

### B.1c Fluvial Geomorphology

**18. Rajiv G. Sudarsana, Reddy, Y. Venkata Ram,** “Hydrological Studies in Nandyal Taluk, Andhra Pradesh, India”, *Geographical Review of India*, 70 (2) 2008 : 132-138.

**Introduction/Objectives:** The paper analyses hydrology of the drought prone Nandyal Taluka of Rayalseema region of Andhra Pradesh. It focuses upon the groundwater investigations and the same is related to the geology of the area. The quality of ground water, the aquifer parameters etc. are analysed. The chief objective of the paper is to suggest strategies to combat problems related to the hydrology of the area.

**Data Base and Methodology:** The paper makes use of primary data collected from the field by the authors and the same have been presented in two separate tables. Thirty samples were collected from wells and five samples were collected from surface water from different water bodies for analyzing the quality of water. The paper follows a descriptive approach. To begin with the geology of the study region, the drainage, surface water sources such as canals, springs, tanks etc. of the study region have been described.

**Findings:**

- (i) On the basis of pH value it can be said that central flat land covered by black cotton soil has comparatively high pH value. It is attributed to canal irrigation of poorly drained area that leads to alkalinity of soils. High alkalinity of soil in turn results in higher concentration of soluble silica due to decomposition of silicates by hydrolysis.
- (ii) Higher fluoride content has also been observed in central plain in case of both limestone and shale aquifers. However, there was no perceptible increase in the fluoride content in the ground water of K.C. canal command area.
- (iii) Nitrates are practically absent from the ground water of upland area, however, in K.C. canal command area high level of nitrate content has been observed.
- (iv) For the development of artificial sources of ground water construction of more percolation tanks, and check dams has been recommended.
- (v) In order to prevent soil erosion due to run off watershed development programme has been recommended.
- (vi) A spacing of 200 to 300 meters between the wells has been suggested in order to control indiscriminate exploitation of

groundwater. Similarly, use of sprinklers has been suggested in the water scarcity areas for making the best use of the limited potential of groundwater.

**19. Ahmad, Shakeel and Kanth, T.A.**, "Soil Loss Assessment in Liddar Basin, Kashmir", *Geographical Review of India*, 70 (2), 2008 : 146-150.

**Introduction/Objectives:** The paper attempts to provide an inventory in the identification of priority areas of Liddar basin with the objective of helping the future planning of the region for its sustainable development. The attempt here is to assess the potential soil loss.

**Data Base and Methodology:** The assessment of soil loss has been made by using various parameters of the Universal Soil Loss Equation (USLE). Before selecting ULSE for the purpose, various parameters of this equation were tested, and on the basis of information of each unit area gathered by using USLE equation, a map was prepared to highlight different soil erosion classes and the spatial variations in the potential average annual soil loss in the study area. Factor values of each parameter were categorized into high, moderate, low and very low values.

**Findings:**

- (i) The potential soil loss in the study area has been estimated to the tune of 0.72 tons/ha/year to 34.5 tons/ha/year. More than 55 per cent of the study area is found to be subjected to high potential soil loss varying between 10.5 ton/ha/year and 34.5 ton/ha/year. The high intensity of erosion in the area is due to slope characteristics, loose texture, and poor organic matter content of the soil.
- (ii) For variations in soil erodability the overriding factors have been topography and soil management factor. The spatial variations in the pattern of soil loss are mainly associated with physiographic disposition, climatic conditions and human mismanagement.
- (iii) The most seriously affected areas by high soil loss need immediate conservational measures like afforestation, scientific terracing and crop selection for long term benefits.
- (iv) If the increasing soil loss goes unchecked, it might result in environmental degradation coupled with serious socio-

economic consequences in this ecologically vulnerable region.

**20. Rana Narendra Kumar, Rajesh Kumar and Dhananjay Kumar,** “Nature of channel shifting of a foothills fed River in the Alluvial Setting - A Case study of River Rapti India”, *Indian Journal of Geomorphology*, 13 & 14 (1,2), 2008-09 : 83-98.

**Introduction/ Objectives:** The foothills fed rivers on the alluvial settings display a great variety of diversity in terms of their morphological and fluvial characteristics. The Rapti river is an important foothills fed river in the Ganga Plains. In the present paper geo-spatial data and sub-surface structural data have been studied, which have helped in understanding the controls on the channel morphology and patterns of channel movements. The paper attempts to study basin morphometry with respect to channel shifting, drainage basin asymmetry, spatio-temporal measurement of sinuosity indices and identification of meander loop behaviour.

