4.1

GEO-ENVIRONMENTAL STUDIES OF MANIPUR RIVER BASIN

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INTRODUCTION

The problems of the environmental management in river basins are treated as periphery problems. Though, these areas are often included in great reserves of natural resources of the nation, their contribution to the main land is quite often in terms of forest, water, wildlife, tourism and leisure industries. Forest and forest eco-systems of north-east India in general and Manipur in particular, are under severe pressures, both from biotic and abiotic factors. The main reasons for it include population explosion, encroachments on forest lands, loss of forest cover for other non-forest uses, shifting cultivation , and degradation caused by illicit felling, lopping for fuel wood forest and fodder, removal of forest cover for litter, forest fires, etc. With rich bio-diversity of Manipur, its conservation now-a-days has become a major challenge which leads to its forest fragmentation. Four most important general factors, viz. shifting cultivation, human population pressure, industrial logging and weak government policies have been studied.

OBJECTIVES

- To apply remote sensing data to study natural resources, including landforms, soil, vegetation, geology, slope/relief on 1:50,000 scale, and
- To create a computerized database of natural resources using Geographic Information System (GIS) and to evaluate geo-environmental assessment.

STUDY AREA

Four river basins of the Manipur state, viz. (i) Manipur river basin, (ii) Barak river basin, (iii) Yu river basin, and (iv) Tizu river basin.

METHODOLOGY

The remotely sensed data was used and visual interpretation techniques were adopted in addition to ground truth investigations. GIS database was created and various resources maps, including vegetation, watersheds, soil, geology, geomorphology, relief/slope, land-use/land-cover and landform were prepared. These maps were digitized using the GIS software and resource evaluation was made of the Manipur river basin.

The digital image processing of IRS LISS III data was done and in addition, ancillary data was used for generation of number of thematic maps. Through assessment of shifting cultivation and other analysis, temporal changes were delineated.

Assessment of the vulnerability of the land to erosion conditions was made. For studying physiographic features, a Digital Elevation Model (DEM) for the Barak basin was generated.

A drainage map was prepared using the topographic sheets of Survey of India (SoI) on 1:250,000 scale which was then digitized to bring it in the GIS format for delineation of sub-watersheds.

A vegetation database from 1934 to 1998 was prepared. Subsequently, the vegetation patterns were compared to assess the temporal changes in the crown conditions. The land-use /vegetation map of 1971 was an updated version of the first forest map of 1934. Six classes in the forest map from the dense vegetation to open mixed jungle made were: (i) Dense Forest, (ii) Medium Forest , (iii) Sparse Vegetation , (iv) Degraded Vegetation, (v) Shifting Cultivation, and (vi) Agriculture.

The land-use/vegetation map of 1984 and 1991 was also derived from the visual interpretation of satellite data, viz. LAND SAT TM of March 1984 and 1991. This map was also later on digitized in the GIS format for further analysis. There was a repetitive attempt to classify the land use for a next date to find out the temporal changes in the vegetation patterns in the river basin. The land-use maps of various subsequent years gave the temporal change analysis in the forest area as well as in the extent of shifting cultivation.

A socioeconomic database of the Manipur River Basin was also prepared. A critical aspect of man's environment is characterized by the way in which man interact with other man and natural environment. Owing to the complexity of his activity and interrelationship, it was difficult to identify the general parameters that describe the conditions of human resources. Because of this generality, the attributes were difficult to measure and define, and as a general rule, an adequate assessment of the impact on human resources was applied. Two major attributes, viz. (i) demography or life style, and (ii) community need or amenities were therefore considered for socio-economic data.

RESULTS /OUTPUTS

The Manipur river originates from north of Karong, in the Senapati district, traversing through a stretch of 50 km in the hilly tract, meanders through the Manipur valley in a North West-South East direction. Its important tributaries are the Imphal or Manipur River meanders through the Manipur valley. There are several shallow lakes or marshes in the inter fluvial areas of these river systems, such as Lamphel pat between the rivers Nambul and Imphal, Waithou pat between the rivers Iril and Thoubal , Ikop pat, Kharung pat and Lousi pat between Thoubal and Sekmai Rivers and Khoidum lamjao and Pumlen pat south of Sekmai river. On the west, between the rivers Manipur and Khuga lies the Loktak Lake which comprises about 20 small and large Pats (lakes) of which Loktak, Takmu, Ungamen, Laphu, Thamnumacha, Khulak, Yena and Tharo pokpi are fairly large. Two other lakes just north of Loktak lake are Sana pat and Utra pat. The total water discharge from the Manipur River Basin draining the eastern half of the state including the Manipur Valley has been estimated to be 1.8545 million hectare metres. Manipur River Basin accounts for 0.5192 hectare metre of annual run-off against a total drainage basin area of 6,865 sq. km in the eastern part of Manipur.

