आज़ादी का अमृत महोत्सव

34th National conference of the

Indian Institute of Geomorphologists (IGI)

Focal theme: Geomorphology, Natural Hazards and Environment

2nd – 4th November 2022

ABSTRACT VOLUME

34th IGI National Conference Pune 2022

Organized by:
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Savitribai Phule Pune University (SPPU),
Pune

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कुलगुरू

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MESSAGE

I am happy to know that the Department of Geography, Savitribai Phule Pune University is organizing a 34th National Conference of the Indian Institute of Geomorphologists on one of the essential themes of 'Geomorphology, Natural Hazards, and Environment.' Savitribai Phule Pune University always promotes such academic endeavors and I am sure that, the Department of Geography will continue the legacy of this University. I trust that this conference will provide a good platform to showcase the research activities of young and enthusiastic scholars across the nation. This conference will also offer a great opportunity for the students to interact and share their ideas with the learned personalities in the field of Geomorphology and Environment, learn new things and widen the scope of their research.

I believe that the conferences' deliberations will be fruitful and will help the administration and society in the preparation and mitigation of natural hazards through the knowledge of Geomorphology.

I wish all the success to the organizers and participants of the 34th IGI National Conference!

Prof. Karbhari V. Kale

*Ref. No.VC/*४००

Date : 18 OCT 2022

IAG GEOMORPHOLOGY International Association of Geomorphologists

MESSAGE

I am pleased to know that the Department of Geography, Savitribai Phule Pune University (SPPU), Pune, is going to organize the thirty-fourth Annual Conference of the Indian Institute of Geomorphologists (IGI) and National Seminar on 'Geomorphology, Natural Hazards and Environment', during November 2-4. 2021.

After crossing cyclic, process, and quantitative phases, the content of geomorphology has taken a new turn since 1970. Since that period, anthropogenic activities have been more responsible for altering geomorphic processes than natural ones, thereby creating many devastating natural hazards. Thus, many applied branches have been introduced in geomorphology, among which 'Environmental Geomorphology' is one of the important branches. The key feature of the subject is the practical use of geomorphology for the solution of problems where man wishes to transform or to use and change the surficial processes through planning and management. From this point of view, the theme of the Conference is of utmost importance.

The conference organizers have rightly kept all the subthemes related to the theme. There will be one exciting session at the Young Geomorphologists Competition. I hope and believe that the conference will be held in a befitting manner and the outcome of the meeting will be worthy for all the concerned authorities to take proper necessary measures to save our environment.

I wish the Conference a grand success.

Prof. Sunil Kumar De
President, IAG

To
Prof. Sudhakar Pardeshi
Convener, 34th IGI Conference,
Head, Department of Geography,
Savitribai Phule Pune University (SPPU), Pune

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Message

We the Convenor and Organizing Committee members are happy to welcome all the delegates, students, and speakers to the 34th National Conference of the Indian Institute of Geomorphologists (34th IGI, Pune). This is a matter of pride for the department of Geography, Savitribai Phule Pune University to host the IGI conference and to welcome eminent scholars from different parts of Pan India. IGI holds conferences annually. This is the 34th year of the IGI conference. This is the third time the Geography Department of Savitribai Phule Pune University got an opportunity to host the conference. Earlier in 1992 and 2004, the department had an opportunity. I hope in the future IGI will give an opportunity to the Department of Geography SPPU to host the IGI conference. As a convener of the 34th IGI conference, I would like to invite all the delegates to participate in fruitful deliberations and in other activities of the 34th IGI including the field trip. We the organizing committee members are honored and graced by the presence of very eminent scholars of geomorphology. It is also a matter of pride for the Department and IGI that, this year we could persuade scholars from different parts of the country to come and share their experiences with the young enthusiasts. There will be sixteen technical sessions in which more than 125 research papers will be presented. Besides these presentations, we tried to invite very eminent scholars in the field of Geomorphology, Environment, and Hazard management. We the organizers believe that this conference hosted by the Department of Geography, Savitribai Phule Pune University will be remembered by the participants as an important event in their academic career for very fruitful discussions. The budding scholars will get the chance to interact with the senior scholars and will get a good platform for 'Young Geomorphologists' to share their research outcomes. Besides academic activities, the participants may also wish to explore various tourist attractions in and around Pune city.

Finally, my best wishes to all the participants, and I would like to thank the participants for their participation in the conference and for making this conference as a grant success.

Prof. Sudhakar D. Pardeshi
Convener

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Presidential Address

It was a late November morning, a bit cooler than usual for Pune. I was sitting inside the imposing Shivaji Hall in the Main Building of the University. Inaugural session of a conference was going on where a professor on the podium was delivering the presidential address: "research in geomorphology over the years has slowly but surely shifted from field observations of forms to an attempt at the understanding of the materials of which the form is made … and then on to processes." . . .

This was the 3rd IGI Conference 32 years ago where my association with the Indian Institute of Geomorphologists started. As you can see, this turned out to be a *long* association. The journey of the IGI through these three decades, 30 conferences and 26 volumes of *Indian Journal of Geomorphology* (1990–2011) and *Journal of Indian Geomorphology* (2012–2022) later, amply bespeaks of its academic achievements. But on another level its activities worked subtly in building bridges between researchers and research centres, inducing friendships, and making the young geomorphologists confident to face the world.

The changes we witnessed in all spheres of life since 1990 are so large that they were difficult even to imagine at that time. A time when typewriters were ubiquitous, computers with <100 MB hard disks just started to make their entry into the university departments, realisation of Windows 3.1 was still a year away, and concepts called e-mail and Internet were unheard of in India. (It was a pleasant surprise for most of us when we found that the Abstract Volume of the 3rd IGIC was brought out using a dot-matrix printer!!) We used to draw maps using pen on papers and our satellite data 'processing' largely meant tracing out the patches of colours from the scarcely available prints of LISS-2 FCCs from the 1988-launched IRS-1A, or from the Landsat FCCs.

We indeed have come a long way from that. Indoors, our seminar presentations evolved from dim projections of 35-mm colour slides and later on from the A4 size acetate sheets to the PPT presentations that can brighten up largest of the screens and can be beamed across the world. Outdoors, seemingly impossible field mapping tasks for the traditional equipment seems like breeze today with GNSS-enabled high-resolution drone elevation mapping and the use of stuff like Doppler current meters cum echosounders. Advancement of technology has changed nearly all the geomorphic approaches we used to adopt, from sediment dating to texture analysis.

How much has geomorphology changed itself during these three decades? The Professor-on-the-Podium, our second President at the 3rd IGIC — Professor R. Vaidyanadhan — stopped at 'processes' and went on discussing the utility of models in geomorphic explanations. We *still are* in quest for the ideal models and for better understanding of all kinds of processes, but only with some higher refinements. Increased computing power and the readily available software algorithms allow us to evaluate, process, and extract trends & patterns from big data within minutes. But besides this, we have diversified a great deal as developments in remote sensing of earth processes and forms have ushered in a new era. We now have near real-time access to an overwhelming array of information ranging from rainfall and river discharge to sea level fluctuations and landscape changes from remotest locations. The space technology has also opened up vistas like planetary geomorphology where the possibilities seem endless as probes beam images of the remote worlds that challenge our earth-based understanding of processes and landforms.

Let me come back to Pune. This is a city where I am privileged by my acquaintances with some of the greatest teachers and researchers I will ever know: Professor K.R. Dikshit (our First President), Professor S.R. Jog, (Convenor of the 3rd IGIC and our 15th President, who was kind enough to be with me in many parts of Konkan & the Trap country), and Professor V.S. Kale (Convenor of the 17th IGIC and our 16th President). Besides them, my contemporaries and juniors from the Savitribai Phule Pune University (University of Poona in 1990!), whom I greatly admire and respect, would make a really long list for here to state.

My eyes, though, search in vain three of the Leading Lights in almost all our annual conferences till at least the first decade of this century: Professors M.K. Bandyopadhyay, S.C. Mukhopadhyay, and S.R. Basu, our past presidents, who were also my teachers. It is, however, with great pride and joy that I make a mention here that my good friend, the soft-spoken and ever-agile Professor Sunil Kumar De, a regular attendee of our conferences and our Secretary for Foreign Matters for a long time, who was groomed by Professor Basu, has been elected as the President of the International Association of Geomorphologists (2022–2026) at Coimbra, Portugal. You will surely agree that as Indian Geomorphologists we are proud of his achievement, a position that came to India so long after the legendary Professor S.P. Chatterjee became the President of the International Geographical Union (1965–1968).

I beg your pardon if I have dealt too much with 1990 → 2022 — but it represents my journey from being a 27-year old in the audience to here where I am standing. There are many twenty-somethings sitting in front of me, I know. You remind me of Professors Devi Datt Chauniyal and Ashis Kumar Paul — my two immediate predecessor presidents of the IGI — who were with me here in 1990. I am sure some of you will repeat our journey. I am also sure that the Indian Institute of Geomorphologists will always be with you for the next 32 years and beyond.

— Sunando Bandyopadhyay
Department of Geography,
University of Calcutta

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Concept Note:

Geomorphology has become one of the important subjects that provides a basis for natural hazard and environmental studies. The popularity of geomorphology has increased because of its application in different disciplines and the scientific nature of geomorphological studies, methodology, and applications. Geomorphology forms the basis of the environment and it is considered an important part of environmental and hazard assessment. Modern studies in geomorphology are application-based and enhanced with geospatial databases and techniques. Modern geomorphology is equipped with high-resolution databases such as DEM and scanning systems like LIDAR. Today, we are in the era of application of artificial intelligence, and cloud computing in geomorphic studies wherein automatic feature identification and morphometric analysis, simulation of the geomorphic process in different and changing environmental conditions, and their response and prediction is possible.

The studies in Planetary Geomorphology, Anthropogeomorphology, Environmental Geomorphology, Geomorphic Impact Assessment (GIA), Geodesign, Geospatial modeling, Computer simulations, and Process response modeling will develop geomorphology as an important subject. Geomorphology will play important role in the analysis of carbon fluxes, and carbon credit estimations in the tropical and subtropical climatic regions of the world. Geomorphology is an active interface between the lithosphere, atmosphere, and biosphere therefore it is going to play a predominant role in climate change studies.

Geomorphology plays an important role in resolving different challenges such as the identification of impacts of sea-level change, climate change, different human activities, and large development projects. It is also important to apply

geomorphic knowledge to understand the geomorphic impact assessment and geotechnical aspects of large projects. Human intervention, land surface alteration, and altered geomorphic processes will be the key areas of research. Geomorphologists have to strengthen the research towards the GIA for environmental conservation, Geodesign in carbon credit claims, and carbon and water footprints. Geomorphic restoration is a challenging field of geomorphic research and application toward the conservation of land surface, water quality, and ultimately well-being of mankind. There are different approaches through which geomorphological studies will be done in the areas such as effects on the Earth system. Considering the futuristic approaches in geomorphic studies the themes of the present conference are premeditated.

Sub Themes:

- Geomorphology of Alpine Environment
- Geomorphology of Arid and Semiarid Environment
- Geomorphology of Humid and Subhumid Environment
- Bio geomorphology
- Geohazards and Management
- Anthropogeomorphology
- Urban Geomorphology
- Climate Change and Geomorphology
- Geomorphosites and Geotourism
- Geomorphological Mapping
- Digital Geomorphology
- Applied Geomorphology
- Geomorphic Impact Assessment
- Any other topic relevant to theme of the conference

About Savitribai Phule Pune University (SPPU):

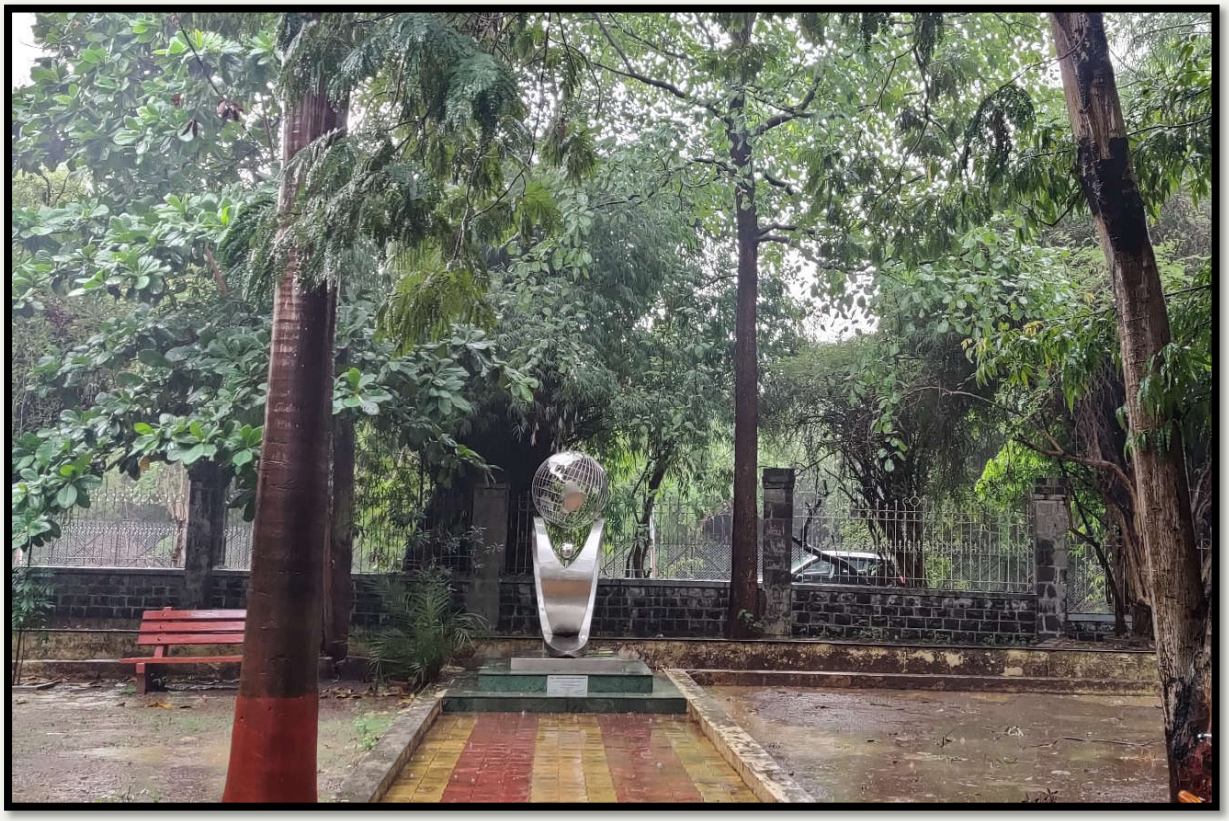
Established on 10th February 1949 under the Poona University Act as the University of Poona and now known as Savitribai Phule Pune University, the university has become one of the leading centres for research and teaching in India where students peruse research in various disciplines of Science, Humanities and Social Science. The University houses about 61 departments/centres, 234 recognized research institutes and 900 affiliated colleges offering a wide array of graduate and under-graduate courses. The university has also been ranked 2nd in India as per the Times higher education world university ranking in the year 2019 and was also re-accredited by NAAC at "A+" level, Status of the university for potential for excellence by UGC, Delhi.