**Data Base and Methodology:** Extensive field study using the topographical data from SOI toposheets of 1970-71 having 1:50,000 scale and satellite imageries was conducted. Arc View GIS 3, 2 a software has also been used.

**Findings:** This study of basin morphology and channel characteristics confirmed its oscillating tendency. The basin morphometry is marked by meandering channels, relict fluvial features like abandoned channels and oxbowlakes. Sinuosity of the Rapti river is found to be constant in 1970-71 and 2002. Extension and translation were the dominant process of change in meander loop behaviour.

**21. Babar Md.,** “Uniformity in Classification of Hydrogeomorphological units: A need for GIS Application”, *Indian Journal of Geomorphology*, 13 & 14, (1,2) 2008-09 : 127-135.

**Introduction / Objectives:** Using several studies it is found that there is a acute variation in the sizes of watershed found in various regions. Minute variation is found in various aspects of hydrogeomorphological units such as spatial dimensions, unit of measurement, nomenclature and terminologies in classification of hydrogeomorphological units and inconsistency in the class

intervals. The paper aims to present a uniform system of classification of various units.

**Data Base and Methodology:** In delineation of watershed survey of India toposheets in combination with the satellite data are generally used. The toposheets provide location, drainage network and contour. The satellite data are useful in updating information on water bodies, drainage etc. The paper argues that for deriving information on surface water body and drainage, transparent polyester film containing minimum base details can also be used.

**Findings:** The paper proposes that towards delineation of watershed, first it is, preferable to locate the largest basin and sub basins and identify water divide line for finding out river catchments. The catchment is further divided into number of smaller units i.e. sub catchment. The sub catchment is further divided into various types of watersheds such as macro-meso, micro- nano, pico and femto watershed until an areal extent of 1 ha. is identified as smallest unit of watershed.

The systematic classification of hydrological unit helps to collect the resource information with different degrees of detail of each level that helps the hierarchy of decision makers and field functionaries in preparing action plan of respective levels.

**22. Singh Ashish Kumar,** “Slope Instability Problems in the Central Himalayas with Special Reference to Karmi Region and the Karmi Landslide”, *Indian Journal of Landscape Systems and Ecological Studies*, Vol.31, No.1, 2008 : 7-22.

**Introduction:** The Karmi region of central Himalaya in Bageswar district in Uttarakhand witnessed a calamitous landslide on July 23, 1983, accompanied with unprecedented flash flood of Saran stream. The Karmi Landslide and associated occurrences was primarily due to heavy rainfall in the upper reaches. The basic factor is the nature of slopes made up of old landslide debris that has been rendered even more unstable by faulty land use practices and deforestation.

**Objectives:** To discuss the related problems of slope instability and their associated aspects of the Central Himalaya considering both the physical and cultural components of this neotectonically unstable terrain with special reference to Karmi region.

**Database:** The study is based primarily on field observations and measurements substituted with local information.

**Methodology:** Forty nine observation sites from seven reference

villages (each one of them from the seven different lithotectonic belts) have been randomly selected based on intensity, magnitude and nature of instability factors. Some of the main criteria in selection of observation sites are border between depressions of streams and open slopes, accumulation of certain types of damage, change in general slope angle, change in landuse and change in slope direction. After assessment and analysis of instability and the parameters influencing instability within each site types and the corresponding degree of instability, their distribution, types and degree of potential damage and management aspects are dealt. Soil samples have been analysed and all observation units have been categorized into four groups according to their suspect ability for their potential assessment of slope instability. The affected area suspected to be unstable: d4 (>50%), d3 (25% - 50%), d2 (up to 25%), and d1 in case of future mismanaged land use.

**Findings:** The striking tectonic features interpreted with their geomorphic significance, slope and drainage in the region reflects high degree of instability. Deforestation and landuse practices have significant impact on the type and extent of slope instability and erodibility of soil. Soil analysis reveals that in the region soil generally is having low water retention capacity. Seven types of slope instabilities have been recorded in the study area; surficial erosion (15.41%), rock fall (21.64%), collapsed terrace (25.26%), slide (32.25%), flow (2.21%), slump (2.13%) and complex (1.10%). None of the seven types have more than 35% area affected, so it is concluded that degradation is within well approachable reclamation limits. According to their suspect ability for their potential assessment of slope instability 12 observation sites fall in d4 group and is suspected to be endangered, 9 sites in d3 highly sensitive, 18 sites in d2, and 10 sites in d1 – in that degree of instability is suspected to be high in case of future mismanaged landuse or tectonic activity. Preventive measures are recommended to reduce the severity and hardness of these calamities like landslides and flash floods.