The Manipur River arises in the north at Karong. It flows southwards of Imphal and is also known as Imphal river. Manipur river basin encompasses an area of approximately 7,000 sq. km in the state. The half of the Manipur valley area is covered by the Loktak and other small lakes. The major tributaries are Iril, Thoubal, Chakpi, Khuga, rivers, which, join Manipur river at different places. It traverses through hills and valleys and displays various geo-environmental regimes

Various maps on 1:250,000 scale were prepared including physiographic map, drainage map, geological map, land-use/land-cover map, geomorphological map, slope map, drainage density map and soil map.

From generating the DEM using physiographic features, the effect of tectonics and relief on the physiographic feature was found appreciable and was followed by earlier deformations, thus leading to the observation of impact of deformation is in the present physiographic features. The area was found rugged hilly terrain with linear ridges and narrow valleys and its topography was relatively immature with topographic features showing high relief. High hill ranges were located in the northern and central parts of the basin and the topographic expression got gradually subdued towards west and ultimately merged with the Cachar Plains of Assam.

The *trellis* and *de-trellis* drainage patterns were the most common drainage pattern identified in the area. Drainage network appeared to be controlled by the underlying lithology and structures. A number of drainage patterns were identified to analyze the impact of initial slope, physiographic, lithological variation, structural controls, recent diastrophism and the neo-tectonic activities in the basin. Drainage density provides an important tool for assessing the erosion characteristics in the watershed. It was observed that the high density in river basin showed a high dissection index and was vulnerable to erosion hazards and the reduced vegetation density and bare soil cover influenced the high dissection index in the river basin.

Geologically, a series of sedimentary rocks mainly sandstone of tertiary age constituted the basin and these sedimentary rocks were subjected to tectonic activities, resulting in the present day topography that is anticlinal hills and synclinal valleys. Geologically these rocks belong to Disang Group (Eocene) overlain by Barail (Oligocene), Surma (Lower Miocene) and Tipam Group (Upper Miocene). The Recent Alluvium (Pleistocene to recent) which is deposited along the river valleys seemed to be derived from the fluvial activities and the large alluvial plains were formed in the Lower Assam. Geomorphologically, the area was a typical manifestation of the geological structure represented by structural landforms such as anticlinal valleys, syn formal ridges, hogbacks, anti-formal ridges, etc. Structural control over the drainage was evident from the linearity of higher order streams and sub-rectangular to rectangular patterns.

Soils, as usual, in the area were one of the important natural resources for the survival of mankind, plants and animals. Since, there was an intimate relationship between soil, water and plants, the study of relationship between soil and water was a key factor that determined the utilization of soil as resource. It was observed that soil colour, texture, moisture content, organic matter content, surface roughness and salinity; all significantly affected the reflectance of soils. Many complex chemical, physical and biological activities were going on constantly in the soils of the area. Influence of climate, vegetation, and topography and parent material on soil was observed distinctly on remote sensing data. Application of remote sensing in soil mapping was proved quite useful. The soil maps were prepared by using various techniques including the use of ancillary data from the Soil Survey Report, National Bureau of Soil Survey & Land Use Planning (NBSS & LUP), Regional Centre, Kolkata. Based on geomorphology, topography, texture and soil characteristics, three classes were identified in the Barak Basin. The soil map from NBSS & LUP was used for the digitization in Geographic Information System (GIS) format and an exhaustive legend was also complied for the required purpose.

From geo-environmental appraisal point of view, the present study highlighted the significant impact on the Manipur river basin for its geo-environmental deterioration. The observations were of various magnitudes and seemed to be very complex and their resulting impact had brought the changes in vegetative cover, soil erosion and land degradation.