About Department of Geography:

The Department of Geography, Savitribai Phule Pune University was established in 1950. It is one of the few leading departments in India with strong Physical as well as Human Geography working groups. The department has received special grants from ISRO, ICSSR and UGC and also had been recognized as a FIST sponsored department by DST, New Delhi. The department provides advanced education in geography through academic programmes leading to the degrees in — M. A. and M. Sc. in Geography, M. Sc. in Geoinformatics, P. G. B. Sc. (Applied) in GIS and Remote Sensing and Ph. D. in Geography. Recently Centre for South Asian Studies (CSAS) has been established in the Department.

About the Indian Institute of Geomorphologists (IGI):

The Institute of Indian Geographers is an association of Geographers, established in 1979 with the Department of Geography, Savitribai Phule Pune University, as its registered headquarters. The Institute strives to promote geographical knowledge by research, teaching and such of the activities as will directly or indirectly lead to the growth of Geography. Since its foundation, the Institute has been regularly publishing the biannual journal, the 'Transactions of the Institute of Indian Geographers', and it is listed in SCOPUS and UGC CARE list. The Institute is regularly organising annual Geographers' Meets at university centres in different parts of the country, often accompanied by field trips, as well as topical seminars from time to time. The Institute proudly counts more than 1000 Life Members, Institutional Members, Annual Members and regular subscribers to the Transactions.



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Abstract Volume

Change Detection Analysis of Surface Water in Jalgaon District by using Remote Sensing and GIS Techniques

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Abstract

Water is an important element and is classified as crucial for survival of life, since years of coexistence in nature, human is consistently coming across natural resources and few of them have exhausted in past decades. In the current study water bodies in Jalgaon district were mapped with the help of cloud-free Landsat_8 data sets. Surface water data sets for the year 2015, 2017 and 2020 were generated and analyzed for water and other surfaces. Change in water bodies with respect to time was done and thus was helpful for studying the water dynamics in Jalgaon District. The technique of Normalized Difference Water Index (NDWI) was used to detect the surface water bodies. The NDWI-generated images were classified into water and non-water pixels, and a supervised classification was performed to find out accuracies of output. The NDWI method displays a good result of water surface detection with for the classified images. The surface water-mapped images were used to classify the water into permanent water, seasonal water and new permanent water. The change detection is performed and mapped using geographic information system (GIS) operations to understand the surface water dynamics from 2015 to 2020. The results illustrated the effectiveness of the NDWI approach for surface water mapping and GIS for change detection analysis, especially in detecting the changes in different times, simultaneously.

Keywords *Landsat_8 · NDWI · Surface water · GIS · Change detection*

Climatic and human impacts on long-term sediment load variation in the Cauvery basin, India

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Abstract

Cauvery, one of the most important drainage systems in Peninsular India ensuing significant changes in its hydrology and sedimentation pattern due to the impact of anthropogenic and hydrometeorological drivers. In this study, we made an attempt to investigate the hydro-sedimentary changes in 14 stations both at spatial and temporal scale. To calculate statistical significance (i.e., change point, upward/downward trends) of these observations, several important non-parametric tests have been done viz. Mann-Kendall, Pettitt test and Sen's Slope. The results of the study documented a decline in sediment loads at 13 out of 14 hydrological stations. Most of the reservoirs entrapping a significant amount of sediment that interrupt the land-ocean interaction and intensifies the delta erosion by coastal waves. Biligundulu, Kollegal, Muthankera, and Nellithurai, which are located in the upper and middle sub-basin regions of the Cauvery River, are more susceptible to soil erosion and experience high sediment yields. Notable reduction in sediment loads due to sediment entrapment have been monitored after the construction of several major dams (such as Harangi, Siruvani, Suvarnavathy, Tarka, Votehole and Yagachi). This resulted in the identification of a major change point in sediment flux between 2000 and 2001. As compared to pre-2000 records, the amount of sediment load in the Cauvery decreased by 67% during post-2000. This may affect both the coastal ecological environment as well as the deltaic growth.

Keywords: *Cauvery, Sediment load, Sediment yield, Streamflow*

Abstract Volume

Prioritization of sub basins based on Sediment Yield Index for conservation planning: A case study of Tavarja lake catchment in Godavari river drainage basin of Maharashtra, India.

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Abstract

Soil erosion because of rainfall-runoff is a global phenomenon. The eroded sediment gets deposited in the lake or reservoirs, eventually reducing the storage capacity. To assess the Sediment Yield Index (SYI), it is necessary to prepare the slope, LU/LC, Soil texture, GSY (Gross Sediment Yield), and Sediment Delivery Ratio (SDR) of the study area. Estimation of sediment yield has become one of the important tasks for researchers, planners, engineers, and decision-makers. This paper aims to prioritize the sub-basins by estimating Sediment Yield Index (SYI) for the identification of the critical areas which need immediate remedial measures in Tavarja lake catchment (Area:250.52 Km²) in the Godavari river basin. Based on SYI very high priority for conservation planning of sub-basins of a watershed requires for Tavarja Lake Catchment Watershed i.e. TLCW 8.8 (10.50 km2, 4.19%) TLCW 8.13 (1.93 km2, 0.77%), TLCW 8.14 (4.82 km2, 1.92%), TLCW 8.16(3.83 km2, 1.53%), TLCW8.17 (11.8 km2, 4.71%) and TLCW 8.24(2.45km2, 0.98%), etc. While sub-basins of TLCW 8.7 (6.21km2, 2.48%),TLCW 8.11 (2.0 km2,0.80%), TLCW 8.19 (0.30 km2, 0.12%), TLCW 8.20 (0.63km2, 0.25%), TLCW 8.32 (1.16 km2,0.46%) and TLCW 8.33 (0.80km2,0.32%) requires high priority for conservation planning. These areas require immediate attention. Conservation methods are suggested and the location of check dams, gully plugs, and cement bunds are proposed after considering the SYI of Tavarja lake catchment.

Keywords: *Sediment Yield Index (SYI), Sediment Delivery Ratio (SDR), Gross Sediment Yield (GSY), Sub basin prioritization.*

Morphodynamic study of beach cusps and sediment composition along Palshet beach of Ratnagiri district, Maharashtra state using geospatial techniques

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Abstract

Beach cusp is an indicator of wave dominant coastal morphology. It forms a regular undulation along the shore zone and characterised by a distinct sequence of bay and horn pattern. Similar patterns are observed along Palshet beach of Ratnagiri district along the konkan coast of Maharashtra state. The main objective of the present study is to assess the morphology, dynamic characteristics of beach cusps formation and quantify their changes over the spatio-temporal scale. The region is highly dynamic in nature with wave dominated processes and fluvial evolution of River Sundari. A field survey was carried out during post monsoon to investigate a beach cusp system and relate it with synoptic hydrodynamic nature. An extensive dataset is generated from beach profiling, soil sampling and GPS surveys. About 7 beach profiles were collected across the beach and along the backshore zone. The 5.4 m depth profile along high beach level cusps indicate a series of coastline regression, while stabilised channel bars with mangroves indicates accretion along the mouth of River Sundari. The formation of different beach cusp parameters is related with hydrodynamics in the study area. Lower beach level cusps form multilevel depositional patterns of height up to 2.2 m form during every tidal cycle. Middle beach level cusps form bay – horn pattern with 2.7 m height indicating high tide zone. High beach level cusps form between spring and neap tide with a height of 3.3 m. A 3D model of Palshet beach cusp system was generated using the above data. Shoreline changes were detected using multi-temporal Landsat satellite data series from 2005, 2011, 2016 and 2022. Delineation of coastline was performed at various temporal scales. Shoreline change rate were calculated and estimated using DSAS software. A resultant statistical mapping indicated the stages of development of beach cusps and migration of River Sundari towards south. These findings give a better understanding of the evolution of beach cusps parameters and can be used to formulate for similar coastal geosystems research.

Keywords: *Beach cusps system, synoptic hydrodynamic, River Sundari, DSAS software, statistical mapping*

Abstract Volume

Estimation of Surface runoff in ungauged river basin using basin morphometric parameters and Rational Method - A study of Mutha river Valley Catchment, Western Maharashtra

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Abstract

As rain falls over land, a part of it flows over the land as surface or overland flow called surface runoff, much of the water in rivers and streams comes directly from runoff from the land surface, which is defined as surface runoff. The major problem in the estimation of relationships between rainfall and runoff occurs when a study is carried out in ungauged drainage basins in the lack of hydro-climatic data. Accurate estimation of runoff in ungauged areas is important task in proper watershed management. The present research work has been carried out to understand the influence of basin morphometric parameters on runoff potential in an ungauged basin using digital data, satellite images, topographical maps, and rainfall data combined with geospatial techniques. The Mutha river valley is an ungauged basin which is located in the Western Ghats of Pune District, Maharashtra State. The Mutha river catchment, from source to Khadakwasala outlet covers about 133 km^2 area. The quantitative analysis of basin morphometry reveals that, the area is under the highly influenced of steep to moderate ground slopes, with moderate to less permeable rocks, leading to high potential surface runoff. The basin is elongated in shape resulting in flatter peak of flow for longer duration. The rational method intended for integration of land use and land cover, rainfall intensity, and hydrological soil groups proved to be suitable in estimations of surface runoff. It has been observed from the analysis that the overall increase in runoff corresponding to the amount of rainfall. The area receives a good amount of rainfall, but most of it is lost as surface runoff (nearly 45% of the total rainfall) due to rapid overland flow and impermeable rocks. Analysis of morphometric parameters combined with rational based approaches can be explored as an alternative for simulating the hydrological response of the basin. The calculation and results, based on the Rational method, shows that the average annual rainfall intensity for the last ten years in Mutha river valley catchment is equal to 227.9 mm, and if the total area of the watershed is considered which is about 133 km^2, the estimated runoff of study area is to the tune of 2795.5 cubic meter/sec./year.

Keywords: *Ungauged basin, Runoff, Rational Method, Land use, Rainfall Intensity, Mutha Valley Catchment*

Abstract Volume

Evaluation of Morphometric Parameters Derived from ASTER DEM - A study of the Koyna watershed, Maharashtra

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Abstract

Morphometric analysis of a drainage basin demonstrates the dynamic equilibrium that has been achieved due to the interaction between matter and energy. It helps to understand the prevailing geo-hydrological characteristics of a catchment. The traditional manual approach for large scale watersheds is time consuming. Using an elevation raster as input to GIS it is possible to automatically delineate a drainage system and quantify the characteristics of the system. In the present study, automatic delineation and drainage characterization of Koyna catchment has been carried out for detailed analysis of its linear and areal parameters using the ASTER Digital Elevation Model together with hydrologic analysis tools in ArcGIS Spatial Analyst. Strahler's scheme was used for stream ordering. The results reveal that the total number of streams is 7365 belonging to different stream orders with the highest order of 6. The mean bifurcation ratio (Rb) value of 1.86 indicates that the geological structures are less disturbing the drainage pattern. A low mean bifurcation ratio indicates a structurally less disturbed drainage network and relatively homogenous lithology. The Form factor, circulatory ratio and compactness coefficient revealed that the basin is an elongated one. Dendritic and Trellis drainage patterns were observed in the study area. The stream frequency (Fs) of 3.166 exhibits a positive correlation with the drainage density value of the area indicating an increase in stream population with respect to increasing in drainage.

Keywords: *Morphometric analysis, Geo-Spatial Techniques, Koyna watershed, Krishna river basin*

Provenance Studies of Conglomerates belonging to the Tyrsad and Weiloi Area of East Khasi Hills, Meghalaya, India using Petrographic and Heavy Mineral Techniques

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Abstract

The present study focuses on petrography and heavy mineral analysis of the conglomerate samples collected. Petrographic studies, largely thin-section examination of the conglomerate clasts from the study area were analysed to understand their palaeoenvironment of deposition. Heavy mineral analysis was carried out on fifteen conglomerate samples by gravity separation method using Bromoform to interpret the provenance of the sediments. Mineral compositions of conglomerate clasts vary as much within individual formations as they do from one formation to another. Conglomerate in this area consists dominantly of particles greater than 2mm in size. For the present study twelve petrographic thin sections were prepared; two from Um Maria, four from Weiloi and two from Kyrphei sampling sites. Preparation of thin-section, petrographic report and heavy mineral analysis was carried out at the Petrology and Chemical Division, Geological Survey of India, North-Eastern Region, Shillong, Meghalaya. Thus, on the basis of the entire heavy mineral assemblage it can be interpreted that the source rock was from igneous origin mainly from acid igneous rocks, granite pegmatites, only few from basic igneous rocks and metamorphic rocks. The petrogenesis of the rock samples shows mixed provenance due to presence of both sub-rounded to sub-angular clastic of the rock some from nearby sourced and others with sub-rounded grains suggesting of more distanced source with prolonged transport. Most of the samples are of a granitic or, gneissic provenance as the source for deposition. The rocks of quartz-vein are medium grained in nature suggesting of relatively moderate rate of cooling Texturally the rock suggest of igneous origin later deformed and metamorphosed.

