithic eruptions, also referred to as "igneous intrusions" because they are formed from magma "intruded" in the earth’s crust. During this process, most of the magma stays trapped below, where it cools down and solidifies very slowly, from many thousands to millions of years (i.e. Henry Mountains in Utah, U.S.A.).
During geological times the earth’s crust has adjusted itself to the changing conditions and has thus produced “folds”. These are the result of the divergent warping strains produced continuously during the adjustment.

Fold Mountains of the world occur by forces formed by orogenic movements by effects of folding of layers within surface of the earth’s crust, mainly due to the movement of the tectonics plates (convergent plate boundary). Because plate tectonics are constantly moving, fold mountains continue to grow and rise, taking up to millions of years to reach their actual height.

Fold Mountains are mainly composed of sedimentary rocks, accumulating layers throughout the time. When the plates and continents collide, the rock layers tend to fold. The folding of the layers may occur in many different ways, depending on the effects of the igneous intrusions. Folds differ in size, shape and angle, determined, one way or another by the position of the axial plane. Below shows a figure with examples of just three of the many different types of folds, where “a” represents symmetrical folds, “b” represents asymmetrical folds, and “c” represents overturned folds:

Some examples of Fold Mountains include:

- The Andes
- The Rockies
- The Alps
- The Himalayas
- The Urals
- The Appalachians

The Himalayans and the Rockies, for example, are considered “young” fold mountains of the world (10-25 million years of age), while the Appalachians and the Urals are “old” fold mountains (over 200 million years of age) and are generally not very high due to the erosion overtime.
The formation of a basin range structure is the result of the movement of rock along faults, or major deep cracks in the earth's crust. Such movements, also referred to as "faulting", causes the rocks bordering on the faults to be uplifted vertically in great blocks. The raised edges of the blocks then appear as mountains, and the depressed edges as valleys.

A third type of mountain formed by uplifting are the ones called "dome". The dome structure was created by deep-seated intrusions of igneous or molten rock that arches the rocks at the surface.

**The Importance of Mountains**

Apart from their value as sources of minerals, forests, agricultural and recreational activity, they exert a significant influence on climate and determine the course of economic and historical trends. The mountains, especially the high ones, markedly affect the weather and climate patterns over vast areas of the earth. This is because they stand as barriers to circulating air masses. For example, moisture carried inland by winds from the Pacific Ocean falls as rain or snow on the windward sides of the Sierra Nevada and the Andes. The leeward or inland sides of these mountains are drier, and the land beyond the mountains is frequently arid.

The importance of mountains regarding history and the economy of various nations can be considerable. An example is the development of the western United States of America. The first travellers and settlers avoided the mountain crossing because of the dangers and costs involved. However, later deposits of minerals in mountainous areas drew people and railways west despite the hardships experienced in traversing the passes. As a result transportation routes and patterns were established that remain today.
The mountains in South Africa also had a limited effect. In the early days of the country populations were, in the main restricted to coastal areas, and it was not until the "Great Trek" that any mass movement across the mountains were made. The discovery of precious minerals in North America made the introduction of railways form the coast to the mining areas inevitable, and these were constructed across the difficult terrain of the coastal mountain ranges.

The political significance of mountains has been noticeable throughout the history of man. Mountain barriers with their narrow features have made mountain ranges throughout the world, natural political boundaries, second in importance only to seas and oceans.

In their control of human activities, mountains have had different effects in relation to the rapidity with which man habitually travels. Under modern conditions, the large ranges are a barrier to human movement, but modern technology by means of air travel and advanced road making techniques has made movement over and through the mountains much easier. However, in historic times travel through the mountains was difficult and most populations remained on one side or the other of the great ranges.

**Volcanoes**

Volcanoes are “pseudo” mountains formed by the cracking or fissure of the earth’s crust as the magma forcefully makes its way to the surface of the earth. Vents in the earth's crust allow molten rock to pour to the surface, building over time the volcanic structure. Volcanoes are usually well known because of their isolated occurrence and the periodically dangerous aspect.

At the summit of a general volcanic structure we can find craters that emit steam, lava, debris and toxic gases. Craters vary in size, where those that extend for over a kilometre to over 50 kilometres are referred to as a very large crater or "caldera".