The human intervention was observed as one of the significant causes for the geo-environmental status of the river basin. The extent of the dense forest and moderate forest was considerably reduced. The commercial exploitation of timber by the forest contractors seemed to be more significant in many sub-watersheds as those watersheds, which were not well connected with the road networks and also not degraded. The extent of shifting cultivation during the period of study (1984-91) had been reduced considerably. Hence, it was found that the forest degradation was mainly due to more commercial exploitation of the timber than by the shifting cultivation. The study indicated that shifting cultivation leads to lowering of organic content; decreasing the available phosphorus, potassium and magnesium contents; lowering the total quantity of iron, aluminum, calcium, potassium, phosphorus, etc. and affecting adversely the cation exchange capacity and physical properties, i.e. waterholding capacity and field capacity and increasing the pH and reducing microbial activity. The watersheds delineation analysis of the Manipur river basin provided a comparative assessment of these 10 sub-watersheds which constitute the entire river basin. The various resources maps such as soil, geology, landforms, slope/relief, and infrastructures were used in these sub-watersheds priority delineation in order to prioritize soil and water conservation measures.

4.2

STUDY OF THE ECOLOGICAL AND ENVIRONMENTAL STATUS OF UPPER CATCHMENT AREA OF PAMBA RIVER BASIN USING SATELLITE DATA

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INTRODUCTION

Land and water are the two basic components which support the very foundation of any economy. The uniqueness of their interlinkage is manifested by river basins, which not only control diversity of the surface of the earth but also act as a definite determining factor of land-use structure. In fact, a judicious land-use planning is essentially concerned with the proper management of land and water. Therefore, the river basins, undoubtedly serve as basic units for the study of land and water management. During the past two decades, general awareness about environmental issues has gained considerable importance and every large-scale project has been subjected to some kind of environmental impact assessment (EIA) study.

Now-a-days, the availability of remotely sensed data has made it possible to view large areas of earth's surface at frequent intervals of time It also makes a realistic consideration of the environment and ecology, monitors changes and activates early remedial measures.

OBJECTIVES

- To assess eco-status of the upper catchment area of Pamba river basin using satellite data and identify ecologically and environmentally fragile areas,
- To study the present land-use pattern and land-use changes over the years in comparison with different land form units,
- To assess land capability and land-use systems of different critical areas of the basin,
- To study environmental pollution problems in the area, especially water pollution in the upstream area of Pamba river and degradation in biomass due to congregation of pilgrims, and
- To suggest action plans for the conservation and eco-restoration of environmentally fragile areas and to suggest catchment area treatment plan.

STUDY AREA

The study area covered about 620 sq. km between 9°10' - 9°28' North latitude and 76°48'-77°17' East longitude.

METHODOLOGY

The study was carried out using mainly remote sensing data that gave repetitive coverages of spatial information and temporal changes for different time periods. The interpretation of satellite images and aerial photographs were carried out to prepare thematic maps on land-use, geomorphology, drainage, infrastructure and communication network, etc. The land-use maps for five time periods were prepared.

A comparative analysis of the land-use changes in different time periods was made and a comparison was made of the changes over the past twenty years using the remotely sensed data. The data sources used were: IRS 1A LISS II Geo-coded FCC of 1989; IRS 1B LISS II Geo-coded FCC of 1993; IRS 1C LISS III Geo-coded FCC of 1997; Aerial Photographs of 1990-91; Survey of India toposheets of 1977; Forest working plans of different time periods, and Soil map prepared by NBSS & LUP. The analysis was carried out using the ARC/INFO Geographic Information System (GIS) software package, and particularly its ARC/TIN module. Digital image processing (DIP) of IRS 1C image was also carried out. Groundtruth survey was conducted at selected locations for the cross verification of the interpreted data.

RESULTS/OUTPUTS

Remotely sensed data was used for a comparative study of the changes that had occurred in an area during different time periods. Different sources of pollution were identified while conducting detailed water quality analysis of samples collected from Sannidhanam and Triveni area of Pamba River. It was found that over the years millions of pilgrims who visit the Swami Ayyappa (Sabarimala Pilgrim Centre) shrine have caused considerable stress and damage to the ecology and environment of the catchment area. The stress was in the form of degradation of forests, soil erosion, pollution of river water, siltation and sedimentation in the river, depletion of minor and major forest resources, etc. The river water was found highly polluted mainly through man-generated and organic wastes. Other major pollutants were plastics, bottles, metal cans, etc; which were also generated as part of pilgrimage. It was identified that the land-use changes occurred during the past twenty years in the upper catchment and the associated environmental problems. The analysis of the study using GIS showed that considerable change in land-use had occurred in the study area, especially in the Sabarimala surroundings and down stream areas. Considerable amount of degradation had occurred in and around Sabarimala, whereas in the down stream area, conversion of forest-to-forest plantations had taken place in a considerable area. The upstream beyond Sabarimala, where the Pamba and Kakki reservoir is situated showed more or less an unaffected area. A matrix showing the environmental status of each terrain unit, based on the information collected in regard to the various aspects like soil, slope, drainage, density, present land-use etc; was prepared, and management practices and treatment plans for each terrain unit were suggested.