Keywords: *Provenance, Conglomerates, Paleoenvironment and Heavy Mineral*

Geospatial study of Forest Fires: An Geomorphological Aspect

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Abstract

Forest fires play a major role in degrading forests and adding more carbon to the environment. Wildfires destroy vegetation and cause modifications to soil properties and structures and lead to major changes in hydrological and geomorphological processes in forested catchments. Wildfire affects each forest type differently by decreasing biomass and increasing soil erosion thus leading to a decrease in soil depth and an increase in soil porosity, which in turn affects afforestation success percentage by poor root stabilization. Therefore, an attempt was made to understand the spread of wildfire in context with the geomorphology of the forest areas. The objective of this study is to provide a general overview to land managers by assessing the main impacts of wildfires, including those on the forest ecosystem. In recent years multispectral satellite remote sensing has opened up opportunities for qualitative analyses of forests and other ecosystems. It has also been efficiently used in the mapping, monitoring, and delineating of forest fire scars. Accordingly, satellite images are analyzed along with Forest Survey of India fire alerts to check the occurrences and spread of forest fires. Fire scars were detected using the Burnt Area Index (Burnt Area Index) from Sentinel- 2 satellite images. BAI index highlights burned land in the red to near-infrared spectrum, by emphasizing the charcoal signal in post-fire images. The index computes recently burned areas. Geomorphological parameters such as slope and aspects are used to understand the nature of fire scars. The analysis of fire scar revealed the spread of fires which depicted high relevance to the slope of the area. This study also helped to identify the large forest fire areas of Pune Forest Circle with respect to geomorphology and different forest types. Fire spread or fire scar extent study will help in pre-fire management activities and prioritization to avoid a major loss to the environment.

Keywords: *Forest Fire, Geomorphology, Satellite Image, Burnt Area Index*

Natural and Anthropogenic Factors Related to Landslide Hazard in South Sikkim

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Abstract

Natural and Anthropogenic Factors Related to Landslide Hazard in South Sikkim This paper will represent an approach of landslide hazard zonation studies, based on the geology, geomorphology along with anthropogenic factors of landslides of South Sikkim, North Eastern India. An inventory map of present landslides of this area based on field survey and other published data, has been developed to determine the factors that caused them. Landslides are generally controlled by several factors, among them present study includes 6 landslide influencing factors, which have been categorized as lithology, soil, hydrological, climate data (rainfall), road network and landuse-landcover. Southern part of the study area mainly covered with very unstable and loose debris material, which causes huge landslides along the road side. But north-eastern part of this area is comparatively stable because of the presence of the thick silt and clay deposits by the rivers and glaciers. Northern and north-western part is covered with glaciers, this area is experiencing avalanches and glacial lake outburst. In the present study, landslide hazard zonation mapping has been carried out using weighted overlay method (WOM) with the help of remote sensing and GIS techniques and divides the area into five different risk zones. Finally, an accuracy assessment has been done by overlaying the landslide inventory map and the LHZ map. 33% landslides come under the very high to high-risk zone, and more than 90% present landslides falls within very high to moderate risk zone. Result shows that quarzitic phyllite are incorporated into recent and older landslides; and slopes with high hazard have the same dip direction. Landslide hazard zonation using structural data contributes to a better understanding of how these structures that preserved under thick debris materials, influence on slope stability and produce landslides. Result shows that buffer zone of 100m wide along highways are very unstable and correlated with landslide events. Tourism is the main purpose for extensive road network construction which leads to more slope instability. Thus, presently human influence has worse effect on slope stability than the natural factors of landslide. This method on LHZ mapping can be use for any existing or new land-use planning purpose.

Keywords: *Anthropogenic, Landslide Hazard Zonation, Lithology, Weighted Overlay Method*

The Geological and Physiographic study of Nilwande Left Bank Canal Command Area for Application of Gravitational Pipeline Canal System

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Abstract

The Geologic and physiographic analysis is most useful for any types of gravitational canal system, because the canal site determined on the slope of the region. Physiographical study has been a vital role to understand the slope pattern of study area (Mustafa, 2011). A topographical survey of the study area should be done before the layout of irrigation canal and canal network can be drawn as a topographic correct map (FAO, 1992). A topographical factor varies water runoff, surplus, discharge, etc. Therefore, the topographical study has been essential for determination of the suitable canal site. It is substantiated that, many developed and developing countries have been using the gravitation pipeline canal irrigation systems instead traditional surface canal irrigation system (Turner, 1994). Therefore, the application of the pipeline canal irrigation system in the left bank canal of Nilwande dam, the geographical profile is to be essential into consideration. The site of gravitational pipeline linked to the physical characteristics i.e. slope, elevation, etc. and water needs based social, cultural and economic factors in the region. According to Bhagat, (2014) the topographic like relief, slope, drainage, etc. and bathymetric features are closely associated with the water management. Therefore, this research paper deals with the physical properties including, Geology and Physiography which are accountable for the gravitational pipeline canal system.

Keywords: *Gravitation, Irrigation, Geology, Physiography, Command area, Catchment area*

Detecting the Temporal Dimension of Soil Loss in the Mayurakshi River Basin, Eastern India: Inferences from RUSLE and Landscape Ecology

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Abstract

Soil erosion is a global problem which has been affecting the sustainability of the human kind since a long time. The problem gets all the more complex due to the fact that the exact quantification of this sub-aerial process of erosion is not possible, especially in the catchment/basin scale. Therefore, researchers across the globe have been depending upon different prediction-based models in this exercise. Amongst myriad erosion prediction models available in the literature, the Revised Universal Soil Loss Equation (RUSLE) has been widely used for predicting the spatial pattern of soil erosion in different regions. The RUSLE incorporates both the physical factors such as rainfall, soil and terrain as well as anthropogenic determinants viz., land use and support practices. The present paper attempts to quantify the amount of soil loss occurring in the Mayurakshi River basin of eastern India with the help of the empirical Revised Universal Soil Equation (RUSLE) Model. Climatic data for monthly as well as annual rainfall were obtained from the Tyndall Climatic dataset and slope was computed from the ALOS-PALSAR DEM of 12.5m resolution. Land use landcover and support practices data were generated by the supervised classification of LANDSAT images. For pedological characteristics, systematic grid sampling was executed in the studied basin and fieldwork was carried out at those grid locations and soil samples were collected and analysed in the laboratory. The areas of high erosion were identified and their spatial and temporal patterns and trends were monitored for the years 2008 and 2018. It was observed that the average soil loss has increased by about 6% from 2008 to 2018. One of the novel approaches used in this study is the application of the landscape ecological metrics in the domain of temporal erosion monitoring. An important conclusion drawn from the analysis is that the patches of high erosion are increasing significantly in terms of areal extent whereas the extent of the patches of low erosion is decreasing with time. Therefore, appropriate management strategies prioritized on the high erosion patches is the need of the hour.

Keywords: *Soil Erosion, RUSLE, Erosion Patches, Landscape Ecological Metrics*

GIS based delineation of potential groundwater recharge zones in the Durgapur Sub-division, West Bengal

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Abstract

Groundwater is the one of the most important natural resources and source of useable water in a region. With increasing population and pressure on surface water resources, the significance of groundwater resources has been increasingly understood in recent years. One of the important characteristics of groundwater is that this is highly dependent on the amount of groundwater recharge. However, the recharge potential of a region is highly dependent on physical factors of climate, topography, nature of underlying material and substrate characteristics. These factors are interdependent and the relative importance of each factor is space and time specific. This makes the exercise of delineating potential groundwater recharge zones a multi-criteria problem. The relative importance of each factor determines the weightage that is to be assigned to that factor. Therefore, delineation of potential groundwater recharge zones becomes a multi-criteria problem with unequal weights. In this paper an attempt has been made to delineate groundwater potential recharge zones in the Durgapur Sub-division West Bengal. Seventeen parameters depicting topography (Relative relief, slope, dissection index), drainage (Drainage density, stream frequency, infiltration number), Climate (rainfall, potential evapotranspiration), pedology (soil texture), substrate characteristics (lineament density, distance from lineaments) and LULC (NDVI, MNDWI, NDBI). For assigning the weightages, the pair wise comparison of the analytical hierarchy process (AHP) was employed. Instead of the traditional AHP approach, we have applied the principle component analysis for determining the importance of each parameter for AHP operation. Results reveal that groundwater potential, more or less decreases from north to south. It may be mention here that the southern part of Durgapur Sub-division comprises the highly industrialised city of Durgapur and it is natural that rapid urbanisation and industrialisation have played a part in decreasing the groundwater recharge potential. The next part of the study involved validating the recharge potential with actual groundwater recharge data obtained from the Central Groundwater Board (CGWB). The validation was performed by using the Receiver Operating Characteristic (ROC) Curve. It is observed that there is about 60% validation with groundwater recharge potential and actual groundwater recharge. Considering the relatively low degree of validation, systematic population data was also employed.

Keywords: *Groundwater recharge, GIS, Analytical Hierarchy Process (AHP), Durgapur Sub-division, ROC Curve*

Altered spatio-temporal variations in the sediment load and sediment yield in the Godavari-Bengal fan system: Anthropogenic influence over climate change regimes

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Abstract

Large river systems around world are increasingly influenced by the anthropogenic activities superimposed over Climate Change phenomena significantly altering the sedimentation regimes in the river basins. Godavari represents the largest drainage basin in Peninsular India, and has witnessed a dramatic decline in sediment load during past five decades. We study the interrelationship amongst sediment load, erosion rates, the land-use and rainfall variation under the influence of dam constructions at both spatial and temporal scales in the Godavari and its major tributaries. While sediment load in the Godavari is declining significantly at various locations, rainfall showed an overall insignificant increasing trend barring the Sabari sub-catchment. Spatial variability in sediment yield is associated with rainfall over land-use variation. Temporal sediment load variations in the Godavari and Pranhita sub-basins are anthropogenically induced, while climate change controls Indravati and Sabari sub-basins. Sediment entrapment in numerous reservoirs in the Godavari catchment during the past five decades, is marked low sediment water ratio and sharp decline in sediment flux to the Bay of Bengal. The dam constructions have increased episodic and irregular sedimentation-erosion cycles resulting in sediment starved delta susceptible to the coastal erosion by wave actions without replenishment disturbing an overall ecological balance in the Krishna-Godavari delta regions. Our observations may have significant implications to the management of reservoirs, land use planning, and prevention of coastal ecology in the Godavari system.

Detecting the Structural and Tectonic Control of the Barakar River Basin, Eastern India: Analysis of Long Profile Derivatives

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Abstract

Fluvial system is the most sensitive of all the landscape elements and any change in prevailing climatic and tectonic condition is reflected by drainage morphological adjustments by the river and its tributaries. Longitudinal profiles represent the long-term morphological adjustments of the river to lithology and tectonics and has been used globally across different river basins. This is a two-dimensional bivariate relationship between the distance from the source and the channel elevation at various points on a river. Rivers in equilibrium and uniform homogeneous lithology display concave up profile which shows as a straight line on a semi logarithmic graph paper. In the present study, longitudinal profiles extracted on 25 sub-basins of the Barakar River Basin of Eastern India have been analyzed with 30mt resolution SRTM DEM data. All the derived longitudinal profiles have been normalized with respect to elevation and distance to neutralize any bias that may arise due to varying stream lengths and absolute elevation. The Barakar River and its tributaries do not exhibit the typical concave up profile as would be expected for a river under uniform lithology and devoid of tectonic activity. Also, the long profiles are plotted on a semi-logarithmic graph paper to neutralize the exponential increase in the distance from headquarters and above-grade condition is observed. The average SL indices of the rivers are below 50 which are much lower than the Himalayan Rivers. The profile concavity which is derived from the bivariate power law relationship between basin area and channel slope indicates convex character. In order to isolate the effect of lithology and tectonics on the long profiles, the lithological units have been overlain on the long profiles and it is found that for most of the cases, the steep segments are associated with the river continuously and this is an implication of a rift valley river. In a nutshell, the Barakar River and its tributaries display ample evidence of litho-tectonic control, however, the episodes of diastrophism do not appear to be geologically recent, as has been observed very low values of SL indices as compared to elevated values observed in case of areas under active tectonics.

Keywords: *Long profiles, SL index, Concavity, Barakar*

Morphological changes of a developing sandbar along the bank of river Ganga in Varanasi

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Abstract

The form of a sandbar is expected to alter often in a dynamic river environment, especially when there is a significant annual sediment input. The study investigates the nature and extent of morphological changes in a growing sandbar. it also investigates river and sandbar mechanisms, the seasonal difference in the area of the sandbar, and typical levels and shapes of the emergent sandbar between 2001 and 2021, using different satellite images. The change in sandbar dynamics across river banks was calculated using google earth imagery and toposheet. The study revealed the continuous change in morphology of sandbar along the bank. The area of the sandbar changed from 3.3 square km to 3.15 square km and the perimeter changed from 12.6 km to 13.7 km between 2001 and 2021. Sandbar has migrated 400 meters towards the north. The minimum area was recorded at 2.41 square km in 2014 and the minimum perimeter was recorded at 9.71 km in 2008. This shows the continuous flood and deposition of sediment across the area. Transect 1 and 7 shows the most changes and transect 3 is the most stable part of the sandbar. A stable zone has developed due to the continuous layering of deposits.

Keywords: *Sandbar, Morphology, Flood, Sediment, Stable Zone*

Finding multicollinearity in soil geomorphological variables: research on the southwest hills of West Bengal

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Abstract

The situation where several variables are linearly associated is dealt with by the widely used statistical technique known as multicollinearity analysis. This technique makes it simple to find the presence of strong association. The main results of the multicollinearity algorithm include the correlation matrix, the route-square, the tolerance, and the variance inflation factor. The focus of the current study is West Bengal's Southwestern Hills (Ajodhya, Garpanchakot, Biharinath, and Susunia). According to changes in elevation and slope, 77 soil samples are taken from the top of the hill to the foothill pediment area. Using a GPS device, the locations of the sample spots have been established. The height of the sample points was determined using an altimeter, and it was then double-checked using a GIS overlay operation on the SRTM digital elevation model. Clinometer compass has been used to determine the slope of the sample locations. Geomorphology and soil have a close relationship. For the investigation, two sets of data were used, each with a common geomorphological variable and a separate soil variable. In the pedological laboratory, soil variables have been identified using various soil sample analysis techniques. Given how closely related soil and geomorphological variables are to one another, this is one of the first attempts to determine various correlations between them. Because strong multiple linear correlation in the variables of sand, silt, clay, organic carbon, and organic matter have been found by route square, tolerance, and inflation factor values, this approach is both very original and pertinent. Principal component analysis is one of the ways that multicollinearity must be handled.

