Concept of Cycle of Erosion

Geomorphology is the study of land forms which is a composite result of different exogenetic and endogenitic activities, which are operating within and outside the land surface or on that region. Exogenetic activities try their best to make a balance with that of endogenetic and their ultimate level of balance is the sea level below which that cannot perform their respective work. So the balance between these two activities in a cyclic process is known as the cycle of erosion .Therefore, these two parts have quite distinctive character, and one without the other has no significance in the creation of development of land forms. An area on to which different exogenetic agents are operating and bringing the elevated land to the sea level and this is the cycle of erosion.

It is important, therefore, to know what the exogenetic forces are. Exogenetic forces are those forces which are operating on the lithospheric surface of the earth and trying its best to eliminate the differences made by the endogenetic forces and made the surface at or near to the sea level, Exogenetic forces are also called denudation and denudation can be divided into two broad categories

Weathering and Erosion.

Weathering is that process which makes the bedrock either weak , fragmented or decomposed on or near the earth's surface or to a depth of a few meters., So the fragmentation , decomposition or weakening of rocks make erosion easier but not a part of erosion . There can be weathering without erosion and erosion without weathering.

According to Thornbuny, “It is true that weathering is a preparatory and make erosion easier, but it is not prerequisite to , nor necessarily followed by erosion.

There are two main type of weathering physical and chemical. Both are affected by rock structure ,climate , topography and vegetation , physical weathering occurs due to differences in the expansion of different minerals with different rate and chemical weathering take place due to chemical reactions with water (and some gasses with water) on the rock and make the rock even soluable.

According to Reiche (1950) the five weathering processes like

1.expansion resulting from unloading,

2.crystal growth,

3.thermal expansion,

4.organic activity and

5.Colloid plucking are physical in nature.

In another words it can be said that repeated thermal expansion and contraction as a result of alternate heating and cooling results in the weathering of rock. Creation of joints and fractures and enlarging of the existing ones and finally to the disintegration of rocks and it is termed as mass exfoliation. In the rocks containing minerals which expand unequally there is granular exfoliation. In the same way chemical weathering takes place through different processes like hydrolysis, oxidation, hydration, carbonation and, solution. The general fact is that chemical weathering is more important than physical weathering.

Erosion:

Erosion is that process in which various erosive agents (running water, wind, glacier, sea waves and underground water obtain and remove rock debris from the earth's crust and transport them for long distance. In another way it can be said that erosion a sum total of gnawing, abrasion and transportation. Agents of erosion are those which participate in the erosional works and mainly they are running water, underground water. Ocean currents, wind, glacier, periglacial etc.

Cycle of Erosion

At first William Morris Davis advanced the idea of “geomorphic cycle of erosion “in 1899. His major objective was to describe and explain the distinctive characteristics possessed by landforms. He deseribed that all landscapes have definite life history after its emergence. In this way through different stages and after a long time the elevated land mass becomes featureless and flat plain known as peneplain is called geographic cycle according to W. M. Davis. He gives the definition of geographical cycle as “The Geographic cycle is the period of time during which an uplifted landmass under goes its transformation by the process of land sculpture ending in low featureless plain”

Philip G. Worcester has also accepted the geographic cycle but he called it as the “cycle of erosion “. According to him “The cycle of erosion is the time required for streams to reduce newly formed landmass to base level”

Throughout most of the world, runoff waters are the dominant geomorphic agency. Except for areas now covered by glaciers there are few places where rainfall not have an opportunity to perform geomorphic work. The main agent of erosion at the present time is water or river and a large percentage of area of the earth surface is eroded by this process. So due to its prominancy this erosional cycle is known as "normal cycle of erosion ".

Davis has described the landscape as the function of structure, process and stage. This means that in a landscape all the three play a dominant role. By structure meant that the nature of the rocks whether it is hard, soft, pervious. In the soft and pervious rocks cycle is completed in very short period than that of the hard rocks. Process determines that type of erosion would come on the surface and what type of

landform would be under in a initial surface . Stage denotes that whether the land mass undergoing its transformation is in the young stage or in the old stage. Landscapes vary in different stages , thus the landscape . is called the cumulative result of structure, process and stage.

Davis assumes that each landscape has definite life history. As soon as a landmass emerged, erosional agents starts their works on it and finally take it to ultimate featureless surface. Newly uplifted landmass has been called initial surface upon which erosion starts. For the purposes of demonstrating his cycle concept is the most simple and persuasive away, Davis imagined as an initial form a mass of land up lifted from beneath the sea by earth movements.

The concept of cycle of erosion was formulated by William Morris Davis, an American geomorphologist, towards the end of the nineteenth century. It is a concept of an orderly sequence of evolu¬tionary stages of fluvial erosion in which relief of the available landmass declines with time to reach a late stage when the landscape becomes a peneplain.

