GEOMORPHOLOGY AND ENVIRONMENTAL MANAGEMENT OF UMIAM BASIN, EAST KHASI HILLS, MEGHALAYA

ABSTRACT

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INTRODUCTION

Geomorphology is a vital component in Environment Resource Management. Its influence on the pattern of development at a particular place is immense. Geomorphology is concerned with the land-water system and frequently recognises that when man uses land, he has to accommodate its relief, material and water resources to his purpose, for which, man has to understand the geomorphology of the area he desires to harness.

With the contemporary concern for environmental management, many problems relate to the interactions between man, land and water. Environmental management is essentially a process of rational utilisation of natural resources and their conservation practices.

Geomorphology plays a pivotal role in all developmental programmes. The knowledge and information of the geomorphic attributes of an area form an important database before any developmental activity is initiated to have minimum environmental imbalances. The land resource management differs in different geomorphic domains. As a result, environmental management strategies also vary to mitigate a common geohazard from one geomorphic domain to other.

Urbanisation and development are related to topographic, hydrographic and socio economic features. So, Geomorphology always comes in the forefront wherever environmental exploitation takes place.

For better living of man, all developmental activities proceed to harness natural endowments and this in turn degrade environment. Thus, development and environmental degradation is a complex situation to be handled scrupulously to avoid environmental crisis.

Environmental crisis is a global phenomenon and is cumulative in nature i.e., a minor deterioration of environment in a small watershed may cause disastrous effects in the downstream basins. This is particularly relevant for hilly and mountainous terrains. The changes in the mountains have immediate repercussions in the valleys and plains below. Hence, environmental appraisal is of paramount importance before any developmental activity is formulated for an area. But, the understanding of geomorphology of the area to be harnessed, is the basic step in any environmental appraisal study.

Therefore the importance of geomorphology in any developmental activity cannot just be overruled. Environmental Management calls for understanding the geomorphology of an area before the land is taken as a resource. The main idea is to identify individual landforms or landform complexes as either favourable or unfavourable to a particular type of economic

activity. In areas, where developmental activities underestimate or ignore geomorphological characteristics, it is bound to create socio-economic conflicts and environmental imbalances.

It is in the light of this relationship between geomorphology and environment, the present study "Geomorphology and Environmental Management of Umiam Basin, East Khasi Hills, Meghalaya" has been conceived to understand the geomorphology of the Umiam Basin and to evaluate the environmental degradational processes in the area for proper management.

CHOICE OF THE AREA

The Umiam river basin offers a variety of landforms in diverse geological milieu. The area exposes many geological sections in an otherwise covered terrain. The hydroelectric project on Umiam river at Barapani has affected the downstream morphology of the river. The entire Umiam river basin offers excellent sections showing the processes of ongoing environmental degradation in different geomorphic domains.

Shillong, the capital of Meghalaya is located within the upper reaches of the basin and is expanding rapidly. The Umiam lake is capable of supporting tourist industry. The hydroelectric project is also in the process of expansion and has encouraged growth of a nucleus of industrial base downstream of the dam. The terminal part of the basin supports tea industry. Evidently, the entire Umiam basin is at the threshold of

development. Keeping in view, the above developmental potentiality of the basin and the ongoing developmental schemes, the areas has been selected for the present study.

THE AREA OF STUDY

The study area covers an area of 1429.510 sq.km. and falls in the Survey of India toposheet Nos. 78 O/10, 78 O/11, 78 O/13, 78 O/14, 78 O/15, 83 B/4, 83 B/8, 83 C/1, 83 C/2 and 83 C/5. It is bounded by the coordinates of 25^{o} 28'00" N : 26^{o}10'07" N and 91^{o}42'00" E : 92^{o}24'30" E.

OBJECTIVES OF THE PRESENT WORK

The aim of the present study is :

(1) To identify and classify different geomorphic domains and landform elements in the area. To study the nature of operative geomorphic processes over the diverse geological milieu.

(2) To evaluate various geomorphic attributes and to identify the various geomorphic risks in the terrain and to evolve cause and effect relationship between the two.

(3) To identify the various Terrain Inherited Geohazards and Man Induced Geohazards and to evaluate the processes of geoenvironmental degradation in the area.