Abstract Volume

Identification and analysis of geological and geomorphological factors responsible for landslides along the Mandi-Manali National highway stretch, Himachal Pradesh

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Abstract

The objective of this research work is to delineate and analyze the geological and geomorphic factors responsible for the occurrence of landslides along the Mandi-Manali National Highway stretch using geospatial data and a digital elevation model (DEM 90 m) through GIS application. The geology and lithology of the region reveal that it is composed of sedimentary and metamorphic rocks which are mainly from the Vaikrita group. The maximum lineament density in the region is 1.9 (km/sq.km). Highly dissected hills and valleys mark the study area. The landform classes include alluvial plain, alluvial fan, terraces, meander scar, point bars, lateral bar etc. The elevation map shows that 61.8% area lies between 1500-3700 meters. According to the slope calculation, 50.6% area is under a steep slope which has a slope angle of more than 25 degrees. The study area is drained by 814 streams of different orders. The secondary data from the Bhukosh portal of the Geological Survey of India has been used to prepare landslide inventory. The landslide inventory includes 302 landslides with their attribute data in the study area. The delineation of terrain and geomorphic units can be applied for planning and development in the hilly terrain to reduce the risk of landslide hazards along the highway.

Keywords: *Terrain, Geomorphology, Lithology, Landslide, Hazard.*

Sequential analysis of variation in land surface temperature: A case study of Pune – Mumbai expressway

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Abstract

In the modern times, there has been a huge impact of human interventions on the pattern of land use, including green spaces. And that will lead to changes in land surface temperature too. The present study has taken emphasis on changes in land surface temperature along the Pune-Mumbai expressway. Due to an increase in traffic, it became essential to build a new and independent Expressway. This expressway transport project was undertaken by the Government of Maharashtra and was opened to traffic on the 5 April 2000.The corridor of Pune-Mumbai expressway with the length of 94.5 kilometers and 6 big tunnels has a great impact on alongside area. Evaluating the temporal changes in surface temperature alongside expressway will be helpful for identification in differences between land use and land surface temperature, as well as in environmental management. In order to bring out the changes in surface temperature within study region, three Landsat-TM satellite images, were analyzed. One is before and one is after construction of the expressway, and last one is from recent time that is from year 2021.The remotely sensed images are pre-processed by techniques such as, layer stack, Geometric and radiometric correction. Then Supervised classification has been carried out in order to get changes in Land use pattern. The Normalized Difference Vegetation Index (NDVI) model along with surface emissivity is used to retrieve Land surface temperature (LST). The analysis has discovered that there has been an increase in and surface temperature after construction of expressway and then gradually decreases over the period of time due to maintain the vegetative areas with suitable actions.

Keywords: *Pune-Mumbai Expressway, NDVI, LST*

Abstract Volume

Morphology of River Valleys in the Humid Tropics: A Case Study of the Lower Umiew River Valley in the Southern Meghalaya Plateau

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Abstract

Rivers and the valley systems they form are some of the most prominent and interesting features on the earth's surface. A product of fluvial erosion, river valleys are one of the most ubiquitous features of the landscape. Lying between 91°57' E to 91°76' E longitudes and 25°18' to 25°43' latitudes, the Lower Umiew River Valley is an important geomorphic feature located along the Southern Slopes of the East Khasi Hills District of the Meghalaya plateau. This region, characterised by hilly terrain and rugged topography is well known for receiving some of the heaviest rainfall in the world. The present study aims at giving a comprehensive description of the morphological features of the Lower Umiam River Valley and to analyse the impact that the long-term heavy rainfall has on the valleys. It also aims to understand how the lithologic variations affect the width and depth of the valley. The approach of the study is mostly based on map works derived from topographic sheets as well as Digital Elevation Models (DEM) generated through ArcGIS. Basic calculations of the width and depth are done using suitable formulas. The results show that the valleys of the Lower Umiew River are broadened or enlarged V-shaped valleys, with steep valley slopes, narrow valley floors with interlocking spurs, and high elevational relief. The valleys comprise of constrained reaches made up of mainly colluvial deposits, influenced by the heavy rainfall in the region.

Machine-learning-based Drought Vulnerability Assessment in Uttar Pradesh

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Abstract

The natural and intricate climatic danger of drought influences the socio-economic and ecological surroundings. In Uttar Pradesh, India, this project attempts to create a drought vulnerability map (DVM) using novel ensemble machine learning algorithms (MLAs). The factors of exposure, adaptation capability and sensitivity were conducted to identify drought vulnerability. Then, for DVMs, three machine learning techniques such as Random Forest (RF), Radial Basis Function (RBFnn), RF_RBFnn_ ANN Artificial Neural Network (ANN) and their ensemble models such as RF_RB Fnn, ANN_ RF, ANN_R BFnn and were developed. The efficiency of innovative ensemble MLAs was assessed using the receiver operating characteristic curve (ROC), root-mean-square-error (RMSE), mean-absolute-error (MAE), precision, and K-index. According to the results, the Ensemble model of random forest, RBFnn and ANN models (RF_RBFnn_ANN) performed best overall, with the greatest AUC, followed by ANN_ RF and RF_RB Fnn, in that order. The development of DVMs would be beneficial for policy action to reduce susceptibility to drought.

Abstract Volume

A catastrophic flood of September 1973 in the Mahi Basin: Western India

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Abstract

The Mahi River is the third largest west flowing interstate river of peninsular India and well known for a flash flood. Several floods were recorded in the Mahi Basin in the last century. Nevertheless, flood of September 1973 was a catastrophic and widespread. Therefore, objective of this investigation is to examine the synoptic conditions associated with the 1973 flood and its hydro-geomorphic effectiveness. Accordingly, meteorological, hydrological and geomorphological analyses were executed based on daily and mean monthly rainfall data, synoptic conditions, hourly streamflows and annual maximum series (AMS) data and channels cross-section surveys on the Mahi River. Analysis of synoptic condition indicate that a sequence of low-pressure systems (26-31 August 1973 and 2-5 September 1973) formed over the Bay of Bengal and contiguous region in a period of two weeks that produced heavy to very heavy rainfall over the Mahi Basin. Hydrometeorological analyses show that antecedent moisture conditions (AMC) played a significant role in catastrophic flooding in the Mahi Basin in 1973. As a result, peak discharges were observed at Wanakbori (40663 m3/s) and Kadana (33097 m3/s) on the Mahi River. A high discharge observed at the Kadana compelled to revise the design flood of the Kadana Dam and a new design flood was fixed at 46871 m3/s magnitudes. After 1973 flood an additional spillway that passes 10000 m3/s discharges was constructed along with the revised main spillway design. The flood hydraulics and hydrodynamics analysis indicate that stream flows are dominantly subcritical, extremely turbulent and are capable of accomplishing a variety geomorphic work such as erosion and sediment transport. The limited systematic gauge records are extremely challenging for flood-hazard assessment and management for engineering community and planners.

Meteorological, Hydrological and Geomorphological Aspects of Large Floods on the Upper Godavari River: Peninsular India

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Abstract

High-magnitude floods during the monsoon are considered to be India's recurring and leading natural disaster. Such large-floods are extremely significant events not only in terms of human impact and but also from the perspective of geomorphic effectiveness and geomorphic work. The Godavari River in Peninsular India is characterized by one of the most intense flood regimes in the seasonal-tropics. The river has experienced largest peak on record in India of a magnitude of 100000 m3/s in 1969. In the present paper an attempt has been made to understand meteorological, hydrological and geomorphological aspects of large-floods on the Upper Godavari River (UGR). In order to understand flood-hydrometeorological situations associated with monsoon-floods on the UGR, the analyses of synoptic conditions coupled with large-floods were carried out. This encompasses analysis of interannual rainfall variability and associated floods and analysis of the storm-tracks. To accomplish above analyses, the annual-rainfall data were obtained for 121 years from India Meteorological Department. The results signify that the interannual variability was characterized by increased frequency and magnitude of floods primarily after 1930s and majority of large floods were connected with low-pressure systems. In order evaluate flood-potential of the UGR, unit discharges (Qu) and flash-flood magnitude index (FFMI) were computed. The annual maximum series data were procured for three gauging sites from CWC. The values of Qu range from 0.16 to 1.13 $m^3/s/km^2$. The FFMI values range between 0.32 and 0.46. The relatively higher FFMI value indicates flashy and variable nature of floods and possibility of noteworthy geomorphic work during large-floods. In order to find out effect of infrequent and large magnitude floods, parameters of flood hydraulics and hydrodynamics such as unit stream power(ω), bed shear stress(τ), Froude number (Fr), Reynolds number (Re) and critical-velocity for inception of cavitation (Vc) were computed for catastrophic 1969, 2006, 2008 and 2019 floods. To compute the parameters, cross-sectional surveys were carried out at four sites. The highest values for ω and τ are 8273.5 W/m^2 and 609 N/m^2 respectively. These values reveal unusually high ability to erode and transport sediments. The Fr are >1, indicating supercritical flows. High values of Re reveal extremely turbulent flood-discharges. The flooding in such large-rivers greatly challenges flood-hazard management, because of limited instrumental records and large spatio-temporal variation. The present study, therefore, can prove to be a significant contribution towards flood-hazard management of UGR.

Abstract Volume

Quantitative Analysis for Prioritization of Watershed Through Morphometric and Land Use/Cover Parameters of Kamlang River Watershed

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Abstract

Considering the relationship and importance of water and how watershed plays a dominant role in the transportation of sediments and water and landforms development, it is very significant to study a watershed as it is an ideal unit for the management of natural resources like land and water. Watershed management has become an effective measure in the mitigation of the impact of human activities and natural disasters and for achieving sustainable development. Remote sensing (RS) and Geographic Information System (GIS) techniques help planners in decision making and hence became an effective instrument for such kinds of studies. Morphometric parameters (linear and shape) with land use land cover parameters were used for assigning ranks based on which prioritization and ranking were made for all the sub-watersheds of Kamlang River Watershed. Different categories of priority from high to low ranks were assigned depending on the parameters and lastly, the compound value (Cp) of all the sub-watershed was calculated. Higher Cp was of low priority, lower Cp was of higher priority. The study demonstrates the presence of high priority in the sub-watershed of SW64 and SW65 on the bases of morphometric studies. Whereas based on land use land cover more sub-watersheds are in the high priority range for example SW1, SW6, SW8, SW12, etc. The combined result of morphometric and land use/cover analysis, however, gives a different result i.e. only SW65 is in the high priority zone. This means the sub-watershed of SW65 is more prone to erosion due to its morphometry and land use land cover type. Therefore, the implementation of soil and water conservation measures for this sub-watershed is necessary.

Morphometric Analysis of Mahalungi River Basin in Maharashtra, India Using Geospatial Techniques

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Abstract

The measurement and quantitative analysis of the dimensions, shapes, and landforms on the earth are known as morphometry. The different morphometric characteristics like linear, aerial, or basin and relief parameters are significant for any river basin management. The present study aims to analyse the morphometry of the Mahalungi river basin area using various parameters with the help of geospatial techniques. The total catchment area of the basin is 283.58 sq. km and it is a 6th-order basin. The mean bifurcation ratio is 3.9780, which indicates that there are fewer structural disturbances in the basin and that the lithology is homogeneous throughout the basin. The drainage density of the basin area is 2.8156 km/ km^2 which indicates moderate drainage density; therefore, the basin area has permeable subsoil. A low relief, sparse vegetative cover, and reduced rock permeability are all reflected by the stream frequency of 3.5757 km^2. The form factor value is (0.1328), elongation ratio (0.4113), and circulatory ratio (0.2311) which indicates the elongated shape of the basin and has a low peak flow with a longer duration of time and is less susceptible to flooding. The research region's drainage texture ratio is 8.1734, which means the basin area has a fine texture. The study area's infiltration number, 10.0678, reveals that the area's infiltration capability is low, leading to higher surface and soil runoff. The stream length ratio in the study area indicates the variation in slope and topography, indicating the youthful stage of geomorphic development in the basin area. The Mahalungi basin's youthful geomorphic stage is reflected by its roughness value of 2.0697. The measurements indicate the dendritic drainage pattern, elongated shape, moderate drainage density, low infiltration, high runoff, erosion potentials, youthful stage of geomorphic development, less susceptible to flooding, low peak flow, and less vegetation cover area, among some other features found in the Mahalungi river basin. The investigation has enhanced our knowledge of the hydrological, geological, and geomorphological features of the study area. This study would help for appropriate planning and optimum utilization of developing management programs for the river basin, watershed management, soil conservations, prediction and management of flood, site selection of water harvesting, management of the drought-affected area, and agriculture practices to will be used by the local administration for natural resources management of the study area.

Keywords: *Morphometric, Mahalungi, Geospatial techniques, Management.*

Impact of Thermal Power Station on Soil Properties: A case study of Thermal Power Station, Eklahare, Nashik, Maharashtra, India

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Abstract

Heavy metal contamination in soil has become a universal threat in recent years. Various anthropogenic activities like manufacturing industries, thermal power plants, mining and agricultural activities are responsible for the increase in heavy metal contamination in soil. In this research work an attempt has been made to analyze the effect of the coal based thermal power station at Eklahare (Nashik) on the surrounding soil properties. Specifically, 02 soil samples from surrounding area of thermal power plants were tested for heavy metal contamination such as Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni) and Zinc (Zn) in soil. Atomic absorption spectrophotometer (AAS) was used to determine the concentration of heavy metals in soil. Soil pH, EC (dSm-1), OC (%), Nitrogen (N), Phosphorous (P), Potassium (K) and Calcium Carbonate (%) are also estimated for the soil samples. The result shows that heavy metals Arsenic (36.59 µg/g) and Mercury (7.05 µg/g) exceeds the permissible limits set by WHO, Whereas Copper (48.94 µg/g) and Nickel (45.65 µg/g) are near at boundaries of the limits in Sample no. SS23. The heavy metals Arsenic (81.83 µg/g), Mercury (18.14 µg/g) and Nickel (66.23 µg/g) exceeds the permissible limits set by WHO, Whereas Copper (62.03 µg/g) and are near at boundaries of the limits in Sample no. SS24. Soil pH found alkaline at contaminated sites. This research suggests the continuous monitoring of the agricultural field of the surrounding area and also the assessment of heavy metal contamination in Godavari river.