**23. Singh Usha**, “Morphometry of Drainage Basin of Punpun River: A Tributary of Ganga River”, *Indian Journal of Landscape Systems and Ecological Studies*, Vol.31, No.1, 2008 : 173-184.

**Introduction:** The drainage basin as a single unit or a group of sub-basins taken together comprises a distinct morphological region having particular reference to geomorphology. The precise and

objective measurement of landforms involves the quantitative investigation of the geometric properties of rivers and their basins. The drainage attributes depends upon the relief and lithological conditions, climatic variations, nature of regolith and vegetal cover and the stage of basin development. The study emphasizes the morphometric evolution of the drainage basin.

**Objectives:** To find out the stages in the geomorphological developments of Pupun river basin with different morphometric attributes.

**Database:** The work is based on Survey of India topographical maps 72 C, D and G along with field checks.

**Methodology:** The morphometric parameters namely, stream order, stream number, stream length, mean stream length, bifurcation ratio, weighted mean bifurcation ratio, sinuosity index, circularity index, percentage hypsometric curve and area height curve were calculated through measurements from the topographical sheets and widely accepted formulae given by various workers in this field.

**Findings:** The main river Punpun is the 7<sup>th</sup> order stream in its basin. The analysis of frequency in tributary basins reveals that maximum frequency is in the first order stream and total length of stream segment is also maximum in case of first order. Both features decrease as the order increases. The bifurcation ratio ranges from 2 to 4, but higher values are also observed. The weighted mean bifurcation ratio ranges from 2.7 to 4.8. The stream length ratio of each successive order varies due to difference in lithological and topographic conditions. The elongation ratio reveals that the ratio varies between 0.6 and 1.0 due to variation of climate and geology. Hypsometric curves show that none of the tributary is in youthful stage. They all fall under mature to old stage of geomorphic development. The percentage topographic curve matches with the integral value of 42 for the entire Punpun basin. The results of area-height curves indicate that the basin has least area coverage of 0.11% in more than 450m height range and maximum area of 68.5% between 75m to 225m indicating late mature stage of development.

**24. Surabuddin Md. Mondal, Pandey, A.C. and Garg, R.D.,** “Groundwater Prospects Evaluation based on Hydrogeomorphological Mapping using High Resolution Satellite Images: A Case Study in Uttarakhand”, *Journal of the Indian Society of Remote Sensing*, Vol.36, No.1, 2008 : 69-76.

**Introduction:** The groundwater resources of the Rishikesh region of Garhwal Himalayas are under threat due to population pressure caused by the expanding tourism in this region. This entails sustainable and judicious use of this precious resource. Remote Sensing has opened up new vistas in groundwater prospect evaluation, exploration and management.

**Objectives:** In the present study authors attempt to evaluate the groundwater prospects in the Rishikesh region based on the hydrogeomorphological mapping of the area.

**Database:** IRS-1C LISS III and PAN merged satellite Images of 6<sup>th</sup> January 2004 along with S.O.I topographical sheets 53 J/4 & 8 on 1:50,000 and the Geological Map of the Geological Survey of India have been used.

**Methodology:** From the above mentioned data, thematic maps pertaining to hydrogeomorphology, geology, drainage, lineament, slope and relief were prepared and analysed in ArcMap GIS. Digitized vector maps of the chosen parameters were converted to raster data using 23mx23m grid cell size. The raster maps were assigned respective theme weight and their class weights. The individual theme weight was multiplied by its respective class weight and then all the raster thematic layers were integrated. A probability-weighted approach is applied with overlay analysis and the layers aggregated in a linear combination equation in ArcMap GIS Raster Calculator module. Based on the results various terrain parameters like lithological setup, drainage density, slope and relief exerting their prime control on movement of surface and subsurface water and occurrence of prospective groundwater reserves were evaluated.