4.3

WATERSHED PRIORITIZATION OF BARAK BASIN USING GEOGRAPHIC INFORMATION SYSTEM AND REMOTE SENSING

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INTRODUCTION

The Barak basin is the second largest basin in North-East India and constitutes the part of Ganga-Brahmaputra river system. It originates from Liyai Khullen, border of Nagaland and Manipur, traverses through the denuded tertiary ranges in Manipur and further drains to lower Assam Plains with its large flood plains and finally joins the Bay of Bengal as Meghana in Bangladesh. The forests of the Barak Basin are important resources for meeting the subsistence needs of rural poor, especially the tribal people and forest dwellers. Collection of forest produce and the livelihood of people (Jhuming) are mainly through clearing of the forest cover, which is developed along the moderate-to-steep hill slopes. The main problems from watershed point of view are shifting cultivation and soil erosion.

The Upper Barak basin constitutes a large geographical area in western Manipur, Nagaland and Mizoram and has a vast hydroelectric potential of the order of 1,500 MW as installed capacity. Recently, North Eastern Electric Power Corporation (NEEPCO), Shillong, has taken over initiatives for the construction of the proposed project. A considerable part of the drainage basin falls within Manipur and the proposed Tipaimukh dam is located at the tri-junction of Manipur, Mizoram and Assam. It was proposed to investigate the erosion patterns in the watershed as well as to delineate the priority among watersheds of the river basin for soil conservation measures. Since, the application of remote sensing and Geographic Information System (GIS) to create a database of natural resources that can be used in future detailed studies by the project implementing authority, has been proved very effective and economical, these techniques were used in the present study.

OBJECTIVES

- To prepare the base map for showing drainage, sub-watersheds and their codes,
- To prepare the GIS layers for watershed characteristics, viz. land use, relief, slope, soil, landforms, geology using the satellite data and ancillary data, and
- To interpret the satellite data leading to run-off yield and Jhuming intensity factor and hence prioritize the sub-watersheds for soil conservation methods.

STUDY AREA

Barak basin located in the Ganga-Brahmaputra River System in North-East of India.

METHODOLOGY

The base map was prepared using the guidelines in order to delineate sub-watersheds. The GIS layers consisted of drainage map, watershed delineation map, soil map, slope map, relief map, land-use/land-cover map (1984, 1991 and 1998) and geomorphological map. The method was based on All India Soil and Land Use Survey (AISLUS), Nagpur, for identification of the priority watersheds for soil conservation purposes. Factors of jhuming intensity and demography were additionally considered in the present study. The mapping legend implied set of relevant parameters that exerted direct and reciprocal influence on runoff and soil detachment. These factors included physiography, slope and land-cover patterns in the river basin. The erosion units were assigned weightage values such that when considered relatively, the weightage values approximately yielded runoff and sediments from the different units.

RESULTS/OUTPUTS

The approximate framework area of the sub-watersheds was 2,000-5,000 ha, which was viable for conservation measures. Delivery ratios were adjusted for each of the mapping units falling in different sub-watersheds. It suggested the percentage of the eroded material to the reservoir. Delivery ratio included factors from physiography, slope, size of watershed, surface conditions, texture of the soil, distance from active stream and reservoir and occurrence of sediment traps. The major problems were shifting cultivation and soil erosion in the Barak basin, therefore, watersheds were prioritized into five categories, viz. very high, high, medium, low and very low priority.

On the basis of Sediment Yield Index, 143 sub-watersheds fell under very high and high categories comprising 62.6% of the geographical area of the Barak Basin. On the basis of Jhuming intensity and sediment, yield index, 145 sub-watersheds fell under very high and high categories, comprising 64.6% of the geographical area of Barak Basin. It revealed that the large-scale Jhuming practice was attributing to soil erosion in the watersheds of the Barak basin. Due to lack of other livelihood, the people were forced to adopt the cultivation. The Barak basin required to be taken care for systematic/phase-wise soil conservation measures in order to sustain the proposed Tipaimukh hydroelectric project. In order to undertake appropriate measures for watersheds treatment, it was found necessary to initiate both long-and short-term measures simultaneously. Considering the socio-economic conditions prevailing in the area, it was difficult to suddenly change the local tribal communities from shifting cultivation to permanent settlement.