**Erosion**

Weather and erosion constantly wear down high mountain peaks throughout the time. The rugged topography of mountain ranges is a clear representation when erosion has and is slowly taking place, giving way to the establishment of sedimentary basins.

Among the physical processes that occur by erosion may be:

- **Water erosion** (i.e. valleys, rivers or streams; glaciers; shorelines or cliffs)
- **Wind erosion** (i.e. deserts, land degradation)
- **Gravitational erosion** (i.e. landslides, slumps)
- **Exfoliation** (rock expansion and contraction due to temperature variations, causing rock fractures and break-offs)
RIVERS

Rivers can be defined as:
Any body of fresh water flowing by gravity from an upland source to a large lake or to the sea, and fed by such sources as springs and tributary streams.

With large rivers, some tributaries may themselves be classified as rivers.

The Formation of Rivers
The course of a river is the line followed by the river from its source to its outlet. The connected streams that unite into one river form a river system. The line that bounds the drainage area is called the water divide or the watershed.

River systems are steadily changing and developing. Rivers that follow the natural slope of the land are termed "consequent rivers". Their tributaries that quickly cut valleys along soft strata are termed "subsequent rivers".

The amount of inclination or drop in a river bed determines the rate of flow of the river. The drop is often greatest near the source of the river, normally in mountainous terrain. In the middle part of its course, a river usually flows along the floor of a comparatively flat valley. Approaching its mouth, the river may pass through a broad flood plain that consists of sedimentary material that the river has deposited. A typical river has three characteristic portions:

- **The Torrential Course**
  These rivers usually start in mountainous region. In this portion, the river flows down the hillside in a narrow ravine as a mountain torrent, much interrupted by falls. This zone can leave behind large erosion channels through rock.

- **The Valley Course**
  In this portion the gradient is gentler and the velocity of flow is less. The river is easily deflected from its course by obstructions and it begins to wind and meander.

- **The Plain Course**
  In this portion the river has eroded downwards, almost to sea level, and so it has a gentle gradient and a low velocity of flow. It meanders widely, but its work is mainly constructive in the formation of shoals, flood plains and deltas.
Many rivers have only a torrential course, and in others the plain course has been drowned beneath the sea by depression of the land. In such a case an estuary is formed. In all of its stages, a river carries out transport work, but the amount of material that can be carried in suspension or rolled along the bed depends upon the velocity of flow. A great deal of matter is also carried in solution.

Rivers are among the chief agents that cause the gradual erosion of mountains and other land masses. Rivers are also of great economic importance to the areas through which they form - they serve as sources of water for the irrigation of crops, as arteries of commerce, and as sources of power.

Some rivers, especially those that flow through rainless areas or receive their water only from rains near to their sources, are intermittent and by excessive evaporation, may cease to flow in their lower reaches.

Most rivers have seasonal periods of floods, due either to heavy rainfall or to the melting of snow near to their sources. Rivers in the high latitudes freeze in winter, but the undercurrent generally remains in motion. When the ice on such rivers breaks up in the spring, there are usually heavy floods. In some regions of the earth composed of soluble rock, rivers frequently flow underground.

Evaporation can also cause lack of rain. High heat areas can see rain evaporating before it reaches the ground. A remedy is to provide good ground cover. This reduces the rising heat and the evaporation, allowing rain to reach the ground.

**Dams (Ponds)**

Dams have both positive and negative ecological effects.

The positive effects are:
- The flow of the river is regulated, reducing flood damage.
- The flow can be regulated so that it is perennial as opposed to seasonal
- Sediment is deposited in the dam that helps the growth of aquatic plants that remove excess nutrients form the water. The water leaving the dam is thus much cleaner that the water entering.