**Findings:** Rishikesh and its environs exhibit diverse hydrogeomorphological conditions where the groundwater regime is controlled by a variety of terrain parameters primarily the landform, geology and slope. Good groundwater prospects dominate in the area with more than 50% of the study area showing moderate to excellent potential. Groundwater prospects zonation clearly indicate that combination of alluvial plains, flood plains,

coarse drainage density, gentle slope areas are the favourable terrain conditions having good groundwater potential. Whereas, structural and denudational hills, fine drainage density, high slope areas have poor prospects. Piedmont zones have much better prospects as compared to hilly regions due to their colluvial material composition, moderate drainage density, moderate slope and nearness to Ganga and Chandrabhaga rivers. The study reveals that remote sensing and geoinformatics can be applied effectively for groundwater prospect evaluation.

**25. Tiwari, S. K. and Anirudh Bhowmick.** "A Review on the Landslide Hazards of Malpa Pithoragrah, Kumaun Himalaya with Integration of Remote Sensing and GIS Techniques", *National Geographical Journal of India*, 53(3,4) 2007: 1-16.

**Introduction / Objectives:** The paper has investigated the vulnerability of Malpa Pithoragarh region in Kumaon Himalayas to landslides. The region is located in Himalayas, a zone of high instability and vulnerability due to convergence of Indian plate here with that of stable Tibetan plateau. In between Himalayas, Main Boundary Thrust (MBT) and Main Central Thrust (MCT) are highly vulnerable to earthquakes and landslides. Malpa Pithoragarh is located close to MCT and has experienced massive landslide in 1998 and 1999.

**Data Base and Methodology:** This region is geologically active as substantiated by field survey (1998) and photographs. The rocks are low to medium grade layered phyllite, mica schist, garnet mica schist and are highly strained and severely folded, faulted, sheared, shattered along the weak planes together with number of cracks, joint sets even in the hard rocks. Rock fall, mass wasting and debris type of landslides are common in the region. Rate of erosion is high due to high rains and is further aggravated by rock cutting and quarrying.

**Findings:** (i) The authors have stressed on the use of Remote Sensing (RS) and Geographic Information System (GIS) for assessment and prediction of landslide areas and production of area risk maps; (ii) Determination of rock types, structures, faults, soil type and moisture, evapo-transpiration, underground water level, slope inclination, elevation and temperature should be assessed for estimation and prediction of landslides; (iii) SAR interferometry or

SAR/optical stereo pairs are highly useful in creating digital elevation model from which slope and aspect can be calculated using GIS. The regular monitoring of landslide areas is emphasized using RS and GIS. For specific areas socio economic data and map on the scale of 1:10,000 are preferred.

**26. Singh, Ashish Kumar.** “Bioengineering Techniques of Slope Stabilization and Landslide Mitigation”, *National Geographical Journal of India*, 53(3,4) 2007: 35-56.

The paper has explained bioengineering techniques that can be successfully used for slope stabilization and landslide mitigation. Vegetation has a crucial role in preventing landslides. However, during monsoon mass wasting increases because soil become saturated with moisture. This together with deeper landslides minimizes the capacity of vegetation in stabilizing slope. Therefore, the use of vegetation together with engineering structures helps in landslide management. Slope grading, contour wallowing, mulching and planting are regarded very helpful in slope stabilization. Excavation of rock and soil from the head of a landslide is also suitable in improving the stability of the landslide but there should be correct excavation of landslide materials. The excavation at the head should be coupled with filling at the toe of the landslide. The large scale excavation of large landslide areas should be avoided.

After excavation and filling of landslides the soil reinforcement practices like use of geo textiles, geo membranes and geo synthetics like pavement cloths, filter cloths, linear membranes, drainage membranes and geo grid products together with plastics and composites are emphasised. Asphalt mulching is found very effective in checking erosion and conserving moisture and nutrients in soil. The land use change from agriculture to horticulture is regarded as of great help in landslide areas.

For controlling landslides on river banks, the construction of rip rap is preferred at the toe of the landslide. For 1<sup>st</sup> order streams temporary check dams, for higher order Gabion check dams are most suitable structures. For reducing the speed of flowing water three types of retards are live hedges, jacks and jetted posts. Gabion toe walls and spurs are required to be put in place where channel slopes are steep and unstable. Channel beds and sides can be protected by planting trees and bushes on levees and embankments.

These bioengineering techniques are thus, highly useful in minimizing the impact of natural events like landslides.

**27. Mishra, Kavita and V. K. Kumra.** “Hydrogeomorphological Approach in Water Resource Management in Part of Chandraprabha Basin, Vindhyan Upland, Eastern UP”, *National Geographical Journal of India*, 53(1,2) 2007: 61-72.