The cycle of erosion, as envisioned by Davis, has its initial stage at a time when the landmass is rapidly elevated by internal earth forces, followed by a very long period of tectonic quies¬cence.

Once raised high above sea level as a landmass, streams come into existence and erosion begins to operate on the uplifted mass which is gradually worn down almost to a plain. The landmass may, at some later time, be rejuvenated and the cycle begins again and remnants of the earlier cycle of erosion are preserved at new and higher levels.

In a normal cycle three stages have been recognized as: youth stage, mature stage and old stage. These follow each other in a regular sequence.

Youth Stage

In this stage the river flows along an uneven surface and there is intensive bottom erosion, the gradients are steep and the erosion is rapid. The rapid deepening of the channel leads to the formation of V-shaped valleys.

Thus during the youth stage of a river, the valley form undergoes vigorous development, particularly in depth and head ward growth. Lakes, rapids, waterfalls, steep-sided valleys and gorges are of common occurrence during this stage. Besides, the phenomenon of river-capture or river piracy takes place in this stage. Youthful rivers have an irregular long profile (thalweg) from source to mouth.

Davis assumed that the up lift the land took place very rapidly, so that the processes of denudation were able to act almost from the start on what was in effect, a stable mass. If the elimate were suffieiently rainy, as would normally be the case in humid temperate lands, a system of rivers would quickly develop on the emerged land

surface, This would comprise a number of consequent streams whose directions of flow and velocities (and thus erosional capabilities) would be determined by the gradients of the initial surface . From the stage of infancy.

These streams would cut rapidly downwards, and would in due course from deep valleys . on these slopes , weathering and slumping would operate , but at quite a slow rate compared with the speed of river in einsion . For a long period the valley Eros profiles would be approx. mutely v. shaped except in areas of complex geological structure where stepped profiles would be developed. Throughout this stage, parts of the initial land surface would be preserved on the watershed between the consequent streams, In infancy the extent of this initial surface would be considerable but would be gradually diminished later in the youthful stage as the valley side slopes experienced retreat and as tributary streams began to extend their valleys in to the interfluve areas by headword erosion.

River Capture

When one of the two rivers flowing in opposite directions from a single divide, becomes more effective in erosion due to steeper gradient (when the slopes are unequally inclined), the divide gradually recedes towards the side with the gentler slope.

In other words, the river with steeper gradient extends its valley head ward thus causing a shift of the divide against the river with gentle gradient.

Gradually deepening of the valley continues head ward with pronounced dissection of the ridge (divide). Sometimes this head ward migration of one river enables it to reach the river on the other side.

But, as the first river has a steeper gradient than the other one, the course of the second river gets diverted and its water starts draining through the channel of the first river. This process of diversion of a river by the head ward migration of another river is known as River-Capture or River-piracy.

The point where the course of the second river is diverted is known as the Elbow of capture. The captured river is known as Misfit and the deserted part of its channel through which no water flows is termed as the Wind-gap.

Mature Stage

In this stage rivers flow with a graded profile i.e. it attains a profile of equilibrium. The land mass is fully dissected and a well-integrated drainage system is developed. Ridges and valleys develop prominently.

Flood plains develop and river meandering takes place. The topogra¬phy consists of features such as: hogbacks, cuestas, mesa, butte, meanders, oxbow lakes, natural bridge, flood plains, alluvial fans etc.

The stage of Maturity:

By the onset of this stage the deepening of the v-shaped valleys characteristic of youth would have been slowed down considerably. Through the formation of their valleys the various streams would throughout youth have lowered their channels nearer and nearer to what Davis termed “the base –level of erosion” (which is normally the level of sea into which the eventually flow, and below not erode. In the process the Congitudinal gradients of the streams would have become ever more gentle, stream velocities would have been reduced, and the streams would possess less and less energy to use in moving their loads and attacking their beds, In fact, Davis suggested that, early in the stage of maturity, streams would attain a condition of grade of equilibrium, in which the entire energy of the stream is consumed in the movement of water and its load. The gentle meanders of the youthful streams responsible for the inter locking spur supposedly typical of youthful valleys , would become wider and more pronounced , and at many points the valley –side slopes would be undereut and driven back , By the end of the mature stage , slope angles in general would have been considerably reduced by the process of divide wasting and smoothly curving slope profiles with no major breaks , would dominate the landscape , An important result of divide wasting during maturity would be the reduction of relief , or in other words a decrease in the vertical height separating interfluve summits and valley floors.

The streams become mature when it stops cutting down the bed and starts widening. The slope of the stream is reduced to such an extent that the hydraulic conditions are just adequate to transport the sediment brought from the upstream reaches and that resulting from bank erosion. If sediment load is excess of the transport rate of the stream, sediment is deposited in the upstream reaches and the stream slope increased thereby. On the other hand, if the stream is deficient in sediment load, material is picked up from the bed and the stream slope reduced. Hence a mature stream adjusts its slope delicately.