The negative effects are:
- The ecological impacts reduce the strong water flow that lessens the river's scouring capacity that in turn can lead to silting of the estuaries.
- When a dam is being created, humans and animals have to be moved.
- The creation of a dam causes the loss of valuable land that could be used for other purposes.
- The creation of large water surfaces can affect the weather of the area and even adjacent areas.
Eutrophication is another problem with dams. The process is triggered of by too many nutrients entering a body of water. The nutrients from sewerage works, industrial effluent and fertiliser impregnated runoff from farm use ‘blooms’ in dams and lakes. These blooms are sudden flushes of algae growth. For example, from time to time the water in the Hartebeespoort Dam turns pea green as the quantity of gelatinous algae build-up. Cattle have died after drinking from the dam poisoned by blue green algae. Paradoxically, the more life there is in the dam, the more death there is. The dead algae and water weeds sink to the bottom of the dam and begin to decay. In this process they take up oxygen that can result in suffocation of the fish. The result of eutrophication is that the water dies and becomes a swamp, giving off methane gas.

This is not an easy problem to solve. The phosphates and the nitrates come from the outflow of sewerage works. These chemicals are potent fertilisers. The principle of sewerage treatment is to turn the harmful organic wastes into inorganic wastes. Unfortunately the nitrates and phosphates, both inorganic, emerge as by-products. They eventually end downstream and cause a boost in plant life. Eliminating these two chemicals is difficult.

**River Catchments**

The river catchment or drainage basin is the land from the top of the mountains to the sea shore drained by a single river or its tributaries. This is the catchment area of a particular river.

Catchment areas vary in size. A large river may have a catchment area of several thousand square kilometres, while a small stream’s catchment area may be only a few hectares in size. The catchments are separated from each other by watersheds (e.g. the ridge line of hills and mountains).

The biological, physical or chemical characteristics of any river area are determined by the nature of the catchment area and its activities. These activities may be natural or man induced.

Maintaining good ground cover is very important for catchment areas. In those catchment areas that have not been developed by humans, the ground cover, or "vegetation" is still in place. In developed areas this cover may have been removed, and replacing it when possible is essential.
Ground cover is important for the following reasons:

- Plants slow down the water as it soaks over the land. This lets the water soak into the ground and replenish the supplies of groundwater. Water seeps from these supplies into rivers, allowing them to flow throughout the year, which is very important for many types of plants and animals.

- Plants significantly reduce soil erosion, because their roots hold the soil in position. This stops it from being washed away. The presence of plants also breaks up the impact of raindrops before they hit the soil. This reduces the erosive potential of heavy rain. The rivers flowing through an undisturbed catchment area are clean and erosion is slow, and generally limited to periods of heavy rainfall.

- Vegetation in wetlands and on banks of rivers is very important. The roots of the reeds, sedges, trees and grasses growing in the wetland and alongside rivers bind the soil of the riverbank, reducing erosion. They also regulate the flow of water, and act as a cleaning/filtering agent.

- In disturbed catchments, where the plant cover has been disturbed by farming, industry and settlements, soil erosion increases. Without the plants the runoff also increases, and the supply of water to the underground sources is diminished because less water soaks into the ground. This is why rivers do not have a continuous supply from the underground sources and flow only in rainy seasons. Much of the deposition of silt in river estuaries is caused by riverbank erosion. When the vegetation on riverbanks is removed, the banks are exposed to the scouring effects of flood waters. These forces scour away the riverbank, allowing the adjacent slopes to collapse.
Urban Catchments

Urban areas can be defined as “those areas where the ecosystem is significantly modified by dense human settlement and associated activities”. The urban catchment is the surrounding creek or river system into which water drains from urban areas.

Over 50% of the world’s population live in urban areas, thus the effects of urban runoff is a global issue.

- In undisturbed forest about 2% of rainfall runs off the surface into creeks and streams. It may have a bit of debris in it (e.g. twigs or leaves), but is otherwise cool and clear.

- In areas where land is cleared for farming or agriculture, about 14% of water runs off. Clearing land leaves soil exposed, so it is easily eroded. Increased volumes of surface runoff erode river beds and banks, releasing even more soil into waterways.

- In urban regions there are large areas of impermeable surfaces (e.g. paving, roadways, and buildings). Around 85% of surface water runs off from these areas.
  - Dirt, litter, oil, garden chemicals & animal wastes are carried with the runoff water into drains and eventually streams, and then estuaries and bays.
  - For example in Melbourne, Australia there are an estimated 200,000 side entry drain pits in roadside kerbing, where litter and other debris (e.g. soil, plant matter) can enter the storm-water system.
  - With much higher runoff, and large areas of impermeable surfaces there may be less water entering groundwater systems in lower catchment areas, although this may be offset by increases to groundwater as a result of cleared vegetation in upper and middle catchment areas.