Keywords: *Heavy Metals, Soil, Contamination, Thermal Power Plant*

Spatial Assessment and Mapping of Gullies on Hill Top Around the Ahmednagar City, Maharashtra, India

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Abstract

Gully is narrow and deep ditch with steep side valley nature landform, formed by running water on loose surface of hill slopes. This is form of erosion having potential to influence agriculture, fertile soils, water bodies, river channel, infrastructures, urban areas etc. It is one of crucial research topic in geomorphology. Geospatial techniques including remote sensing, GIS, GPS are empowering to scholars to conduct rational study at local scale on gully. The present study is lighting on spatial assessment and mapping of gullies on hill top around the Ahmednagar city, Maharashtra, India. Hills around the Ahmednagar city are belonging to Balaghat Range which is offshoot of Sahyadri Mountain. Under the influence of multiple natural and man induced factors gullies have been formed on hill tops. Spatial assessment and mapping of gullies at large scale essential with geospatial techniques (Golosov, et al. 2018) to suggest sustainable strategy to control the gully erosion. Present work is an attempt to carry out spatial assessment includes distribution, density, and size of gullies and mapping with help of geospatial techniques. The open source remote sensing data such as, Google earth, Sentinel images, SOI toposheets etc. and open sources software's are been used to accomplish the study. Conclusions of study encompass gully distribution map, pattern of gullies, gully classification with suggestions and scope for further study.

Keywords: *Gully, gully erosion, geospatial techniques, spatial assessment, mapping.*

Abstract Volume

Land facets and slope wise evaluation of soil properties: A case study of ghera Sinhagad land system, western Maharashtra, India

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Abstract

Land evaluation has worldwide significance in sustainable land resource management (SLRM). Pedo-geomorphology approach of study provides methods for the appraisal of land resources. Pedological and geomorphological analysis, Geo-ecological perceptive and land system approach are crucial in the SLRM. An attempt has been made in the present investigation to assess the physical, chemical and hydrological properties of soil and their slope-wise variability for land facets conservation. The Ghera Sinhagad Land System is a study area situated on the Deccan plateau along the eastern flanks of Sahyadri ranges, Pune, Western Maharashtra. It includes a 131.62 Km^2 area. The land facets identified in the study area include plateau summit surface (PSS) 36.66% (48.25 Km^2), plateau fringe surface (PFS) 28.23% (37.15 Km^2), pediment surface (PDS) 28.17% (21.40 Km^2) and plain surface (PDS) 13.53% (17.81Km^2). Detailed fieldwork was undertaken in the study region for collections of soil samples and soil-hydrological measurements according to slope and land use. About 291 soil samples from slope <10% (93), 10-20% (134), 20-30% (85), 30-40% (39) and >40% (10) was collected and analyzed in the laboratory to estimate the physical and chemical properties. The spatial variation map of each property was prepared and aerial extent has calculated. Attempts were also made to infer soil properties variation of land facets with slope variability. The correlation matrix of slope and all soil properties analyzed shows a positive relationship with % Cs, % Fs, % silt, Db, Moisture, pH, TSS, Oc, OM, Fe, K, P04 and a negative relationship with porosity and clay. The soil properties in the area are influenced by physiographic and climatic conditions. Extremely high potential land comprises under PLS i.e. 8.33%. High potential soils confined to PDS (12.26%). Moderately potential soils consist of 9.54% of PFS. Moderately low potential soils comprise around 16.17% of PSS. The PFS and PSS facets are highly affected by severe runoff and soil loss, and it decreases the quality of soils. The PDS land facet has highly potential soils if appropriate steps of SLRM are undertaken.

Keywords: *Pedo-geomorphology, land facet, slope, SLRM.*

Abstract Volume

Measuring the effects of damming-induced wetland fragmentation and water richness change on wetland ecosystem services

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Abstract

Inland wetlands, rivers, and lakes have ecosystem service values (ESV) ranging from 4267 to 25682 US$ /ha/year; however, will these ESVs remain constant as the landscape fragments and develops hydrological instability? The present study evaluated the ESV in various fragmented wetland units and over various water richness zones in relation to hydrological alteration brought about by damming the Punarbhaba river in 1992. (a transboundary of India and Bangladesh). The support vector machine (SVM) model was used to map the wetlands for both pre- and post-dam conditions. After that, wetland fragmentation analysis and spatial weighted fuzzy logic-based water richness modelling for both the pre (1989) and post-dam periods were done using satellite image-derived parameters such as hydro-period, water depth, and consistency of water presence (2019). The findings indicated that the wetland area decreased between the pre- and post-dam periods from 205.24 km^2 to 73.22 km^2, and as a result, the ESV decreased from 10596 104 US$ to 3874 104 US$. Effect reduced the high-water richness area from 71.83 percent to 7.65 percent, resulting in a 62 percent decrease in ESV during the post-dam period. The ESV value was 45 percent lower in the post-dam period due to an increase in patch frequency and a decrease in the core area, which is what is known as the fragmentation effect. This work has excellent policy implications on a priority basis for wetland conservation because the study identified the areas with declining ESV values.

Flood hydrology and Geomorphology of the Damanganga River: Western India

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Abstract

The magnitude, frequency and hydraulic characteristics of the floods play a significant role in modelling the river channel as well as the landscape in monsoon dominated tropical rivers such as the Damanganga River. Therefore, an attempt has been made to understand the hydro-geomorphic characteristics of the Damanganga River. Accordingly, annual maximum series (AMS) data were obtained from Central Water Commission (CWC) and river cross-section data were acquired by conducting cross-sectional surveys. The analysis of discharge variability reveals that there are certainly not great fluctuations in the annual maximum stream flows in the Damanganga Basin. The highest value of the ratio between coefficient of skewness and coefficient of variation (Cs/Cv) signified that positively skewed distribution of the annual peak discharge due to effect of the large floods during gauge records. The relatively higher flash flood magnitude index (FFMI) value of the Damanganga River (Nani Palsan site) indicates slightly flashy and variable nature of floods. The high unit discharges observed at Shinde (70.66 m3/s/km2) and Gonde (63.41 m3/s/km2) denoted that upper basin of the Damanganga River has capacity to produce large floods. Besides, channel morphological analysis showed that the maximum channel width (water depth) of the Damanganga River and Wagh River is 441 m (17.69 m) at Valwada and 175 m (11.5 m) at Ozarkhed respectively. The channel of the Damanganga River is box-shaped, with more or less flat channel floor and bounded by elevated banks at Khamshet and Zari. The analysis of downstream variation in width-depth ratio reveal that range of the W/D ratio of the Damanganga River with respect to high flows and low flows significantly increases in the lower reaches due to wide channel of the river.

Keywords: *hydrology, geomorphology, Damanganga River, flood.*

Identification and mapping of Multi-hazard using Geospatial Techniques in Jammu Division, Jammu and Kashmir, India

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Abstract

Environmental hazards have always been a source of serious concern as they are becoming more severe and larger in scope, increasing the risk of additional losses and harm to the environment and public health. In order to mitigate and prevent from effects of natural disasters, hazard mapping has emerged as the core component of disaster mitigation strategy. Single hazards have been extensively studied but after the international convention on sustainable development, the multi-hazard approach is widely used as part of the disaster risk reduction plan. Multi hazards are defined mostly as "all hazards at place" "more than one hazard" or "multiple hazards". It is challenging to cover all the hazards in a study, so, in this research, an attempt is made to recognize and map out multiple hazards occurring in the study area. Lying in the vicinity of the Himalayan region, Jammu Division is prone to many hazards which have led to numerous causalities. In this study, landslides, floods, earthquakes, droughts, forest fires and soil erosion are considered for mapping in the Geographic Information System (GIS) environment using geospatial techniques. Analytical Hierarchy Process (AHP) is adopted for standardizing and normalising the weights to be given for mapping purposes. The final map, which shows the different zones of occurrence of multi-hazard, will be of immense use for decision-makers.

Abstract Volume

Assessment of Flood Vulnerable Zones Using Geospatial Techniques- A Case Study of Greater Mumbai, Maharashtra

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Abstract

Owing to shifts in rainfall patterns brought on by climate change, urban floods as well as its socio-economic impacts are dramatically increasing internationally in a number of coastal communities. Mumbai, the financial centre of India, is one such city. The main goal of the study is to identify flood vulnerable areas in Mumbai using a multi-criteria evaluation (MCE) technique. GIS is used to extract, combine, and perform geographical analysis of each factor under consideration. Using the Analytical Hierarchy Process (AHP), the weights of flood vulnerable influencing factors such as rainfall, slope, land use/cover (LULC), vicinity to sewers and storm water drainage, vicinity to natural drainage, vegetation, and soil were assessed. Using the AHP technique, the following factors are given equal weights as: rainfall (29.42%), slope (20.96%), LULC (17.52%), vicinity to sewers and storm water drainage (13.99%), vicinity to natural drainage (8.97%), vegetation (5.58%), and soil (3.56%). According to the projections, only 34.54% of the study area falls into the category of slight to moderate vulnerability, compared to 18.74% of area lies in high to very high category and 46.72% of area in severe category. Researchers were able to validate the modelling conclusion by examining all 234 water-logged locations in the study area. According to the field assessment of the locations that are being taken into consideration, the majority of the water-logged sites, or 85.46%, were detected in regions with severe to very high vulnerability. Identifying the sites at risk of flooding is a key step, based on the results of multi-criteria in GIS environment. These model-based flood vulnerable scenario maps are essential for strategizing flood conservation and control strategies to prioritize the area based on the degree of vulnerability.

Abstract Volume

Quantitative Morphometric Analysis of Wah Daiñthlen Catchment, East Khasi Hills, Meghalaya

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Abstract

Wah Daiñthlen catchment is located in the southern part of Meghalaya plateau which is one of the rainiest and most tectonically active places on earth. The area receives an average annual rainfall of about 12000 mm and just in the year 2020, the catchment receives an amount of about 13994.3 mm of rain. The primary source of drinking water for the villages inside and surrounding the watershed is Wah Daiñthlen. However, in spite of the area receiving the highest amount of rainfall in the world the people of the area (for example in Sohra / Cherrapunji) suffers from inadequate drinking water. Quantitative evaluation of the morphometric parameters under such conditions of extreme humid environment gives a better understanding about the hydrological and morphological nature of the catchment. The study focuses on examining the three parameters of lineal, areal and relief aspects using geographic information system (GIS) techniques. Wah Daiñthlen is the fifth ordering stream and has a total length of about 339.93 km which comprises of streams of all orders. The correlation between stream order and number shows a negative strong relationship as the stream length decreases with increasing order. The sinuosity index is 1.30 which is a meandering river and the catchment is elongated in shape. The drainage density and frequency is 5.65 km per sq.km and 15.57 per square kilometer. The relative relief is about 1619m and the dissection index is about 0.96. The hypsometric integral shows a value of 49% which indicates that the catchment is in the mature or the equilibrium stage. Quantitative analysis helps in evaluating the impact of geomorphological processes on the watershed's hydrology and is useful for soil and water conservation as well as for the proper planning and management of the area as a whole. Due to low infiltration rate especially in the upper and middle part of the catchment there is high surface runoff throughout these areas. Suggestions like rainwater harvesting in every household and re-vegetation through afforestation and reforestation is strongly recommended especially in the upper and middle part of the catchment. Awareness programmes should also be conducted to make people aware about watershed management and restoration.

Soil salinity risk assessment and mapping for sustainable land resources management (SLRM)- A case study of village Kolgaon in Niphad tehsil, Maharashtra

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Abstract

Soil, water, and crop management are essential for rural-agricultural development and to afford adequate resources for the rising population. Soil salinization and water logging is foremost Geo-environmental problem which decreases the land productivity. One of the significant threats to the sustainability of irrigated agriculture is the risk of increase of soil salt concentrations, leading to crop yield reductions. Hence it is noteworthy to study micro level geo-environmental assessment of soil salinity and its mapping for optimum use of land resources. The present investigation processes the Soil Salinity Risk Index (SSRI) by Chaaou, 2020 for the spatial variation in soil salinity at village level. Attempt has been made to evaluate and mapping of soil salinity of village Kolgaon, (996.94 ha) Niphad tehsil of Nashik District, Maharashtra. Elevation ranges from 450 to 550 m. and slope between 1-12%. A detail field survey was undertaken in the study area to measure the infiltration and hydraulic conductivity rate of soils. The soil properties evaluated through soil sample collections and soil health card data (103 samples data) from GOI. The SSRI input parameters viz, elevation, slope, climate type, soil texture, Electric conductivity of the soil, surface water, depth of the groundwater and aridity index spatial variation map with standard grid was prepared. Reclassification of grid was performed for assign ranking and weighing. The result shows that salinity index value ranges between 27- 62. The maximum land of the study area comprises under severe salinity class. Spatial salinity index result verified with 20% sampling of the study area. The salinity indicators (White layer, Acacia Nilotica, Salt tolerant weeds, etc.) verified in the field as per result. Hence the pedo-geomorphic assessment using field survey and GIS techniques provides adequate and precise results for implementation of SLRM.