4.4

STUDY OF ENVIRONMENTAL STATUS OF FOUR RIVER SYSTEMS IN THE SOUTH-WESTERN GHATS AND ITS INFLUENCE ON LAND AND WATER SYSTEM OF KUTTANAD AREA USING REMOTE SENSING DATA AND GEOGRAPHIC INFORMATION SYSTEM

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INTRODUCTION

The integrated river basin management planning or more precisely watershed management is mainly concerned with water budget, which depends on rain fall, evapotranspiration and run-off. The amount of water entering the lower reaches of the river depends on the management practices upstream and therefore, these management practices would affect the magnitude and flow of flood, sediment load and other hydrological parameters.

OBJECTIVES

To assess the various developmental activities in the area, especially the land-use changes and its impact on the land and water system of Kuttanad region.

STUDY AREA

Kuttanad region including the catchment areas of four rivers in the southern western Ghats, viz. Pamba, Achancovil, Manimala and Meenachi Rivers that flow through Kuttanad region and ultimately drain into Kuttanad region, which is very typical as major part of it is under water.

METHODOLOGY

The remote sensing data for three time periods were interpreted along with the Survey of India (SOI) toposheets and was analyzed using Geographic Information System (GIS). Ground truth survey was carried out in specific locations to verify the interpreted maps and also to collect additional information from the field. Water quality analysis was carried out in the field for specific additional information from specific points in all the four rivers as well from Kuttanad region. Detailed socio-economic survey was also carried out in the Kuttanad region. A comparative analysis of the land-use changes was made in different time periods in catchments of these river systems and Kuttanad. Finally, the changes over the past twenty years were compared using the remote sensing data and SOI toposheets. The final analysis was done using the remote sensing data and SOI toposheets using the ARC/INFO GIS software package, which had a number of optional facilities for comparative analysis of different environmental parameters.

RESULTS/OUTPUTS

It was found that tremendous change in the land-use pattern in these areas occurred and these changes had ultimately influenced the land water system of Kuttanad. The changes were mainly in the form of conversion and degradation of mixed crops into rubber plantations, degradation of forest areas into grass lands and open scrubs, reclamation of paddy fields and flood plains for non-agricultural purpose. The land-use changes in the catchment area of four river basins pointed to the following aspects:

- The forest area in the catchments of rivers had been reduced considerably during the past twenty years.
- The scrub areas represented by open scrubs and dense scrubs had also increased considerably, which was an indicator of forest degradation.
- Grassland area showed an increasing trend. One of the major reasons for the increase in grassland area could be the degradation of forest area cleared for power line inside the forest.
- The plantation area had increased considerably during these periods and rubber plantation showed tremendous increase as compared to the status in 1977.
- Area under paddy cultivation was diminishing. More paddy fields now remained as uncultivated flood plains.
- Mixed cultivation practices were slowly disappearing from the midland and high-range areas.
- Meenachi, Manimala, Pamba and Achancovil rivers had flood plains in the downstream along with the Kuttanad region. However, the important aspect to be noticed was that the area of flood plain had considerably reduced.

Another major threat to these rivers and Kuttanad region was the indiscriminate sand mining, which lowered the riverbed and slowly killed the river. Detailed water quality analysis was also conducted from both upper catchments and lower reaches of all these four rivers and also from Kuttanad region. The water analysis showed that the river water was comparatively less polluted in upstream regions but when it reached down streams, it became highly polluted mainly through faecal contamination and pollution through organic wastes. The pesticide and chemical fertilizer consumption had tremendously increased, ultimately polluting the rivers and Vembanad lake. This showed an increasing trend in recent years by the introduction of high-yielding paddy varieties in Kuttanad, which required heavy doses of fertilizers and pesticides.

Threats like invasion of weeds, lowering of water tables; intrusion of saline water into interior areas, regular floods and land slips and slides triggered by unscientific cultivation practices were also identified. Human intervention was altering basin ecology like reclamation of wetlands, water bodies and flood plain, embankment construction triggered the flood incidences. The construction of the Thanneermukkom Barrage had interrupted the migration route of marine fishers and prawns. During the closure of the barrier, the upstream area was no longer flushed by the tides and water was polluted into the Kuttanad. Worsening this problem, the Meenachi River was being diverted to Idukki from its upper catchments and another similar diversion scheme was going to be implemented in the upper reaches of Achancovil to Tamil Nadu.

An assessment of the health status of dwellers of Kuttanad region by a survey found incidence of vector-borne diseases like cholera and dysentery, the cause of which could be attributed to unhygienic drinking water. Infective jaundice, diarrhoea, dysentery, typhoid, etc. were indicative of polluted water.

