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Modern geomorphic concepts: A Review

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Abstract

Geological geomorphology has been renamed to 'geophysical geomorphology' Geomorphic concepts including size, process–pattern linkages, hierarchy, variability, variety, sensitivity, equilibrium, connectedness, nonlinearity, and complexity are now being used to explain the evolutionary histories of landscapes/landforms. "These investigations have been given a new dimension by the human-induced change of the Earth's surface. In order to understand the spatiotemporal variability and evolutionary aspects of landscapes and landforms, current geomorphologic research studies both anthropogenic and natural variables simultaneously. This has also contributed to the concept of the 'critical zone', which is defined as the 'heterogeneous, near surface environment in which complex interactions involving rock, soil, water, air, and living species govern the natural habitat and determine the availability of life supporting resources'. The 'usage' of Earth's surface and 'critical zone' will only increase as human populations continue to rise at an exponential rate". There will be increasing complexity in socio-environmental systems like major rivers as a result of human-induced perturbations in most surface settings.

Key words: Equilibrium, geomorphic, large, rivers, nonlinearity, threshold. Etc

Introduction

Tectonic uplift and subsidence and coastal geography are shaped by a mix of surface processes and geologic processes on the Earth's surface. Water, wind, ice, fire, and life on Earth's surface all have a role in surface processes, as do chemical reactions that generate soils and modify their physical qualities, as well as the stability of topography and the pace at which it changes under the force of gravity. Climate has a big influence on several of these elements. The creation of deep sedimentary basins where the Earth's surface declines and is filled with material eroded from other sections of the landscape is an example of a geological process known as isocratic change in elevation. Because the Earth's lithosphere and hydrosphere, atmosphere and biosphere all interact with one other, the Earth's surface and topography are an intersection of these three systems.

The Earth's surface and subsurface are shown through its large-scale topographies. Geological processes cause mountain ranges to rise. Sediment is transported and deposited elsewhere in the landscape or off the shore as a result of the denudation of these high elevated zones. Individual landforms respond to the balance of additive and subtractive processes as they grow at smaller and smaller sizes. Ice sheets, water, and sediment are all loads that modify topography through flexural isostasy, and these processes are often intertwined.

Development of geomorphic thoughts

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Spatial scale:

This research takes a landscape- and landform-scale look at advances in geomorphic thinking in multistage systems. Various landscape evolution models sparked the development of geomorphic ideas at the landscape scale. Geomorphologists, on the other hand, turned their focus to smaller scale research, i.e. landform scale, because these models were too generic and hence of little utility. Further emphasis was placed on the importance of scale, which governs the causation and geomorphic processes of the natural world.

Temporal scale:

The identification of the dominating process or event that shapes a given landform has remained one of the most difficult challenges in geomorphology for the past many centuries. "In geomorphology, one important question is whether a high-magnitude–low-frequency event will play a more effective role in the development of geomorphic characteristics, or whether a low magnitude–high-frequency event will even play a more significant role in the development of geomorphic characteristics. The historical data of rivers in the United States has revealed that occurrences of intermediate magnitude and frequency are responsible for the majority of the geomorphic work done by rivers. Palaeohydrological research, conducted at a later time, confirmed the presence of 'big' but infrequent catastrophes and offered support for the notion of neo-catastrophism, which was previously dismissed.

Technological advancement and growth in geomorphic research

The developments in technology over the last few decades have had a significant impact on geomorphic study in many ways. Survey equipment and field measurements initially supplied quantitative data for landform-scale study, but advances in remote sensing applications in the 1990s made it possible to pursue geomorphic research at the landscape size. The development of new chronological techniques, like as 14C and OSL dating, for determining the speeds of depositional processes has offered a significant boost in recent years. While cosmogenic radionuclide dating was useful in estimating the erosion rates of landforms, it was not widely used. In addition, the chronological database served as the foundation for advances in sediment budgeting, which have assisted in the measurement of processes in various landforms and the interrelationships between different landforms and landscapes. It was discovered that chemical (isotope) fingerprinting of sediments could be used to analyse provenance and spatio-temporal variability in sediment supply at the landscape scale, which improved the accuracy of the sediment flow estimates made using sediment budgeting.

Applications to the Ganga River system

Hierarchy and spatial and temporal dimensions

Currently available knowledge of the Ganga dispersion system gives adequate information to analyse the hierarchical structure of this geomorphic system. The dispersion system of the Ganga may be classified into two categories: sediment-source regions and storage zones (the Ganga Plains and the delta region). In addition, these source and storage locations are classified according to the nature of the driving factors,

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which include tectonics and climate (rainfall distribution) in the hinterland area and energy distribution in the alluvial plain. In a specific geomorphic class, this categorization allows for a more in-depth knowledge of the major processes occurring.

Magnitude–frequency analysis

A few research on the sediment transport features of the Ganga Plains have yielded a preliminary magnitude–frequency analysis of the region's sediment movement. The study of sediment movement at the decadal scale reveals the important impact played by floods (events of large size and low frequency) on fluvial processes. Observations made in the rivers draining the north Bihar plains reveal that the monsoon season, which is marked by high flow, is responsible for transporting 90–95 percent of the sediment load. These findings are consistent with data from the neighbouring Brahmaputra River, where sediment load transit accounts for 85 percent of total transport during the monsoon season86 (see Figure 1). The erosion processes in the Nepal Himalaya, on the other hand, provide a quite different image. Daily flow and sediment load data from the Nepal Himalaya imply that moderate events with high frequency, rather than large events with low frequency, are more important in controlling the erosion process than large events with low frequency.

Equilibrium and complexity

As well as through looking at shape and dynamics, the Ganga basin has provided insight into the nature of balance. The idea of balance of a landform may be examined at a variety of spatial and temporal dimensions. It is possible to think of landforms on a small scale as landforms in equilibrium with high-frequency and low-magnitude phenomena, such as bars, piedmonts, channel slopes and widths, and so on. Change in these landforms (departure from equilibrium forms) is therefore utilised as a signal of major tectonic or climatic events, as well as changes in anthropogenic activity, when they occur.

Conclusions

Large river systems, in particular, are critical for the existence of human cultures because they provide a critical water supply". It has been demonstrated in this particular study of a large river system the importance of scale, process–pattern relationships, hierarchy, variability and diversity in natural and human systems, as well as the importance of equilibrium, connectivity, nonlinearity, complexity, and multi-causality for the dynamically coupled natural and human systems of the earth.

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