Many major cities have two separate water removal systems:

1. Sewerage (this will be directed through treatment systems/plants of some sort).
2. Storm water (rarely passing through any sort of treatment system).
3. The storm water system is designed to move large volumes of water quickly to prevent flooding, but as a result it also collects and transports huge amounts of contaminants. Illegal connections of storm water pipes to sewage pipes can cause overflowing of sewerage through overflow pipes out into the environment (e.g. creeks) which can cause major pollution.

How can we clean up Storm water?
There are various things we can do to improve storm water quality such as:

- Understand the sources of pollutants, and then take action to reduce their impacts.
- Adopt design principles which help prevent pollution. This is also called "water sensitive design".
  Examples of such design include:
    - House and street designs that retain water on site and encourage absorption into the ground.
    - Creation, reclamation or enhancement of wetlands. These can help retain water on site, use up nitrates and phosphates leached from the soil or washed in surface water, provide valuable wildlife habitat, as well as being aesthetically pleasing.
Irrigated tree plantations, using runoff water, on large industrial sites.
- Diverting runoff from factory, warehouse or shopping centre roofs to feed wetlands.
- Xeriscape gardens - this involves the use of plants that don't require supplementary watering. This reduces the need to utilise valuable water supplies, and can greatly reduce water runoff from irrigation activities.
- Design for water efficient gardens, such as drip or trickle irrigation systems instead of sprinklers or hand held hoses, and mulching garden beds.

Establish treatment plants for storm water as we do for sewerage. This option is an expensive one, so ideally we should attempt, as much as possible, to use the first two options as much as possible.

REDDUCING POLLUTANTS

Waterborne Litter
This is a major problem for nearly every major city and is exacerbated in developing countries that cannot afford the technology needed to reduce waterborne litter.

- In the US, it was found that 18% of all litter dropped on the ground makes its way to the streams, rivers, lakes and oceans through storm water runoff.

- In the Australian state of Victoria alone over $50 million is spent per year removing litter from lakes and waterways. Over $2 million is spent removing litter from beaches.

- A targeted litter survey carried out in Melbourne found that 90% of the litter in the bays, rivers and on the beaches of Melbourne was washed there via the cities storm water system. It was also found that the majority of litter on Melbourne’s beaches was not left there by beach users, but was washed down into the bays by streams.

- Washing driveways, paths and roads (e.g. roadside kerbs) flushes a lot of debris down the storm water system.

- Some local councils have mechanised road sweepers that periodically sweep roadside kerbs clean, but this rarely occurs at frequent intervals, so much of the debris/litter reaching the road ends up in the storm water system.

- Litter and debris can also originate from water-based activities such as offshore drilling platforms, ships, boats and offshore rigs.
SEDIMENTATION

Sediments are commonly carried in the storm water runoff to larger water bodies. Sedimentation can have negative impacts on aquatic life by inhibiting photosynthesis in plants, respiration, growth and oxygen exchange in the water. Sediment also carries other pollutants including trace metals and hydrocarbons. Sediments can also smother sea grass beds, clog wetlands, and reduce the flow of rivers (blocking). Oil and toxic chemicals can cling (bond) to sediments harming aquatic life.

Case Study – Sedimentation in UK River Systems
Research undertaken of sedimentation in urban river catchments found that the largest source of sedimentation was that of road-deposited sediments (RDS). Materials found in river sediments from RDS include exhaust emissions, tyre and body wear (which is a source of both Copper and Zinc), brake-lining material, building and construction material, road salt and paint, rubbish waste and organic materials. The most urbanised sections of the Air-Calder river basin showed an RDS composition of 19-22%, with 14-18% sewage. This is much higher than in non-urban areas.

Case Study – Yarra Valley, Australia
The Yarra River deposits around 70,000 tonnes of soil per year into Port Phillip Bay. It is naturally a muddy river, picking up soil as it flows through an area of unstable clays in the Upper Yarra Valley (around Yarra Glen), however the turbidity of the river has greatly increased due to human activity in the rivers catchment (i.e. poor land management).