Keywords: *Salinity, Soils, Productivity, Risk Index, Mapping.*

Study of Sediment Dynamics in Indian Sundarban Based on Field Observations and Numerical Models

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Abstract

Sundarban, located in the Ganga-Brahmaputra-Meghna confluence zone, is one of the most vulnerable and heavily damaged coastal landscapes in the world. Sea level rise (SLR), SLR induced increased erosion, changes in freshwater flow, and sediment movement into the ocean have historically altered this landscape. As a consequence, the current research aims to explain the amount and character of suspended sediment (SSC) movement in this changing environment, as well as its relationship to estuarine hydrodynamics. An emphasis was also placed on determining how vertical accretion rates varied spatio-temporally in estuarine mudflats with varying hydro-geomorphic properties. The SSC variation was studied by randomly collecting 40 water samples from different locations along the Thakuran and Matla River systems during the pre-monsoon, monsoon, and post-monsoon seasons. We then filtered and weighted the samples and used the results for calibrating the satellite images so that we could extract the SSC content of the entire rivers based on the DN of the NIR bands. Additionally, a MIKE 21 FM model with mud transport module was run to evaluate differential flow characteristics and their relation to SSC movement. The vertical accretion of mudflats was also measured using 18 separate profiles of vertical sedimentation pins. Results indicate that SSC differs significantly between monsoon and post-monsoon seasons as well as between interior and sea-front areas of the estuary. At 20 km inland from the estuarine mouth, SSC levels are around 2.44 g/l during monsoon season and decrease to around 0.08 g/l during post-monsoon season. Based on numerical studies, the density of SSC in estuaries is correlated with current speed. In the monsoon season, highest accretion occurs in inner regions of the estuary with a sheltered environment, between 1 cm and 5 cm. This rate is however reduced after the monsoon. Conversely, sedimentation pins along the seafront exhibit negligible accretion to erosion.

Abstract Volume

Investigating the Navigable Palaeo-course of Bidyadhari River in reference to Cartographic and Literary evidences- A study around a prospective Archaeological Site of Kochpukur, West Bengal

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Abstract

In lower deltaic Bengal, there are a number of sites which bear the evidences of old riverine or estuarine settlements in the Hugli-Ichamati interfluve region, some of which have already been discovered, based on the evidences of relatively well-preserved habitation mounds. The study site Kochpukur, situated on the suburban fringe zone of Kolkata Metropolitan area in South 24 Parganas district, adjoining the northern boundary of East Kolkata Wetland (Ramsar site). The site has recently been brought to light as a prospective archaeological site (December 2022, The Monthly Bulletin, Asiatic Society). The interesting folk tales state that in the past the site was located on the bank of the Bidyadhari river, where large boats used to frequent. The present study aims to investigate this area and trace any probable connection between the riverine settlement and the navigable palaeocourse of the major river Bidyadhari, based on some morphological and environmental indicators, coupled with old maps and local legend. Careful mapping of the main river channel from the satellite images, along with superimposition of earlier courses from Rennel's map of 18th century, SOI topographical maps and other relevant old maps of Kolkata and its surroundings, has been done which provides an idea about the presumed navigable channel adjoining the study area. Sediment samples and shell fragments have been collected from the study area and analysed. Ground truthing includes surveying the surrounding area; delineation of old temples, sacred groves and other perennial plant species; coring of some identified old trees, all of which coupled with cartographic evidences, supports a prospect of early navigable channel of river Bidyadhari.

Keywords: *palaeocourse, tree Coring, presumed navigable channel, local legend*

Abstract Volume

Assessment of tidal creek health of Bengal deltaic region based on water quality indices.

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Abstract

The Bengal delta is a tide dominated region, where tides play an important role in shaping the delta through sediment dispersal process. Due to land conversion from forest to agricultural land, embankments have been built to protect the land from intrusion of salt water to the field. Recently the sea level rises due to climate change make the delta more vulnerable. Also, tidal creeks are way to translocate the polluted effluents from inlands' points and non-points sources to the ocean. The growth of small industries beside the rivers and use of agricultural manure are very much affected to the river health. The Bidyadhari river is working as an effluent drainage system day by day. The present study is carried out the Bidyadhari river from Haroa to Hingalgunj at the meeting point of Bidyadhari and Raimangal. This basin area is used for agricultural purposes and there is small industrial hub and increasing settlements in Haroa, Minakhan and Hasnabad Blocks. Another important thing is the upper part of this river gets a large supply of polluted effluent from the cities and towns of North 24 parganas and Kolkata. Water samples are collected along the river to understand the health of this tidal river. Pollution load in a river not only effect the properties of water but the properties of sediments are also affected. We select some physio-chemical parameters to analysis the water quality of the river those are DO, BOD, COD, pH, Phosphorous, Lead, Copper, Total Dissolved Solid, Total Nitrogen, Sodium, Calcium, Sulphate, Faecal coliform, Salinity. Three tide gauging station at Haroa (Station A), Malancha (Station B) and Dhamakhali (Station C) are selected for tide monitoring to get the data of the tidal range and tidal flow. The fluctuation of physiochemical parameters throughout the year resulted the changing nature of estuarine ecosystem with possible human induced impact. Therefore, assessment of the river health using water quality parameters are significant in this study. On the basis of (a) Ecological Pollution Index, (b) River Pollution Index, (c) Overall Index of Pollution health of Bidyadhari is calculated.

Assessment of Coastal Vulnerability Index of a part of Mandarmani Coast, West Bengal

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Abstract

Coasts face a much higher risk of hazards and hence more vulnerable to natural and anthropogenic forces because of their location in high-energy and rapidly developing environment. Coastal Vulnerability Index (CVI) is one of the simplest and most commonly used methods to assess the natural and anthropogenic forces responsible for increasing the vulnerability of coastal zones to erosion (First used by Gornitz, et.al 1991, model developed by United States of Geological Survey). The Mandarmani coast experiences low wave height (mean deep sea wave height less than 4 m in monsoon conditions) and high tidal range (more than 5 m in spring tide) and has experienced some major storm surges in recent years (cyclones Aamphan and Yaas). There are several artificial structures like hotels, seawalls, bridges etc. constructed by flattening of the natural dunes. These human interferences against natural processes led to the retreat of the high tide line and other related phenomena which increases the vulnerability of the surrounding environment and livelihood. The CVI has been estimated considering the parameters of dune condition, mean grain diameter of sediment, beach slope, nearshore gradient, NSM (net shoreline movement), EPR (endpoint rate) and percentage of area under vegetation and built-up area covers. Based on the assigned weightage of these different parameters the vulnerable zones were marked, categorising the vulnerability zones in to — low, moderate, high and very highly vulnerable areas. The CVI shows marked variation from the western Jaldha sector to the eastern Pichaboni sector of the Mandarmani coast. In this particular coast, the most significant variables in determining CVI are dune width, height and coastal vegetation status. CVI values are found high in the Jaldha sector because of dunes alteration, less vegetation cover and more built-up areas, whereas, the Pichaboni sector shows low to moderate CVI values due to the presence of flat dunes, vegetation cover and being free from built-up coverage. Depending on this procedure, more than 40 per cent of the coast in Mandarmani area is at very high risk, which calls for urgent planning and protective measures.

Identification of Role of Geomorphology on Surface Runoff and Groundwater Storage in Purulia District, West Bengal

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Abstract

Geomorphological landforms effect the surface runoff and groundwater storage. Runoff is excess water that cannot be absorbed. Although the precipitation rate is substantially low in Purulia district of West Bengal but here geological characteristics and landforms assist rainwater to be drained out. This study is done on Purulia district to illustrate the scenario of geomorphology upon runoff and groundwater storage. Another objective is to portray the relationship between runoff and groundwater storage. Daily surface runoff data and daily groundwater storage data of 20 years (1998-2018) has been downloaded from GIOVANNI-Earth DATA-NASA site. The gathered data was put in R-software for the calculation of 12 months standardization for runoff and groundwater storage. Final layout was constructed by placing standardized data into IDW tool of ArcGIS software version 10.4. Geomorphological map of Purulia district was acquired from BHUKOSH/GSI site. "Standardised Runoff Index" revealed that runoff was less in south western and partially in north eastern segment. This phenomenon is because of the presence of dissected hills made up of granite-gneiss hard and phyllite-mica soft rocks which do not permit high degree runoff. In the north-western and eastern parts more runoff was noted because of high slope of plateau specifically from where the Rivers Kangshabati and Kumari flow. Groundwater is influenced by lithology, drainage, soil texture and other physical factors. This region has an issue of groundwater recharge as it is composed of hard rocks. As a consequence, infiltration gets barred by hard surface and groundwater storage is affected by low permeability and porosity. "Standardised Groundwater Storage Index" exhibited that it is high in the eastern part and low in the western part of Purulia district. In the eastern zone many rivers merge to form alluvial plain. As a result, high infiltration through the permeable alluvial track makes high groundwater storage. Another major consequence which came into light was low run off in the west due to steep slope near hard rocked plateau. Here runoff is high and accordingly the ground water storage is low. Whereas, in the east runoff was high largely due to high drainage density and the presence of alluvium. In this high runoff region, groundwater storage was also high. This phenomenon is quite contrary to the generalisation where normally runoff is high, groundwater storage is found to be low.

Keywords: *Standardize Runoff Index, Standardize Groundwater Storage Index*

Insights of Urban Geomorphology and its Relationship with Informal Settlements in Vadodara City

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Abstract

Urban geomorphology is the study of anthropogenic activities as a physical process of change, in which people modify natural landforms and produce an anthropogenic landscape. Due to the resultant overpopulation in cities and lack of enough space, individuals are forced to choose poor housing and unhygienic conditions. As a result, the number of slums is rapidly increasing. This study focuses on the physical morphology and links it with the slums in Vadodara city. The Landsat-5/TM (Dated:20/03/2000 and 12/02/2010 with 30m Spatial-Resolution), Landsat-8/OLI/TIRS (Dated:15/04/2021 with 30m resolution), Satellite data of 2001, 2010 and 2021 periods have been obtained from the USGS, ALOS PALSAR data (Dated 12/04/2007 with 12.5m Spatial-Resolution) for preparation of DEM and for generating various layers like LULC maps, drainage, elevation and anthropogenic features. ArcGIS (10.3) and ERDAS Imagine (16.6.0.2100) applications were applied for getting the output. Slum Development Plan -2018 (Vadodara Municipal Corporation) has been used to gather demographic information, slum demarcation as well as preparation of base map. The ground truthing process has been done with help of Mobile GPS (2.8). Total 336 slum pockets with 2.57 lakh population (20% of total population in 2011) have been found along the banks of Vishwamitry river, Bhukhinala, Vadodara Branch Canal, Ahmedabad-Mumbai railway line and below the over bridges; low elevation area of the southern parts where flash flood generally occurs in rainy season. Most of the slums have developed in the central and northeastern parts of the city. The major slums pockets are identified in ward-2, 3, 4, 5 and 6. The concentration of slums in these wards are directly influenced by the presence of the Vishwamitry river, Bhukhinala, large number of small lakes and water bodies and the railway line. The less development of the slum pockets has been notified in wards-1, 10, 11, 17, 19 and in the periphery of the city. However, under JNNURM, few slum pockets have been demolished and rehabilitated in other parts of the city. To conclude, there is a need for restricting the growth of slums and it is pertinent to integrate slum development plan proposed by Vadodara Municipal Corporation.

Keywords: *Anthropogenic Landscape, Slum, Urbanization, Urban Geomorphology.*

Space-time pattern of surface runoff in coastal watersheds of Tamil Nadu: Implications for coastal hazard management

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Abstract

Assessing surface runoff is key to watershed conservation and hazard management strategies. The present study used the National Resources Conservation Service-Curve Number (NRCS-CN) method to estimate the surface runoff on a watershed scale for the hazard-prone coastal region of Tamil Nadu, India. The entire coastal plain region (~26,000 sq.km) is divided into 38 coastal watersheds with the help of digital elevation models and a toposheet-based 40 m contour. The daily rainfall data (2000-2015) were collected from 38 representative rain-gauge stations and used to assess the surface runoff of the coastal watersheds. The land use/land cover and hydrological soil units of the coastal watersheds were mapped, and hydrological response units (HRU) were delineated. The curve number was assigned for each HRU of the watersheds, and the weighted values arrived for surface runoff estimation. About 200 major rainfall events (>20mm) were considered, and the average surface runoff for each coastal watershed was estimated based on the weighted curve numbers and antecedent moisture conditions (AMC). The results indicate that the Coleroon watershed had the highest rainfall events (345 events) and experienced the highest surface runoff (614 mm), corresponding to 51.3% of annual average rainfall (1147mm). Mann-Kendall statistic-based space-time pattern analysis was used to identify the spatio-temporal trends in the surface runoff. The analysis found that the coastal watersheds of Pulicat, Vellar and Coleroon are under sporadic hotspots and Cooum and Adyar watersheds are under oscillating hot spots with a strong statistical significance (>90%). The results of surface runoff are also compared with the flood susceptibility in the study area, and found that the watersheds that fall under hots spots also have higher flood susceptibility. As these watersheds experienced severe flooding in the recent past at many locations, the surface runoff potential and its pattern identified by this study can be used effectively to understand the hydrologic nature of each watershed and implement appropriate strategies for coastal hazard management in the coastal plains of Tamil Nadu.

Keywords: *Surface Runoff, Curve Number, Coastal Hazard, Watershed, Flood Management*

Geomorphic Processes and Landforms in the Indus Valley between Hemiya to Khalsi, Leh District, Ladakh, India.

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Abstract

All topographic features that have emerged on the surface of the earth are influenced by both external and internal processes. In the present study, an attempt has been made to identify and understand the various geomorphic processes and their resultant landform operating in the study region. The study also deals to understand the anthropogenic influence on the processes and landforms of the study area. Extensive Field survey supported with satellite data and Digital Elevation Model (DEM) has been taken to analyze, identify, and map the study area for better identifications of landforms. From the field observations, spatio-temporal study of satellite data, Google earth images it is very well understood that the processes operating in the study area intensified due to anthropogenic influence. Alluvial fans, river terraces, river bank deposits, alluvial plain, hill slopes have been highly altered and lost their natural entity.