**Introduction / Objectives:** The paper has explored the availability of ground water resource in Chandraprabha basin of Vindhyan upland. As the pressure on ground water is increasing it is very important to identify and demarcate ground water potential in hard rock terrains also. Therefore, the authors through hydro-geomorphological mapping identified the ground water availability in the Chandrapabha basin. The hydro-geomorphological mapping is now very well practiced with the advancement in techniques of data capture and analysis using Remote Sensing and Geographic Information system.

**Data Base and Methodology** The study is based on the analysis of Survey of India toposheet no. 63 P/1 on 1:50000 scale and IRS-1B, LISS II, FCC image (1992) on same scale. Visual image interpretation is done. The analysis of change in water table in pre and post monsoon time is also attempted by taking two villages, Jaimohani and Majhgain. The analysis covers time period of 1993 to 2002 for which data are obtained from ground water division of Government of Uttar Pradesh.

**Findings:** (i) The study area consists of 4 hydro-geomorphological units viz. pediment, buried pediment, dissected plateau and flood plain; (ii) Pediments have poor potential of ground water. They are composed of sandstone and possess poor intra granular space; (iii) The buried sediments covering southern and south western part of the basin have very good to moderate potential. The deeply buried sediments have very good prospects while shallow buried sediments have good to moderate prospects. The region is extensively cultivated; (iv) Dissected plateau zone has moderate potential. Very limited recharge is observed along lineaments, valleys and slopes of low angles; (v) Flood Plains near the Chandraprabha reservoir comprising of clay, silt and sand have moderate ground water potential. Thus, overall ground water potential is moderate in the study area. In both the villages

fluctuations are high, but higher in Majhgain than Jaimohani in pre monsoon time. It is due to the fact that Majhgain village is located on shallow buried sediments and Jaimohani on deeply buried sediment.

**28. Bhakar, Rajesh, Sharma, H.S., Srivastav, S.K. and Jetten, Victor,** “Delimiting Spatio-Temporal Distribution of Ground Water Recharge Zones using Remote Sensing in an Irrigated Landscape of Thar Desert, India”, *Transactions*, 30(2) 2008: 137-158.

**Introduction/Objectives:** This work focuses on the delineation of temporally varying groundwater recharge zones in spatially distributed form in a dune dominated charanwala irrigation system of Indira Gandhi Nahar Project, situated in the Thar Desert. The study has used multi-temporal satellite imagery. It highlights the potential of Geo-Spatial technologies to generate reliable model inputs in a data.

**Database and Methodology:** The remote sensing data used in the study are:

- Advanced space borne Thermal Emission and Reflectance Radiometer (ASTER) imagery, on board TERRA satellite captured on 14<sup>th</sup> December 2005.
- Linear Imaging Self Scanning Sensor-III (LISS-III) imagery on board Indian Remote Sensing Satellite (IRS), captured on 12<sup>th</sup> May 1999, 14<sup>th</sup> September 1999, 11<sup>th</sup> February 2000 and 20<sup>th</sup> February 2001. The images of 1999 and 2000 were selected because the agricultural year 1999-2000-2001 was chosen for modeling.

Ancillary data used in the study are:-

- Interviews with farmers during field work time, the cropping calendar for choosing the relevant dates for acquisition of the satellite imagery from, Agriculture Extension Officer.
- Consolidated Statistics of the cropped area from the office of the Director, Agriculture Extension Wing CADA, IGNP.
- Supervised image classification and band-ratio (normalized Difference Vegetation Index, NDVI) are used for information extraction.

**Findings:** (i). The area contributing to ground water recharge as a result of return flow from irrigation varies intra and inter annually

depending on the spatial distribution and areal extent of irrigated crops, which in turn depend on the canal inflows. (ii). The information generated has been used to spatially and temporally allocate the quantum of applied irrigation water as input to surface water and groundwater modeling study for simulating the risk of water logging in response to applied surface water irrigation.

**29. Karlekar, Shrikant**, “Use of Directional Derivatives in the study of Estuarine Sedimentation Process on Konkan Coast of Maharashtra”, *Transactions*, 30(2) 2008: 159-164.

**Introduction/Objectives:** The process of estuarine sedimentation on Konkan coast of Maharashtra is very complex and leads to development of complex bed forms and sedimentation process in Konkan creeks and estuaries. An attempt is made here to describe and discuss a technique of directional derivatives and examine how it, could be used to understand the morphological details of accumulation forms indicative of process of sedimentation.