NUTRIENTS

- Animal droppings, plant wastes, fertilisers, and pesticides are a significant source of nutrients in storm water. Most home gardeners, for example, over fertilise, or use inappropriate forms of fertiliser. A lot of the plant waste from gardens can be composted and used in the garden as compost or mulch. Nitrogen and phosphorous are the two major components of fertilizers commonly found in waterways.

- For many years nutrient rich overflows from septic tanks have been a major problem in many cities in Australia. Large amounts of waste leaked from these systems into the surrounding water table and waterways. This problem has declined in recent years as many houses are now connected to the sewerage system, or are in the process of being connected.

- Detergents containing phosphates that are used to wash cars are a problem. High levels of phosphates in waterways can lead to explosion in algae and water weed populations. It has been found that the major sources of phosphates are detergents and fertilisers that are washed from hard surfaces down storm-water drains.

- Nutrients released from sewerage treatment plants, are a significant part of the nutrient load (especially nitrogen and phosphorous) reaching many bays across the globe. This can lead to eutrophication which can lead to increased weed growth. However new technologies are significantly reducing the amount of nutrients being released to bays by the treatment plant.
Excess nutrients can also cause algal blooms, which is a rapid increase in the population size of algae. This can seriously deplete levels of dissolved oxygen in the water where the blooms occur, impacting marine organisms.

Mussel harvesting in many bays both in Australia and the US have been suspended on many occasions in recent years due to the presence of toxic algae.

*E.coli* and other bacteria can also be a problem (particularly as a result of animal wastes entering our water bodies). High levels of these bacteria have resulted in the closure of beaches, lakes and rivers to activities such as swimming where there is direct contact with the water.

**OTHER TOXICANTS**

Other toxicants can also be major problems. These include: petroleum products, pesticides, heavy metals and automotive products (e.g. tyre rubber, brake linings, rust, plating, antifreeze, etc.).

- One litre of oil is enough to pollute one million litres of water.
- Shellfish can concentrate background levels of toxicants many thousands of times.
- In Melbourne storm water is the big problem. Most industrial discharges go into the sewerage system. Illegal dumping of industrial wastes can still, however cause major environmental damage.
DAMMING OF RIVERS

The placement of dams on rivers can result in major changes to ecosystems both adjacent to the dam site, and also as far downstream as where the river system reaches the sea, ocean or lake.

Effects of Damming Rivers

The water impounded behind dam walls is a valuable resource for such things as drinking water, irrigation, power generation, and recreation. There are many negative aspects of river damming. These include:

- Changes to existing flow regimes of rivers. This can include reversal of normal flow patterns, where large amounts of cold water are released in dry seasons for irrigation purposes, while in normally wet seasons the water is trapped and stored behind the dam wall. The change in flows and water temperatures can severely affect organisms downstream of the dam. In many cases floodwaters, that may be important in the lifecycle of many organisms, and in replenishing flood plains with nutrient laden sediments may be trapped, and only released in small amounts at a time. The change in flow patterns can also result in changes to the physical characteristics of the river itself, particularly if water is diverted away from the river to other river systems, as in Australia's Snowy Mountain Scheme, or is piped or transported away via aqueduct.

- Flooding of the area behind the dam wall may result in the loss of valuable agricultural or forested land, or require the resettlement of local residents.

- The dam wall may trap sediments that are important for replenishment of flood plains downstream.

- The presence of a large body of water behind a dam wall can radically alter the local environment. Many plants and animals may die out, and others take their place. If the mass of water is large enough, then the stability of the area can become a problem - earth tremors can occur.

- Water seeping outwards and downwards from the dammed area can alter groundwater levels in the area. On mountainous sites where instability of slopes is a problem, then landslips may become more frequent due to increased moisture levels in the soil.

- The large area of still water may create good conditions for the rapid spread of some pests and diseases. This has occurred with the Aswan Dam on the Nile River.

- If the mass of water retained by the dam is big enough, then local climates can be affected.

- Failure of dam walls can have catastrophic effects downstream.

DESERTS

Deserts are regions in which few forms of life can exist because of the exceptional drought or exceptional cold conditions. The term "desert" is applied to regions of the earth that:
• Are characterised by less than 254 mm (10 inches) of rainfall on average per year.