On the basis of the data collected through the detailed studies, a catchment area treatment plan was formulated and appropriate management practice for each terrain unit was made. This was done after analyzing the present environment status of each terrain unit in relation with the present land use. A matrix including the various aspects like geomorphology, soil details like texture, drainage, depth, present land-use and drainage density, etc . Using this matrix, the environmental status of each terrain unit was identified. On the basis of this information, appropriate management practices for each terrain unit have been suggested. Among land-use types, the areas with degrades natural vegetation showed maximum slide intensity. Based on the Land Hazard Zonations (LHZ) study, critical zone, moderately unstable zone, moderately stable zone and stable zone were identified in the area. In the entire study area, the Poonjar-Theekoy area near Erattupetta and Ranni-Athikkayam area were much prone to landslides.

It was seen that a considerable amount of degradation had occurred in the proximity of three major routes to Sabarimala. This could be identified in the terrain units, DH-4 which was near to Karimala and was on the way from Erumeli to Sabarimala route; DS-7 represented by the Neelimala area and which was on the way from Pamba (Triveni to Sannidhanam) and PL-1, the present land use of which was grassland and was on the Vandiperiyar route. All these areas required appropriate management practices. The degraded areas in these terrain units needed to be protected from further degeneration after providing a buffer area around the existing foot road. The buffer area could be afforested with species which could be utilized by the pilgrims for their use and thus to minimize the dependence of natural forest for meeting their various needs during pilgrimage. In the plateau region, near the reservoirs, there were problems of high erosion, slope failure and slumping along reservoirs. Soil management practices and erosion control measurement like afforestation with reeds, bamboo, etc., could be considered in this area.

Various aspects like extent of degradation, and socio-economic causes of this degradation were also studied in details. It was very clear from the results that, continuously evolving economic, social and cultural pressures on land and water resources, including pollution and excessive uses were increasing external costs and multiplying conflicts between users of this strategic resource for domestic, industrial, and agricultural purpose and food production. Due to reclamation, there had been a gradual decrease in the area occupied by water body. An increase of flood plain was noted in Kuttanad, the reason for this could be attributed to the fact that large area was now remains as uncultivated marshy lands and wetlands, where paddy was cultivated in earlier days. A sudden sharp decrease could be seen in the paddy area of Kuttanad, from 462.82 sq. km in 1977 to 393.83 sq. km in 1998. Built-up land showed a tremendous growth over the years. Urbanization, land reclamation and conversion, etc. were the driving force behind this growth. In 1977, built-up land was only 98 sq. km and by 1998, it rose to 22.06 sq. km, which could be attributed to shifting of primary occupation to different occupational structures.

4.5

GEO-ENVIRONMENTAL STUDIES IN THE BANAS DRAINAGE BASIN, RAJASTHAN AND PREPARATION OF GEO-ENVIRONMENTAL DATABASE

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INTRODUCTION

Geomorphology and geology of Rajasthan have an important control on the land system and land use. The processes and products of desertification and land degradation have caused extensive disorganization of the drainage system, resulting in sand, blanketing and buried drainage network. In this dynamic geo-environmental setting of Rajasthan, the important drainage basin that survived albeit strongly modified and immensely disorganized is the Banas drainage basin.

OBJECTIVES

To understand the physical and environmental stresses and their responses that exist in the semi-arid terrain, and the modifications that take place in a drainage basin under a dynamic geo-environmental setting dominated by geomorphological terrain changes.

STUDY AREA

Banas drainage basin that is largest in Rajasthan and straddles different agro-climatic and physiographic zones. This feature makes the basin very critical as well as vulnerable to geo-environmental and anthropogenic changes.

METHODOLOGY

A new method of Transverse River-valley Profile (TRP) study and interpretation was adopted. Several TRP parameters were identified which were quantifiable, and, therefore, useful in the inter-TRP and inter-drainage comparisons and correlations. The method was applied to the study of several TRPs of the Banas drainage basin. Several multi-disciplinary thematic maps on uniform scale were prepared. These themes included quantitative geomorphology, drainage network, geology, tectonics, soil types and properties, soil erosion, gully growth and land degradation, etc. When it was found that high erosion had taken place in the central segment of the basin caused by a high rate of incision by the Banas and its tributaries, this feature was related to neo-tectonically controlled river grade adjustments. The TRP study could also differentiate a four-tier terrace system (T1-T4) in the Banas drainage basin, and its differential dissection and displacement.