Old Stage

In this stage the gradients are gentle and the velocity is low. Accord¬ingly the rivers lose most of its erosive power and flow in a sluggish manner. In old age a river has maximum meandering. The river at this age does little of erosion and transportation but is mostly engaged in deposition. This stage is characterised by the development of distribu¬taries and the river flows almost at the base level of erosion.

The topography consists of features like peneplains, natural lev¬ees, deltas etc.

Most of the cycles of erosion do not reach the final stage, as sometime during their operation either climatic or tectonic disturbances take place, and thus results in an incomplete or partial cycle.

The various stages of streams are determined by the characteristics they exhibit. According to generally accepted concepts, a young stream is always able to erode its channel in the vertical direction; the slope of a young stream is always greater than the slope necessary to carry the sediment load coming into it. Because of its ability to cut its bottom downwards, a young stream usually flows through v-shaped deep gorges or canyons. There is no flood plain for young streams and they occupy the entire floor of the valley at all stages. Other characteristics of the young stream include presence of rapids and waterfalls, steep and varying gradients, and presence of lakes. According to Johnson early youth ends when the lakes are eliminated and middle youth ends when falls and rapids are eliminated.

Relief features

Land relief is the vertical and horizontal dimension of land surface. When relief is described underwater, the term bathymetry is used.

Terrain is used as a general term in physical geography, referring to the lay of the land. This is usually expressed in terms of the elevation, slope, and orientation of terrain features. Terrain affects surface water flow and distribution. Over a large area, it can affect weather and climate patterns.

Importance

The understanding of terrain is critical for many reasons:

•The terrain of a region largely determines its suitability for human settlement: flatter, alluvial plains tend to have better farming soils than steeper, rockier uplands.

•In terms of environmental quality, agriculture, and hydrology, understanding the terrain of an area enables the understanding of watershed boundaries, drainage characteristics, water movement, and impacts on water quality. Complex arrays of relief data are used as input parameters for hydrology transport models to allow prediction of river water quality.

•Understanding terrain also supports soil conservation, especially in agriculture. Contour plowing is an established practice enabling sustainable agriculture on sloping land; it is the practice of plowing along lines of equal elevation instead of up and down a slope.

•Terrain is militarily critical because it determines the ability of armed forces to take and hold areas, and move troops and material into and through areas. An understanding of terrain is basic to both defensive and offensive strategy.

•Terrain is important in determining weather patterns. Two areas geographically close to each other may differ radically in precipitation levels or timing because of elevation differences or a "rain shadow" effect.

•Precise knowledge of terrain is vital in aviation, especially for low-flying routes and maneuvers (see terrain collision avoidance) and airport altitudes. Terrain will also affect range and performance of radars and terrestrial radio navigation systems. Furthermore, a hilly or mountainous terrain can strongly impact the implementation of a new aerodrome and the orientation of its runways.

Importance

Relief (or local relief) refers specifically to the quantitative measurement of vertical elevation change in a landscape. It is the difference between maximum and minimum elevations within a given area, usually of limited extent.[1] The relief of a landscape can change with the size of the area over which it is measured, making the definition of the scale over which it is measured very important. Because it is related to the slope of surfaces within the area of interest and to the gradient of any streams present, the relief of a landscape is a useful metric in the study of the Earth's surface.

Geomorphology is in large part the study of the formation of terrain or topography. Terrain is formed by intersecting processes:

•Geological processes: Migration of tectonic plates, faulting and folding, volcanic eruptions, rivers.

•Erosional processes: water and wind erosion, landslides.

•Extraterrestrial: meteorite impacts.

Tectonic processes such as orogenies cause land to be elevated, and erosional or weathering processes cause land to be worn away to lower elevations.

Land surface parameters are quantitative measures of various morphometric properties of a surface. The most common examples are used to derive slope or aspect of a terrain or curvatures at each location. These measures can also be used to derive hydrological parameters that reflect flow/erosion processes. Climatic parameters are based on the modelling of solar radiation or air flow.

Land surface objects, or landforms, are definite physical objects (lines, points, areas) that differ from the surrounding objects. The most typical examples arelines of watersheds, stream patterns, ridges, break-lines, pools or borders of specific landforms.\

•Smaller circles denote a summit or basin, but the inside of a contour circle is normally higher ground.

•Flat areas like river valleys and the sea have very few or no contours.

•Contours are only ever on top of one another if it’s a vertical cave or cliff.

•A ‘V’ or ‘U’ shape pointing downhill denotes the spur of a hill.

•Contours descending in number on either side of a line show a ridge.

•Contours bunched together on either side of lower, more evenly spaced contours show a valley or col between two areas of high ground.

•Small downward lines inside a contour circle are known as ‘hachure marks’ and signify ground that is sunken beneath sea level.