**Database and Methodology:** The directional derivatives of first and second order were attempted to understand the complexity in the morphology of estuarine bed forms. Bed contours on the hydrographic charts of certain creeks were used to obtain their surface features. Surfer software is used for the depth values on the hydrographic charts after reducing to datum level.

**Findings:** (i). The model shows that the sand accumulation forms in the creeks are oriented East-Southeast to North-Northwest. (ii). Advantage of such derivatives is that they help in demarcation of major sub environments such as marsh edge, high tide flats, scoured channels and creek banks which are products of site specific sedimentation process. (iii). The trends obtained by directional derivatives are indicative. (iv). The derivative enhanced bed configuration of lower reaches shows bed forms that are characteristics of forms developed in coarse sediments. (v). Estuarine banks and middle reaches show smooth, convex lenses developed in silts and clays.

**30. Dongre, N.L.**, “Rational Derivation of River Bed Profile”, *Transactions*, 30(1), 2008: 15-23.

The purpose of in this paper is to review certain principles which afford a rational derivation of the profile of river beds and to test

the results on Denwa River tributary of Tawa River of Central India. The Denwa river and its sand bank offer corroborative evidence of the validity of the rational equation for the slopes of river, because the plot of the profile data on a semi-logarithmic chart exhibits an overall linear trend well within the limits of accuracy of such morphologic data; the wear-coefficient derived from the profile agrees astonishingly well with the nature of the bed-load or bed material of the rivers.

**31. Singh, Kh. Pradipkumar**, "Siltation in Loktak Lake: A Geographic Study", *Transactions*, 30(1) 2008: 25-32.

**Introduction/Objectives:** The main thrust of the present study is to analyse the relationship between the amount of sediment discharge by the thirteen rivers into the Loktak Lake and the problems associated with the siltation.

**Database and Methodology:** The study is based on both primary and secondary data. Base map and other thematic maps are prepared from the topographical sheets – 83H/9, 83H/10, 83H/13, 83H/14 and 83H/15. Necessary data and information on land use, discharge and sediments loads are collected from the office of the Loktak development Authority, Imphal. Intensive field work has been carried out to identify the geology, landforms and drainage networks in the upper catchment area. Pre-field and post-field surveys were made seasonally to collect data related to siltation in the lake.

**Findings:** (i). The overall ecosystem of Loktak Lake is getting disturbed by heavy siltation, lowering of water holding capacity, frequent occurrence of flood, indiscriminate fishing in the lake, sudden decline in fresh stock etc(ii). The drainage characteristics, the present landuse system and the prevailing topographic features (abrupt change in slope with short distance) are some of the factors responsible for the higher rate of soil erosion. This is responsible for the exceeding run off rate infiltration.(iii). Water quality is deteriorating year after year as it receives the polluted water from rivers like Nambul, Nambal and Moirang.(iv). After the construction of Ithai Barrage, there is a significant decline in the fish production from Loktak Lake, as it has blocked the migratory pathway. (v). Loktak lake receives substantial amount of silts both from direct catchment and indirect catchment areas. (vi). Excessive growth of floating weeds is one of the factors for reduction of water capacity

of the lake.(vii). As a result, the lake is gradually silting up and getting shallow.

**32. Chaudhuri, Subhamita, Wakhare, Anargh and Kamble, Ajay,** “Effect of Construction of Protection Wall on Beach Dune Morphology of Shrivardhan Bay Mouth Spit, Konkan Coast, Maharashtra”, *Transactions*, 30(1) 2008: 52-68.

**Introduction/Objectives:** In this paper an attempt has been made to monitor and document the morphological changes that have been brought about in the beach dune morphology of the Shrivardhan bay mouth spit by the construction of the protection wall. It further tries to assess the direct or indirect effects of wall on the position of the high tide line of the beach.

**Database and Methodology:** Periodic theodolite surveys have been carried out for three consecutive years (1999, 2000 & 2001). Periodically photography has been carried out to monitor changes of micro-relief forms. Wave refraction diagram was prepared for the month of July to detect any possible relationship between wave refraction pattern and the zones of erosion and compare the results with field observations. Survey of India’s topographical sheet no. 47F/4, 47B/6 of 1968 are used.