• An evaporation rate that exceeds the rate of rainfall.

• A high average temperature.

Because of the lack of moisture in the soil and a low humidity in the atmosphere most of the sunlight penetrates to the ground, where daytime temperatures can reach 55 degrees Celsius in the shade.

At night the desert floor radiates heat back to the atmosphere, and the temperature can drop to near freezing point.

Deserts are caused by a combination of climate patterns and geological features. It is noteworthy that the great hot deserts of the world are all on the west of the continents:

- Sahara
- Kalahari
- Colorado
- Atacama
- West Australian

Other deserts are situated either in the interior, for example, the Gobi Desert in Asia, or in Arctic or Antarctic latitudes, where the intense cold checks precipitation and makes life difficult. The above mentioned regions are deserts, not because the never get any rain, but because the supply is deficient.

**Wind Systems**

Most desert regions have been formed by movements of air masses over the planet. As the earth turns on its axis, it produces gigantic air swirls. Hot air rising over the equator flows northwards and southwards. The air currents cool in the upper regions and descend as high pressure systems in two subtropical zones. North and south of these zones there are two more areas of ascending air and low pressure. Still further north and south are the two polar regions of descending air. As the air rises, it cools and loses its moisture. As the air descends it warms and picks up moisture drying the land.

These downwards movements of warm air masses over the earth have produced two belts of deserts. One of these belts is along the tropic of Cancer, in the Northern Hemisphere, and the other belt is along the Tropic of Capricorn, in the Southern Hemisphere. Among the deserts in the northern region are:

- The Gobi Desert, in China
- The deserts of south-western North America
- The Sahara in North Africa
- The Arabian and Iranian deserts in the Middle-East.

The deserts along the southern belt are:

- Patagonia, in Argentina
- The Kalahari Desert, in Southern Africa.
- The Great Victoria and the Great Sandy Deserts of Australia.
Other deserts result from the influence of ocean currents on land masses. As cold waters move from the Arctic and Antarctic regions towards the equator and meet the edges of the continents, they are augmented by upwelling of cold water from the depths of the oceans. Air currents cool as they move across the cool water. These air currents carry mist or fog, but little rain. Such currents flow across:

- Southern California
- Chile
- The south-west of Southern Africa.

Although these coasts are often shrouded in mists, they are deserts.

**Land Formation**

Mountain ranges influence the development of deserts by creating rain shadows. As moisture laden winds flow upwards over the windward slopes of mountain ranges, they cool and lose their moisture as rain and snow. The dry air descending over the leeward sides of the mountain ranges evaporate moisture from the soil.

The Great Basin, a desert of North America, results from the rain shadow produced by the Sierra Nevada range. Other deserts in the interiors of some continents have come about because the prevailing winds in these areas are far removed from any large bodies of water, and by the time that they reach these regions they have lost most of their moisture. Such deserts are the Gobi, and the Turkestan of Eurasia.

The landscape of a desert is stark. It is shaped by wind and, paradoxically, by water. When the rains do come to the desert, the soil, unprotected by vegetation, quickly erodes. This forms canyons where the water rushes down from the hills.

From the eroded angular peaks composed of harder resistant rocks, alluvial fans lead away to deposit large slopes of debris at the base. These slopes level off to form basins. During the infrequent rains, these basins fill with water. The rainfall then evaporates leaving behind, on the surface, a layer of glistening salt dissolved from the ground. Such salt lakes are a common feature of some deserts, for example, the salt pans of Namibia, and the Great Salt Lake of Utah in the United States of America.

The winds literally sand blast rocks to unusual shapes and build up the dunes. In sandy deserts such as the Sahara, parts of the North American desert and the Simpson Desert in Australia, sand dunes are typical features.

Wind built mounds of sand can reach heights of up to 200 metres or more in the Sahara, Arabian and Iranian deserts.

In those deserts where the prevailing winds are strong and sand is scarce, such as the coastal deserts of Peru, the dunes may take on a regular crescent shape. These shapes move continuously across the desert floor. Dunes may be longitudinal ridges resulting from winds blowing strongly in only one direction, as in the Simpson Desert in Australia, or they may be star-shaped in regions where the wind blows from all directions.
Plant Adaptations to the Desert
All but the most arid of deserts support life in some form. This life is frequently abundant and is well adapted to the scarcity of water and the high daytime temperatures and the cold of the night.