(4) To prepare a Geohazard Zonation map of the basin for rationalising developmental activities and resource exploitation for sustainable development and to evolve strategies for geohazard mitigation.

WORK PROCEDURE

The present study was carried out in the following three phases :

(1) Pre-Field Phase

(2) Field-Work Phase

(3) Post-Field Phase

(1) Pre-Field Phase

The basic objectives during this stage was literature survey and collection of secondary data viz., Geological, Hydrological, Meteorological, Seismological; procurement of toposheets etc. The secondary data was synthesised to prepare the preliminary database. Concurrently, laboratory work was carried out for relief analysis, slope analysis and drainage analysis on 1:50,000 scale.

(2) Field-Work Phase

On the basis of preliminary database, field checks were planned and field work carried out in critical sectors to collect geomorphological as well as geoenvironmental data.

(3) Post-Field Phase

At this stage, all data were classified, collated and processed for interpretation.

PLAN OF WORK

To understand the geomorphology of the Umiam Basin and to evaluate the environmental degradational processes in the area for proper management, the following interrelated aspects were studied, (1) Geology and Structure, (2) Weathering, Mass Wasting and Soils, (3) Terrain Analysis, (4) Watershed characteristics

and Morphometry, (5) Geomorphic characteristics and (6) Geoenvironmental Degradation : Processes and Mitigation.

Geology and Structure

The Umiam Basin is confined to the eastern part of the Shillong Massif exposing by and large, Proterozoic Shillong Group of rocks, Proterozoic Granitoid Plutons and the Pre-Cambrian Gneissic Complex. The Gneissic complex is confined towards the northwestern flank of the basin. However, within the basin, it is exposed as minor strips along the left bank periphery only. The major part of the basin is occupied by the Shillong Group of rocks which is mainly represented by quartzites, phyllitic quartzite - phyllite, slate - siltstone - shale, mica schists etc. The basin and its adjoining area is studded with a number of Granitoid Plutons. The Quaternary Alluvium occurs mainly in the terminal part of the basin. Over the uplands, these deposits are chiefly confined along stream channels as impersistent strips.

The basin is traversed by number of criss-cross lineaments. The Tyrsad - Barapani shear zone is a prominent structural trend in the basin. The basin configuration is mainly controlled by the different Granitoid Plutons and the Tyrsad - Barapani shear zone.

Weathering, Mass Wasting and Soil

These three phenomena occur in nature in a sequence. Weathering is the initial phase in the denudational history of

any landscape as, rocks must be weathered before the debris can be transported. The area experiences tropical monsoonic climate. The high rainfall and plateau nature of the area is conducive to deep chemical weathering.

Mass wasting is an important gravity controlled movement of materials over the earth's surface. In the area, the landslide prone zones are confined within the Shillong Group of rocks. The slides are mostly slumps, debris slides and rock slides. They are more frequent where the developmental activities modify the slope profiles making them unstable with a tendency to fail as and when the equilibrium is disturbed.

Thick mantle of lateritic soil profile is found in the area in response to deep chemical weathering.

Terrain Analysis

Absolute Relief (AR), Relative Relief (RR), Dissection Index (DI), Average Slope (SL), Drainage Frequency (DF) and Drainage Density (DD) are the different geomorphic parameters analysed in the basin to differentiate physiographic characteristics. These geomorphic attributes of the basin show manifestation of fragmental or remnantal imprints arising due to polycyclic denudation. The terrain characters reveal a stepped or cascading physiography. The concentration of high relative relief in the basin is collinear with the Umiam gorge section as well as with the Tyrsad-Barapani shear zone.

The higher dissection index in the Granitoid areas indicate removal of overlying Shillong Group of rocks from over the Granitoid Plutons and superimposition of dissection over their irregular surfaces, marking sporadic and periodic high erosion. The low dissection index over the Shillong Group of rocks suggest that the Cretaceous-Tertiary cover sediments were stripped from over Shillong Group only recently which is a consequence of Quaternary erosional processes.

The average slope distribution reveal the presence of very high steep slope in Umiam gorge section and it also coincides with the trace of the Tyrsad-Barapani shear zone.