GIS-based delineation of potential recharge zones of groundwater and its validation with actual recharge in the Nangasai River Basin of Eastern India

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Abstract

Groundwater is one of the most significant natural resources. However, due to continuous use and over-exploitation of groundwater this resource is under continuous threat of depletion. Under such circumstances, it is imperative to detect the possible recharge zones for assessing the groundwater scenario of the region. Identification of groundwater recharge zones is predominantly index-based and is dependent on multiple parameters which, more or less, act in tandem. This has called for the application of multi-criteria decision-making techniques (MCDMs) in this domain. The present paper is therefore, an application of the Entropy-based MCDM for assessing the potentiality of groundwater recharge in the Nangasai River Basin of Eastern India. This included an integration of physiographic (relative relief, slope), drainage (drainage density, stream frequency), land use (NDVI, NDBI) and structural (lineament density) factors which influence groundwater recharge to some extent. The results of groundwater recharge potential were extracted with respect to sub-basin and village level. The model was tested with respect to its validity as the results were compared with the Central Groundwater Board (CGWB) derived actual recharge. The validity came out to be only 0.47 (47%), which was moderate. So, we looked for other factors such as potential evapotranspiration and population. Although the ROC Curve yielded unsatisfactory results (33% validation) with potential evapotranspiration, the results were more favourable with respect to population (46% validation). Also, the spatial pattern of the actual recharge, more or less, coincided with the population pattern. This study, therefore, concludes that along with the physical factors, the draft and usage of groundwater plays an important role in groundwater recharge. Also, the villages in the southern part of the basin are characterized by very low recharge, in spite of considerable potentiality of recharge. So, proper planning and construction of artificial recharge structures is the need of the hour.

Keywords: *Groundwater recharge potential, Entropy; ROC Curve; False Positive; Nangasai*

Variability in snow cover area and its association with hydrometeorological parameters over Parvati River basin, India using MODIS & MEERA-2 satellite data during 2001-2017.

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Abstract

The Parvati River basin situated in the Western West-Central Himalaya Mountain ranges, it is the major tributary of Beas River in Himachal Pradesh, India. Snow cover dynamics in Mountainous regions is a vital input for energy Balance, glacier mass balance, climate change and hydrological behaviour of the river. Satellite based remote sensing is a convenient tool for the study of cryosphere that allows to carry out investigations over large and inaccessible areas. The present investigation has been carried out to monitor variability in the Snow Cover Area (SCA) for the Parvati basin. This analysis has been done using MODIS & MEERA-2 satellite data for the past 17 years (2001– 2017); the temporal snow cover being derived using the Normalized Difference Snow Index (NDSI). Results are as follows: (1) The snow cover areal extent had increased over Parvati basin due to Snowfall increased over the period of time. (2) The seasonal analysis reveals that the Maximum coefficient of variation in SCA has been observed in the post-monsoon season (24%) and minimum in the winter season (4%). (3) A statistically significant decreasing trend of SCA during monsoon season due to a significant increasing trend observed in snowfall and temperature during the monsoon season. (4) The ablation of SCA is more constant than accumulation of SCA in the Parvati basin. This has harmful effect on the cryosphere of Parvati basin. (5) The mean annual SCA trend has been shows a significant increasing tendency in Zone III with the higher variability due to the offset effect of the significant increase trend in snowfall during the study period. (6) SCA has been observed a strong negative relationship with temperature in zones IV and V during the monsoon season. The regions more prone to snow-related disaster in western-central Himalayas becoming key zone of snow-cover monitoring and disaster prevention and mitigation.

Keywords: *Snow Cover, Elevation zones, Ablation, Accumulation, Modis, Meera-2, NDSI, western and west-central Himalaya.*

Spatio-temporal analysis of groundwater levels using GIS techniques in Jammu District, Jammu & Kashmir, India

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Abstract

Admittance to hydrological resources is one of the foremost challenges being faced globally. Water paucity, chiefly groundwater resource, is the foremost pervasive concern for the country. Groundwater resources are used to meet out drinking water supply, irrigational practices and industrial application. Owing to population growth and insensate urbanization, groundwater resources are often overexploited leading to swift declination in the groundwater level, however ground water sustainability necessitates an enhanced understanding of ground water systems for the accurate prediction of ground water levels. Groundwater level changes and its trends were assessed spatially and temporally for both pre and post-monsoon seasons in North western Himalayan District of Jammu. Pre-Monsoon and Post-Monsoon data for 26 years (1994-2020) was collected from Central Ground Water Board, Jammu. Long-term variations of seasonal groundwater level were examined using the statistical approaches, viz., Mann–Kendall test, Sen's slope estimator and linear regression method. After the detailed analysis, it was observed that the average depth to water level during pre-monsoon season ranges from 7.08 to 9.77 m, whereas in post-monsoon season, the average depth to water level ranges from 5.58 to 7.38 m. The mean of water level fluctuations during pre and post-monsoon seasons was found to be -2.32 and -1.45 m, respectively. The analysis of the results showed mostly decreasing trends in the time series of the study area. Slopes obtained by Sen's estimator varied from -0.06 to 0.76 m/year for pre-monsoon and -0.07 to 0.22 m/year for post-monsoon season. From the linear regression method, minimum and maximum declining rate of -0.81 and -0.09 m/year for Pre-monsoon and 0.21 to -0.08 for post-monsoon season was obtained. Comparison of the statistical tests indicated that the significant trends detected by the Mann–Kendall test and Sen's slope estimator were more or less confirmed by the linear regression method. This lowering of groundwater level may affect most of the water-dependent activities and thus need of the hour is that the groundwater resources within the study area should be managed judiciously in coming times. The outcome of this study emphasized apprehensions about the sustainability of groundwater resources in the study area.

Flood and River Bank Vulnerabilities: Survival fight by people of Rohmoria, Dibrugarh, Assam

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Abstract

Among the various human vulnerabilities created by nature on the earth surface, the ones caused by floods and river bank erosion are most common and quite substantially problematic in nature if they are with high intensity. Rohmoria located in the upper reaches of the Brahmaputra river in the district of Dibrugrah in Assam, is severely affected by flood and river bank erosion since many decades. Rohmoria area has the highest rate of bank erosion in the south bank of the Brahmaputra among the other worst erosion affected areas of Assam. Bank erosion per unit length of the river Brahmaputra at Rohmoria is nearly 0.069 sq.km. per year. The rate of erosion at Rohmoria became more intense after the great earthquake of Assam, 1950. More than 9,000 hectares of land were eroded since 1950. Erosion has threatened to wipe out Rohmoria mauza under Lahowal Assembly constituency from Assam's geographical map. More than two thirds of land area of Rohmoria has been eroded by the Brahmaputra. In 1915, the land area of the Rohmoria mouza was 236.54 sq.km.; which was reduced to 163.53 sq.km. and 74.57 sq.km. in 1975 and 2005 respectively. It is evident from the fact that the width of the Brahmaputra has been widened by 7.22 km in 1966 to 16.20 km in 1996 in just 30 years. And from 1996 to 2007, about 12 km of land area has been eroded. Already 30 revenue villages, 4 big tea estates, more than 50 small tea gardens and one sericulture farm have been swept away due to river bank erosion at Rohmoria. More than 15,000 people were displaced till date. This paper is an attempt to focus the dreadful plight of the flood and erosion prone Rohmoria. The paper also tries to examine how source of livelihood and occupational pattern of affected people are changed after they are displaced or affected by flood and erosion hazard in the study area and how such hazard changed their mode of living. The proposed study will be historical and analytical. An impact assessment study will be done to analyze the impact and vulnerabilities of flood and river bank erosion on the dwellers of Rohmoria by considering the socio-economic attributes. The study will mainly rely on the collection of primary data and some statistics from government sources.

Keywords: *Flood, River Bank Erosion, Vulnerabilities, Resettlement*

Prospecting of primary diamond sources using Remote Sensing techniques: insights on tracing the mantle sources of the Koh-I-Noor and other Golkonda Diamonds

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Abstract

Diamonds are the Earth's mantle-derived phases formed under high pressure and temperature environments and brought to the surface by the kimberlite and lamproite rocks. Koh-I-Noor and other world-famous diamonds such as Hope, Orloff, Great Mogul, Nizam, and Pitt, well-known in the industry as 'Golkonda Diamonds', are very well recognized for their highest purity. These renowned Golkonda diamonds were recovered as placers from the mines present on the banks of the Krishna River in South India. However, their principal source rocks (either kimberlites or lamproites) still remain unknown. Correctly identifying the primary rocks of such significant 'Golkonda diamonds' is crucial in terms of finding their sources, for understanding their deep mantle origin, nature, and timing of magmatism carrying those diamonds, and from economic and geoscientific perspectives. A multidisciplinary approach incorporating geochemical, geological, and GIS (remote sensing) studies were employed to locate the probable primary sources of these renowned diamonds and their placer deposits. Compositions of kimberlite indicator minerals (KIMs) and whole-rock trace elements were used to find the diamond potential of the known primary source rocks, from the Eastern Dharwar Craton, Southern India. Among southern India's two significant kimberlite fields, garnet, clinopyroxene, spinel, and ilmenite compositions of the Wajrakarur and Narayanpet kimberlite fields (WKF and NKF) were studied for their diamond potential and preservation. It indicates the presence of strong diamondiferous mantle roots and ultimate diamond preservation potential only for the kimberlites of WKF. Wajrakarur field is located in the Anantapur district of Andhra Pradesh and about 250-300 km away from the placer locations of the Golkonda diamonds. Therefore, it is important to know the transport mechanism of the diamonds and their dispersal as placers in the Krishna River alluvium. Remote sensing imageries and GIS tools helped us to understand the significance of the drainage pattern of rivers that influenced the deposition of placers and the dispersal of diamonds. Landsat optical imagery, LISS III, and NDVSI false colour composite were employed to calculate moisture content and vegetation index. It helped to locate the ancient paleo-channel which shows a north-easterly flowing course in the past that connects Penner to the Tungabhadra River (a tributary of Krishna). This paleo-channel provides an exact path of diamond transport which is responsible for the transportation of diamonds from their Mesoproterozoic source rocks at Wajrakarur up to the final site of recovery, i.e., Kolluru and other mines situated on the banks of the Krishna River.

Flash flood risk zonation in the Little Rangit river basin of Darjeeling Himalayas using GIS-based multi-criteria decision analysis and the Analytical Hierarchy Process

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Abstract

Flash floods are short-term extreme natural events that typically occur suddenly, with little warning for downstream communities, and are a major cause of death due to flooding worldwide. As a young and tectonically active mountain belt, the Himalayan Mountain system is vulnerable to natural disasters such as landslides, floods/flash floods, and earthquakes. Little Rangit is a right bank tributary of the Rangit River that joins the main stream near Jorethang, Sikkim. Lying almost entirely in the Siwalik Hills, Little Rangit Basin (LRB) is prone to flash floods and landslides. Past records suggest that, as a result of intense rainfall in the Darjeeling Himalayas, this basin experienced excessive flash floods from 2nd to 5th October 1968. Furthermore, as recently as 2021, heavy rainfall caused the river to overflow in the concerned localities. The purpose of this research is to identify the flash flood risk prone areas of the LRB using remote sensing (RS) and geographical information system (GIS) approaches. Six flash flood conditioning factors obtained from various sources, namely rainfall intensity, slope, land use land cover, profile curvature, distance from river and drainage density, have been integrated in a GIS environment. These layers were then integrated into ArcGIS based on the weightages determined by the Analytical Hierarchy Process (AHP). The result of this study shows that, areas with moderate risk account for the greatest proportion (28%), followed by high (24%), low (23%), very high (15%), and very low (10%) zones. Furthermore, the majority of the moderate, high and very high-risk prone areas are concentrated in the central and south western part of the LRB, while the areas with low to very low risk zones are located in the east and north. The towns of Bijanbari and Pulbazar, where a devastating flash flood occurred in 1968, fall within the high-risk zones, confirming the findings of this study. Because Bijanbari and Pulbazar are important regional centers, special attention must be paid towards mitigating the flash flood risk in these areas, failing which significant economic and human losses may occur. The methodology used in this study can also be beneficial to map flash flood risk zones in other river basins or administrative regions in a mountainous setup.

Abstract Volume

A Systematic Review on Occurrence, Spatial Distribution, Approaches and Methods Used for Analysis of Microplastics in Estuarine Environment

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Abstract

An estuary is an important geomorphic landform that acts as a natural filter where the sediments, nutrients, and other pollutants carried by the river from the upland are being deposited. In recent decades, the increased disposal of non-decaying single-use plastics has led to severe plastic pollution, particularly in the estuarine environment. The larger particles of the plastics break down into smaller plastic particles over a period of time. The plastic particles less than five millimetres in size are called microplastics, and they are becoming part of the Earth's fossil record in our current Anthropocene era. So far, proper methods for the disposal and effective management of plastic waste are not materialised. Most untreated plastic wastes end up in rivers and subsequently reach estuaries and oceans. This activity has even given a new marine microbial habitat called the "plastisphere". The origin, fate, and typical residence time of microplastics in estuaries remain poorly understood, and still, it is not clear whether estuaries function as net sources or sinks of plastic litter. In this review, we have made a detailed study on the global status of microplastic pollution research in estuaries. Using the keywords "Microplastics OR Microplastic AND estuaries OR estuary", 460 articles were collected from the Scopus database and analysed for this review. The awareness of microplastic pollution in estuaries started at the beginning of this decade. However, the scientific attempts to analyse microplastics in this ecologically sensitive region have been increasing only in the last few years. For instance, from 2010 until 2017, only 53 research papers were published related to microplastic pollution in estuaries, and the majority of works were published in 2021-2022. Globally, China produced the largest number of research papers on microplastic pollution in estuaries, followed by the United States and the United Kingdom. Most of those studies deal with the occurrence and distribution of microplastics in estuaries, and around 40% of study focuses on environmental aspects of estuaries. We found that the estuaries of the world's most polluted rivers remain unexplored for microplastic research. Though estuaries are ecological niche zone, studies on exploring the source, cause, and effects of microplastics in estuaries are minimal. In India, studies on microplastic pollution in estuaries are in the infancy stage, and there is a lack of a multi-disciplinary approach. In this study, we have reviewed and documented all the impactful works on occurrence, spatial distribution, approaches and methods used to analyse microplastics in estuarine environments for comprehensive scientific understanding and promoting studies in all major estuaries of India.

Keywords: *Estuaries, Pollution, Microplastic, Anthropogeomorphology, Environmental management*

Abstract Volume

Investigating the Characteristics of Quaternary Beach Rock and its Implication on the Geomorphic Evolution of a Mesotidal Bay — A Case Study of Shrivardhan, North Konkan Coast, India.