Desert plants have evolved methods of conserving and efficiently using the water available to them. Some desert plants only live for a few days or weeks. These are known as ephemeral plants. Their seeds lie dormant in the sand, sometimes for many years. When a soaking rain comes along the seeds germinate and very quickly bloom and produce seed.

Woody desert plants either have long root systems that reach deep down to find water sources, or they have spreading, shallow roots that can take up the surface moisture from heavy dews and occasional rains.

Normally desert plants have small leaves. This conserves water by reducing the surface area from which transpiration can take place. Other plants shed their leaves during the dry periods.

Many also have waxy cuticles or fine hairs on their leaves, or modified leaf shapes (e.g. rounded or needle-like) to reduce transpiration losses.

The process of photosynthesis, by which sunlight is converted into energy by the green leaves, is taken over in the desert plants by the stems.

Many desert plants are succulents. They store water in their leaves, stems and roots. Thorns on the plants, which are commonly modified leaves, serve to guard the water from animal invaders.

Desert plants may take in and store carbon dioxide for use in photosynthesis only at night. During the day their pores are closed to prevent evaporation. Those desert plants that grow on saline soils may have a concentrate of soil in their sap. This salt is secreted out through their leaves or stems.
**Animal Adaptations to the Desert**
The few amphibian species that have their habitat in the desert are capable of long-term dormancy during the dry periods. When the rains arrive, they mature with great rapidity. They quickly mate and lay eggs.

Many birds and rodents reproduce only during, or following periods of winter rain that stimulate the growth of vegetation. Some desert rodents, such as the North American Kangaroo rat, the African gerbil, and many of the marsupial rodents of Central Australia, feed on dry seeds. Their metabolic processes are extremely efficient at conserving and recycling water, and their urine is highly concentrated. There are several desert mammals, such as the camel, that can withstand considerable dehydration.

Most of the desert mammals and reptiles are nocturnal. They remain in cool underground burrows or in the shade during the heat of the day and emerge into the cool night.

Certain desert reptiles, such as the horned toad, can control their metabolic heat production by varying the rate of their heartbeat and the rate of body metabolism. There are animals, such as the desert Oryx that vary their body temperatures, by the process of storing heat during the day and releasing it at night.

**Human Impacts on Deserts**
The deserts are the only places on earth where it can be said that man has least influence. True, there are nomads who live in the desert. They wander from place to place in search of grass and water to feed their animals, or to find animals to hunt. As their name suggests they do not settle in one place. They live in tents or impermanent shelters, and when the food in one area becomes exhausted they move in search of more. They usually move from watering place to watering place. This is usually a fertile place in the desert where water comes from an underground stream.

In some deserts of North America, Arabia and Iran are to be found some of the world's largest oil fields. Because mineral oil is such an important commodity in today’s life, the whole environment in these desert countries has changed. There are now oil rigs pumping oil to the ports where it is taken aboard tankers for shipment around the world.

**The Spreading Deserts**
The deserts are growing larger. The sand is spreading by as much as 60cm per day. This is especially so in the Sahara Desert, which is extending southwards at an alarming rate. Scientists theorise that the spread of deserts is mainly because of the creeping sand dunes and over grazing of the grasses at the edge of the desert.

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**SELF ASSESSMENT**
Perform the self assessment test titled 'Test 5.1'
If you answer incorrectly, review the notes and try the test again.
SET TASK

Visit a local stream or river. Observe the condition of the stream, particularly the presence of indigenous vegetation and its effect on stream bank condition. Also look for evidence of human activity on the condition of the stream or river (e.g. litter, grazing animals trampling banks). Take notes.

If there are restrictions in terms of accessibility or remoteness you may like to choose watercourse that you are aware of and research this chosen waterway. You could use the local library, the internet, or even documentary videos showing various ecosystems and draw your observations from this. Find out as much as you can about this waterway including its condition, evidence of human activity (or known human activity) and its effect on the stream or river, presence of indigenous vegetation and its effect on the stream bank condition (see above).

ASSIGNMENT
Download and do the assignment called ‘Lesson 5 Assignment’. 