High drainage frequency cluster is very sporadic in the basin. Inspite of being part of very high rainfall region, very low areal distribution of this cluster suggests presence of higher secondary permeability and lower concentrated flow. The clusters of high drainage density category incidentally falls in the deforested terrain signifying higher channelisation of run-off due to deforestation. The drainage analysis reveals that the channel segments have very spectacular structural control.

The correlation among these geomorphic attributes show that no single parameter has controlled the development of other parameters significantly which is typical of plateau character.

Watershed Characteristics and Morphometry

The different morphometric characteristics have been

evaluated in the basin. The trunk stream is the 7th order Wah Umiam with 120 component basins. It suffers a fall of 1810m in its total length of about 151km from its source to mouth. The longitudinal profile of Umiam shows cascading nature conforming to the general stepped physiography of the basin. To evaluate basin development, 29 morphometric parameters defining indices of drainage network, basin geometry, intensity of dissection and relief have been used. The analysis reveal localised vigorous headward enlargement of component basins. Incidentally such vigorous erosion is confined in areas of heavy deforestation. The interrelationship among the 19 morphometric parameters were studied which reveals that all these 19 parameters do not depict interdependency and have not contributed equally in the development of drainage hydraulics.

Geomorphic characteristics

Broadly the basin is divisible into 3 geomorphic domains.

(1) Alluvial Plain Domain
(2) Hill Domain
(3) Plateau Domain

Each domain is characterised by distinct landforms and denudational imprints. The Alluvial domain is confined in the terminal part of the basin characterised by multiple pleistocene - Holocene terraces. The younger terraces are flood prone while the older terraces are stabilised and support settlements and tea plantation.

The Hill domain represents exhumed topography with overprinting of fluvial cycles. The domain is conspicuous with rounded and irregular domal topography expressed over the Granitoid Plutons.

The Plateau domain reveals the imprints of polycyclic rejuvenation and erosional surfaces. This domain is characterised by entrenched deep gorges cut by Umiam river into the Shillong Group of rocks collinear with the Tyrsad - Barapani shear zone.

Geoenvironmental Degradation : Process and Mitigation

The Umiam basin is at the threshold of development. Unfortunately, the developmental activities have largely remained concentrated in the southwestern part of the basin. The various environment protection regulations are not being enforced under the prevailing land holding system in this part of the country. As a result, resource exploitation and the developmental schemes have extensively degraded the landscape in the basin due to Man Induced Geohazards (MIG) like deforestation, upland erosion, silting of Umiam lake, land scarring, waste dispersion, landslides etc. beside the Terrain Inherited Geohazard (TIG) like gorges, escarpments, steep slopes, high dissection, swamps, flood prone areas etc. The MIG has overtaken the TIG in the basin due to unplanned and over exploitation of resources.

The identification of these different geohazards have been utilised to prepare Geohazard Zonation Map of the basin according to which the basin has been classed into five geohazard

zones. Over 52% area of the basin fall under moderate to very high geohazard zone indicating the fragile status of the basin. The area suitable for resource exploitation is restricted to very low to low geohazard zone.

RECOMMENDATIONS

To check further geoenvironmental degradation and to promote sustainable development in the basin, following strategies are suggested :

(1) The development and exploitation of the natural resources in the basin need to be done as per terrain characters.

(2) The development in the entire basin should be conditioned by the Geohazard Zonation Map. Developmental schemes should be avoided in high to very high geohazard zones.

(3) All developmental schemes should include cost of landscape conservation and reclamation. Sustainable development to be initiated in the basin by promoting environ friendly industrial base to raise the socio-economic status of the inhabitants.

(4) The unplanned growth of Shillong Agglomeration in the moderate to high geohazard zone should be checked.

(5) The existing garbage disposal system should be stopped forthwith and modern technology for the waste disposal system to be introduced.

(6) The constructional activities in the basin should integrate aseismic designing in their structures against earthquake risks.

(7) Land scarring through indiscriminate quarry operations should be stopped within the urban limits to restore aesthetic view.

(8) Mining Regulations should be enforced.

(9) Slope profile modifications should be graded for landslide management.

(10) Upland erosion should be checked by multitier afforestation schemes.

(11) Logging/Lumbering of immature trees to be totally banned in the basin.

(12) Reserve forest coverage to be increased.

(13) Social awareness to Geoenvironment to be spread.