Hypsometric analysis of the Banas drainage basin was carried out to decipher the stages of landform evolution, and to assess the influence of geologic and tectonic factors on topography and its modifications. It was concluded that the area of the sub-catchments controls the aspect ratios of the basin because of lateral drainage branching and network bifurcation. Two landform evolution models were generated on the basis of variations in the coordinates of the slope inflection points on the hypsometric curves in terms of relative height and plain area. Fluvial erosion dominated in Model 1 and diffusive mass wasting in Model 2. The landform of the Banas drainage basin had approached almost steady-state equilibrium stage. An empirical relationship between terrain uplift and hypsometric parameters was derived. It was suggested that the SW part of the Banas drainage basin, covering parts of the Aravalli hill range, has been uplifted more than its NE segment.

RESULTS/OUTPUTS

Geologic features, especially the dislocation and fault zones, indicated that the Banas drainage basin had a protracted geological evolution that led to the development of various types of bed-rocks and different structural zones, some of which were still active, controlling the geomorphic features and tectonic topography. Some of these fault zones were seismogenic, viz. capable of generating earthquakes. Long to great group of Ustochrepts soil and its various types covered nearly 80% of the basin area. The soils hardly showed well-defined profile development and contained a large component of Aeolian sands in stabilized and old dune fields. The topsoil was generally oxidized in a mature topography of stabilized dunes, and was variably calcareous and essentially alkaline. There were well-developed calcrete horizons (a conglomerate of surficial gravel and sand cemented by calcium) at many places beneath the topsoil, especially in the NE segment of the basin. The soil salinity status was variable, but generally the soils of the down faulted and depressed terrains were more saline than those of the uplifted uplands.

Gullies and rills had developed extensively in the NE segment of the basin, especially in the lower reaches of the Banas river valley. Because of the occurrence of calcrete beneath the topsoil, the gullies had grown horizontally rather than vertically. This feature together with extensive piping had led to soil erosion, badland development and land degradation. It was estimated that between 1970 and 2000, the gullied area in the NE segment of the Banas drainage basin had increased at the rate of 2% per year, although in specific areas the rate could be as high as 4-6%.

4.6

THE SUBANSIRI RIVER, ASSAM: ITS MIGRATION AND EROSION-A CASE STUDY

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INTRODUCTION

The lands located along the rivers have always been very attractive for human societies. They are often fertile lands of high agricultural value. But, these lands are also flood plain episodically, inundated by large floods. The study for a selected stretch of the Subansiri River channel within Assam was thought essential.

OBJECTIVES

To study the alarming situations of the Subansiri river in relation to its geomorphologic attributes

STUDY AREA

The Subansiri River, Assam, located in North-East of India

METHODOLOGY

The study was conducted with the available data spanning for the period from 1914 to 2000 of critical areas where time-based flood mitigation and management was strongly warranted.

RESULTS/OUTPUTS

The river course as evident from the 1914 Survey of India (SOI) toposheets was significantly meandered in nature and exhibited almost NS flow trend. The course of the river changed from meandering to braiding after the Great Assam Earthquake of 1950. The 15th August 1950, Great Assam Earthquake with magnitude of 8.6 on Richter scale had played a significant role on the Brahmaputra Valley in general and change of river channel in particular. It was reported that the Subansiri River course at the high gorge section near Sipomukh was blocked by a massive landslide, leading to development of a natural dam impounding a huge volume of water for three days. The sudden outburst of this enormous amount of water had flooded the lands, specifically on the alluvial plains south of the foothills of Arunachal Himalaya. This catastrophic flood had swept away the villages like Gergaria, Rupahigaon and Balijangaon with a vast tract of the Pathalipam Tea Estate. The river course underwent a significant westward migration up to 5 km with change in flow direction from South East (SE) to South West (SW). The river course was also shortened by 7 km, leaving the significant meander band near Gargeria-Naharhabikora Chuk. The remarkable change during the period 1975 to 1990 was demonstrated by the widening of river course and by eastward migration as well as development of relatively short span connecting channels.