**Findings:** (i). The wall had a definite influence on beach elevation, development of runnel and low tide bar. (ii). The protected portion of the beach first starts to gain elevation with accelerated sand accumulation at the base of the wall. If there is subsequent seaward shifts of the high tide line the zone comes under the purview of wind deposition and the beach assumes an accretionary nature. (iii). The unprotected southern part of the beach, down-drift of the wall experienced active erosion as a major proportion of the wave energy has expanded where the wall terminates.

**33. Nag, Surekha,** “Estimation of Soil Loss in Puruliya District, West Bengal”, *Geographical Review of India*, 70(4), 2008: 327-338.

**Introduction/Objectives:** The present study calculates the soil loss in Puruliya district in West Bengal. Puruliya District is an undulating area where the slope of land accelerates soil erosion to a great extent.

**Database and Methodology:** The work is based on 100 soil

samples taken by random sampling method and the estimation of soil loss has been done following universal soil loss equation by Wichmeier & Smith (1978). The texture, organic matter content, structural types and permeability of the soil samples are determined by laboratory analysis. Climatic data are collected from Agro Meteorological Department, Kolkata. Nature of vegetation cover and conservation practices are collected from field data.

**Finding:** (i). The rate of the soil loss has reached such a limit that further loss could lead to a catastrophe to its economic development, especially agriculture. (ii). Various conservational methods like field bundling, terracing, contour bundling and gully plugging are practiced in almost all the blocks; but these are not sufficient for a district like Puruliya. (iii). There is a heavy pressure of population on land and it cannot be kept unused. Therefore, strict agronomic and engineering methods are to be adopted to check the problem of soil erosion in the area.

**34. Basu, Subhash Ranjan and Howlader, Kalyan,** “Some Considerations on the Process of Sedimentation in the Ichamati Tidal channel”, *Geographical Review of India* 70(4), 2008: 369-380.

The study deals with heavy siltation in the river bed due to natural and constant human interference causing obstructions in the form of encroachments, fisheries, brick fields and dumping of garbage etc. The study also suggests suitable measures for its prevention. Once a prosperous river the Ichamati is now in a lamentable state of decay aggravating the problem of water-logging and floods.

The river Ichamati is subject to tidal incursion twice daily from the sea upto Bangaon, a distance upto 40 km. The lower reaches of this zone have been heavily silted up due to tidal effect. The incoming high tide brings in lot of sediments from the sea and deposits it on the river bed in absence of any upland discharge from the off-take during the non- monsoon months. Thus this zone of 52 kms has turned into a zone of siltation. The injection of saline water by the tides into the sweet water of the Ichamati has an indirect but more lasting effect on the load movement behavior of the river Ichamati. In order to resuscitate the river the primary objectives should be to remove the silt below the off take point, so as to usher regular flow of water from the parent river through the year.

**35. Dubey, Anupama and Rai S.C. ,** “The groundwater economy of the Indo-Gangetic Plains, India ”, *Annals of the National Association of Geographers, India* 28(1) 2008: 51-63.

**Introduction/Objectives:** The present paper is an attempt to comprehensively assess the tubewells, their utilization factors and the total withdrawal of groundwater, problems associated with farmers, effect of energy price on tubewell irrigation etc. Allahabad district is selected as one of the unit for detailed study.

**Database and Methodology:** Primary data are the backbone of the present study. Village is selected as the basic unit of study. Two villages from each physiographic zone have been picked up as sample villages. From each sampled village, more than 15 tubewell owners were randomly selected as respondents. In all, there are 62 respondents distributed in the following manner: 18 in Yamunapar, 20 in Doab and remaining 24 tubewell owners in Ganganagar region of the district. The distance between two sample villages was kept more than 30 km. A comprehensive questionnaire was developed to collect information.

**Findings:** (i). Number of private tubewells in Allahabad districts is approximately 80 percent of the total. Majority of tubewells are diesel operated because of low installation cost, no power cut down, and suitable for fragmented land. (ii). The cost of installing tubewell increases rapidly as water table depth declines. Bore depth varies from 101 m in Hakkim Patti to 329.59 m in Tendwavan of Yamunapar region. It indicates that Yamunapar region is facing severe water scarcity. (iii). High energy cost, declining groundwater tables and incipient secondary salinization are considered to be the biggest threats to the sustainability of groundwater irrigation in the district. (iv). Groundwater economy is largely farmer financed, about 80% tubewell owners used their own funds, and others acquired bank loans and borrowings from relatives and friends and depended on subsidy to install the private tubewells.