The period during 1990 to 1995 had not revealed any prominent change in morphology of the river channel. The river exhibited its tendency to flow as a single channelled river in easterly direction. The major flow of the river was diverted through Ghuna Suti -Khaboli sector and the flow in southeasterly direction through Kherkatia Suti became significantly weak. As a result, the river channel under Khaboli sector widened by two-fold. The straightening of course was mainly achieved by neck cut-off through meander bends. The westward movement of both the banks significantly manifested the migration of the channel. The shifting of bank was more pronounced near Chauldhuagaon-Bhimpara Chapori, where the channel changed its course up to a distance of 4.15 km. The activity of erosion/deposition processes operated over the period 1914 to 1975, 1975 to 1990, 1990 to 1995 and 1995 to 2000. The period during 1914 to 1975, witnessed unequal rates of erosion/deposition processes for both the banks. However, the rate of erosion was prominent on the west bank than east bank. The total land area suffering erosion and deposition during the period 1914 to 1975 was 130.16 sq. km and 77.65 sq. km, respectively, which evidenced dominant erosion-prone activities over deposition. The annual rate of erosion during this period represented 2.13 sq. km/year. The period during 1975 to 1990 exhibited increasing activities of both the aspects than the 1914 to 1975 period. The annual rate of erosion during this period as evident was 3.88 sq. km/year. The period during 1990 to 1995 indicated dominant depositional activities over erosion. The annual rate of deposition was observed to be 5.00 sq. km/year and the rate of erosion was 4.32 sq. km/year. The erosion rate was observed to increase by two-fold during the period 1995 to 2000, the rate as observed was 8.25 sq. km/year and the total rate of deposition was observed to be 5.10 sq. km/year.

From the available data resource at hand it was clear that the period 1995 to 2000 witnessed a period of significant erosion over the basin. The problem of bank erosion and channel instability was inherently connected to flood stage of the river. The basin area being very unstable seismically, the morphology and behaviour of the river undergoes drastic changes both over time and space. Combining with extremely dynamic monsoon regime, the unique geological formations, active seismicity, mass deforestation, intense land use pressure, explosive population growth, especially in the flood plain belt and insufficient / improper measures in relation to flood mitigation aspects are some of the factors that cause/proliferate the intensity of erosion and consequent migration of the channel course. It was concluded that the present approach has thrown an insight in some of the existing aspects in relation to mitigate the channel instability towards management of perennial flood problem of the Valley and to open up avenues for further studies.

4.7

BIOGEOCHEMISTRY OF THE WESTERN GHATS REGION BETWEEN GOA AND MANGALORE, USING REMOTE SENSING AND OTHER MODERN TECHNIQUES

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INTRODUCTION

The Western Ghats provide the principal geographical barrier in the path of the Arabian Sea branch of the South-West Monsoon and are responsible for the heavy rainfall over the western coastal belt. The rivers in the Western Ghats region generally originate at an elevation ranging from 400 metres to 1,600 metres above the mean sea level, close to the Western Ghats ridge. The rivers generally flow westward and meet the Arabian Sea after a short-run, varying from 50 km to 300 km. The rivers are very steep in the upper reaches and fairly steep in the middle reaches. It is only near the sea that they have relatively flat gradients and some sort of flood plain. The Goa coastal region, which extends between the Western Ghats, edge of Karnataka Plateau in the east and the Arabian Sea in the west, covers Uttara Kannada and Dakshina Kannada districts of the Karnataka state. This region is traversed by several ridges and spurs of Western Ghats. It has difficult terrain full of rivers, creeks, waterfalls, peaks and ranges of hills. The coastal plain represents a narrow stretch of estuarine and marine plains. The abrupt rise at the eastern flanks forms the Western Ghats. The northern parts of the Ghats are of lower elevation, i.e. 450-600 metres as compared to southern parts i.e. 900 to 1500 metres. The coastal belt, with an average width of 50-80 km was cover a distance of about 267 km from north to south.

OBJECTIVES

To study the biogeochemistry of the Western Ghats region using remote sensing and other modern technologies

STUDY AREA

Western Ghats and the coastal plains of the western parts of India, including the state of Goa and north-western parts of Karnataka

METHODOLOGY

Using remote sensing and other modern tools, two rivers from Goa, viz. Mandovi and Zauri, and six rivers from Uttara Kannada, called North Kanara till recently, and Dakshina Kannada districts of Karnataka state, namely Kalinadi, Gangavali, Agnshini, Sharavati, Gangoli and Netravati were investigated.

RESULTS/OUTPUTS

There were a number of free catchments, between the identified river basins, which had small streams directly draining into the Arabian Sea, besides two rivers from Goa and Dakshina Kannada districts and eight flowing rivers. These free catchments were close to the sea and were at lower elevation. Kalinadi, Gangavali, Agnshini and Sharavati were the prominent rivers of North Karnataka. Sharavati was the shortest river and was famous for the mighty Jog falls, the site of the hydel project.