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Abstract

The Holocene sea level was 1–4 m higher than the present sea level between 4000 and 1000 year BP (Mathur et al., 2004). The Holocene transgression reached a maximum level between 2200 and 2600 years BP and left evidences of fossil beach ridges about 2 m above the high tide line along the Konkan coast (Bruckner, 1987). All along the Konkan Coast, fossilized beaches back the present-day beach-dune complex. These formations are the only consolidated records of the depositional environment in the immediate past. Shrivardhan, a meso-tidal bay, is partially cut off from the sea with the development of a bay mouth spit, giving the bay a pseudo-lagoonal appearance (Chaudhuri, 2003). The area is also characterised by a central island within the bay. Exposures of beach rock have been observed in well sections adjoining the northern headland and in the island. The beach rocks here are grain dominated and fossiliferous. The grains of the samples are poorly micritized. Peloids are present but not abundant. The signatures of silicification are present in some of the samples. Algal fragments are frequently present, along with mineral grains and rock fragments. The samples adjoining the northern headland have coarse, poorly sorted grains cemented by sparry calcite, signifying meteoric phreatic diagenetic environment. The cement shows abundant evidences of neomorphism. The samples from the island are different from the rest owing to the presence of aragonite and high Mg calcite as their cementing material. The grain size and sorting characteristics, together with the seaward dipping parallel bedding, indicate deposition in the high energy condition of the intertidal and subtidal zone — probably in a beach environment. The percentage of cement is quite high (around 10-15%). The nature of the cement shows two main diagenetic scenarios. In the island samples, the presence of aragonite and high-Mg calcite forming isopachous rim around bioclasts and lithic fragments indicate an initial stage of marine diagenesis, which took place in the marine phreatic zone. In the island samples unaltered aragonite and high-Mg calcite crystals are still preserved. This implies that signatures of marine influence are still persistent and fresh water diagenesis has not yet been able to wipe off all evidences of early marine diagenesis. The geomorphic evolution of Shrivardhan from a mesotidal bay to a lagoonal setting and the growth of the bay-mouth spit from north to south can be correlated with this transition from marine to freshwater diagenetic realm.

MORPHOMETRIC ANALYSIS OF SHYOK RIVER, LADAKH.

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Abstract

The Trans Himalayas is dominantly governed by the presence of major active faults mainly Karakoram Fault in the Union Territory of Ladakh. The alignment of the faults and the lithological control is, in general, responsible for the drainage pattern in the Shyok river which forms the main river of this region. It originates from the Rimo glacier, which is one of the tongues of the Siachin glacier and takes a sharp turn downstream further resulting in parallel flow to its original watercourse. The present study involves the morphometric analysis of the Shyok river demonstrating the quantitative representation through stream order, stream density, longitudinal profile, hypsometric curve, sinuosity and swath profile using the topotoolbox and geomorphic toolbox. The morphometry is performed on SRTM 30 m Digital Elevation Model (DEM). The hypsometric integral and curve of main trunk of stream is convex up with high value (0.65) indicating the active tectonic regime and active uplifting topography. The transition of sinuosity value of channel from 1.2 to 1.9 at bend is interesting as it immediately switches to meandering from sinuous pattern. Moreover, the development of prominent trellis drainage pattern represents the folding or tilting of lithology accompanied by varying degree of erosion depending on its resistance to hard or soft rocks present parallel to each other at this turn. The swath profile of 500 m, 1 km, 2 km adjacent to the longitudinal profile is also calculated to get a distinct insight of the tectonic activity in the region. The profile presents prominent high valley walls or topographic highs at 4200 m and 6000 m which suggest high incision activity or neo-tectonic upliftment in this region. And at around 5000 m, low topography on both sides is probably indicative of wide U-shaped glacial valley. The changes in the morphology of the channel are certainly controlled by the geological and structural characteristics of the area.

Controls on the Rate of Mat Grazing by Coastal Crab Population in Sagar Island, Hugli Estuary.

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Abstract

Onshore bioturbation by mat-grazing crab populations (Ociopoda,Dottila) of the southern beaches of Sagar Island, Hugli Estuary, are characteristically patchy in their distribution. Intensity of bioturbation, as measured from net bioturbated product (abundances of feeding pellets) and percent area bioturbation vary in the bioturbated patches. Primary controls on net (quantitative) bioturbation and rate of bioturbation appears to be the time available for feeding between the tides and the feeding efficiency of the participating crab populations. A number of other local factors like tidal height, sediment texture and distance between dwelling and feeding zones, particularly for the larger crabs, appear to play subtle role that influence the selection of feeding sites. Optimality of several conditions rather than the influence of any particular factor determines the quantitative aspects of bioturbation by crab grazers in the study area.

Quantitative Analysis of the Dhansiri–North River Basin, Bhutan, Arunachal Pradesh and Assam

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Abstract

A river maintains a state of dynamic equilibrium; any alteration in one of its controlling factors leads to changes in the others to re-establish the equilibrium. The fluvial landscape arises out of combined effects of lithology, climate, and tectonics and is quite sensitive to their changes. A river basin may indicate active tectonic movements more precisely than the best space-based geodetic techniques. Its morphometric analyses with the help of DEM and GIS often provide insights into the tectonic history of an area. The 2404-km2Dhansiri–North basin (26°29'11"–27°18'30" N, 91°47'15"–92°27'45"E) lies on the north bank of the Brahmaputra and on the northern part of the Kopili fault, which is tectonically active at different times. This paper analyses the impact of geological and geomorphological processes on drainage pattern development in the basin based on various morphometric parameters of linear (stream order, stream number, length of stream channels, bifurcation ratio), areal (basin area, basin length, basin width, basin configuration including form factor, circularity ratio, basin elongation ratio, drainage density, stream frequency, length of overland flow) and relief (basin relief, relief ratio, relative relief, ruggedness number, stream channel slope, maximum valley side slope) aspects. The Dhansiri–North is a sixth-order basin characterised by dendritic drainage pattern. The bifurcation ratio reveals low structural control. The morphometric parameters derived from the basin imply that this elongated basin has various imprints of geological complexity that reveal the intensity of tectonic activity in the area.

Keywords: *Morphometric parameters, tectonics, Dhansiri–North river basin*

Spatio-Temporal Changes of River Bank Erosion and its Impact on Land-Cover Changes of Morigaon District, Assam

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Abstract

The state Assam in North East India is the most affected and hazard prone regions in terms of natural calamities and disasters like floods, earthquakes and landslides. The geographical factors like location, underlying geological structures, relief induces such natural calamities. River bank erosion, a natural phenomenon, is the wearing away of the banks of a stream or river. It is a very dynamic process occurring rapidly for a short residence in the times of flood and post flood occurrence, resulting in the river meandering and modifications in its course. Morigaon district is located on the south bank of the River Brahmaputra is constantly facing the problem of bank erosion. Every year the bank line gets eroded thereby washing away the fertile land area and pose a serious threat to settlement. In order to study the vulnerable areas subjected to bank erosion, satellite data of different time intervals for 2000 and 2020 have been analyzed using Remote Sensing and GIS. Land use Land cover map have also been prepared for the two years using Supervised Classification Techniques showing the channel shifting. The result indicates that the river has widened in the northern part and is continuously shifting its course towards south ruining a large number of villages making people homeless.

Keywords: *River Bank Erosion, Land Cover changes, Brahmaputra River*

Abstract Volume

River Bank Erosion and Channel Shifting of the Jiadhal River in the Dhemaji district of Assam, India

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Abstract

Every year bank erosion and shifting of channels create severe problems for the people of the floodplain areas and is considered a disastrous phenomenon all over the world. Due to its large-scale impact, many people are left homeless. Bank erosion, sediment deposition and channel shifting are considered the main characteristics of the Jiadhal River in the district of Dhemaji, Assam. This river frequently changes its course and leaves the people of that area in jeopardy. A study on bank erosion and channel shifting on the river Jiadhal was carried out using satellite images for the years 1973, 1987, 1997, 2007 and 2017. This paper also assesses how the shape, size and position of the river have changed from 1973 to 2017 using remote sensing and GIS. The outcome of the study indicates that the area in the upper catchment is under an active erosional process, whereas in the lower reach of the river heavy depositional process are prominent that raises the bed of the river. The study also shows that the shifting of the channels is due to both bank erosion and point bar deposition.

Keywords: *Bank Erosion, Channel Shifting, Jiadhal River.*

Evaluation of physico-chemical conditions of Vettar estuary: Implications for environmental management

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Abstract

Estuaries are transient and act as a filter between the river and the ocean water. Deterioration of this ecotone region intensifies diversity loss, environmental degradation, and human health. The water quality of estuaries has greater stress from the pollutant input from various anthropogenic sources, and vigilance is necessary. Cauvery river is the fourth largest in peninsular India and has a delicate prograding delta. Out of many distributaries in the delta, the study specially focuses on the micro-tidal estuary of the Vettar river. Twenty surface water samples were collected on the 8th of April, 10 km upstream from the confluence. Physical and chemical parameters were analysed to understand the water chemistry, hydro-chemical process, and environmental degradation in the estuarine environment. Methods including Schoeller plot, Piper plot, Gibbs diagram, saturation indices, Principal Component Analysis (PCA), and correlation matrix were used to analyse the hydrochemical characteristics. The spatial variability maps were created using the spline interpolation method to demarcate sensitive regions. For environmental degradation assessment, pollution index (PI) and land use and land cover (LULC) maps were generated and evaluated. The results showed that, the order of concentration(mg/l) of major cations (Na+ > Ca2+ > Mg2+ > K+) and anions (Cl- > SO4-2 > HCO3- > CO3- > NO3- > F-) and the Piper graphs demonstrated the dominance of alkali earths over alkaline (Na + K > Ca + Mg), and strong acidic anions exceed weak acidic anions (i.e., Cl + SO4 > HCO3). Gibbs diagram shows the dominance of evaporation over atmospheric precipitation which is typical of the arid region. Thirteen hydrochemical variables were subjected to PCA, PC1 component is loaded with TDS, EC, salinity, Na+, K+, Ca2+, and Cl- which explains 58% of the variance. TDS, EC, and salinity displayed similar spatial variability; the rest all the other parameters showed irregular spatial distribution. PI was calculated and the values range between 9 - 25, with an average of 16, with respect to WHO standards, considered as very highly unsuitable for domestic purposes. And these values resonate with the LULC map and field observation, the quality of water in the lower reaches of the estuary is more deteriorated due to significant anthropogenic influence, especially due to unregulated solid waste disposal sites. The present study forms the baseline data to understand the physicochemical condition of the Vettar river estuary and the results could be useful for effective environmental management.

Anthropogenic Impacts on the Water Resources of the Indian Sundarban Region

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Abstract

The Indian Sundarban Region, situated in the southernmost part of the Ganga-Brahmaputra-Meghna Delta region is a very fragile network of tidal channels experiencing neo-tectonic geological dynamicity, ecological and social diversities, and climatic constraints. Due to global warming induced climate change, the region has been frequented by intense geo-climatic hazards. In this estuarine environment, even though, water is found in abundance, the freshwater resource is significantly scarce, more so inadequate for human demands. Hence this paper delves into the issues of over exploitation of water for agricultural, homestead, tourism and other uses that has taken a heavy toll on its availability and equitable distribution. The study estimates the local annual water budget with reference to both surface and sub-surface water availability and quality. The data source consists mostly of published reports and literatures along with primary data collected from interviews and questionnaire surveys from selected households. The water footprint (WF) multidimensional indicator, showing water consumption volumes by source and sectorial demands is used to assess the challenges in water resources faced by the consumers in this region. Availability of sweet water in the deeper aquifers, to the tune of more than 300m below ground level, on the average, is not only costly for installation of deep tubewells, but also availability of groundwater may not be sustainable due to low recharge rate and presence of saline water pockets at shallower aquifers. The moribund nature of the rivers and channels coming from the northern parts, due to lack of freshwater supply, has aggravated the situation and therefore almost all the channels, in between the Malta and the Hugli are fast decaying. The overall situation has led to a scenario where the entire Sundarban region is heading towards severe water crisis in the near future, due to the shortage of drinking water as witnessed in several pockets of the region. The thriving water business is already in vogue, where water has become a profitable commodity to create sharp division among the people in terms of access to potable water as per their economic status. Thus, not only the hydro-geomorphic character of water resources is of concern in this part of the country, but also the anthropogenic influencers that needs to be highlighted for the ecological sustenance of the habitations in the Indian Sundarban Region.

Keywords: *water crisis, water footprint, sectorial demand*

Topography and its impact on water resources in Longding District, Arunachal Pradesh

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Abstract

The state of Arunachal Pradesh is endowed with abundant water resources. The water resources of an area are directly impacted by the topographic attributes. Topography is an important variable of erosion. The steepness and length of the slope determine the surface runoff and surface area for water collection. A clear understanding of the impact of topography on the water resource of an area is necessary for proper management of the available water resource. This study is aimed to assess the topographic characteristics of Longding District and its influence on the water resources. The topographic positioning index (TPI) has been used to measure topographic slope positions and to automate landform classification. Stream order, its flow length, accumulation, and flow direction maps have been prepared using DEM. The study shows that topography has a direct impact on the distribution of water resources. The steepness of the slope controlled the surface runoff and soil moisture of the study area.

Keywords: *Topography, Topographic Positioning Index, Digital Elevation Model*

Abstract Volume

The Tidal Flat Ecosystem of the Estuarine Coast in the Lower Ganga Delta under stress: A review

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Abstract

Tidal flats of the estuarine coasts are classified as supratidal flats, inland flats, intertidal flats, and subtidal flats under the complex systems of tidal ranges, sediment accumulation rates, location, and energy conditions that vary in the lower Ganga delta. The current study depicts the various effects of coastal hazard on tidal flats caused by extreme weather and sea level rise. Restoration of the natural ecosystem of the tidal flats will ensure coastal resilience and provide opportunities for essential ecosystem services on the estuarine coasts of the Indian Sundarban. The tidal flat wet land ecosystem of the region is vegetated by mangroves, saltmarshes, and other sedge plants under a setup of complex natural dynamics of sediment accumulation, erosion, tidal inundations, and the impact of marine hazards in the region. The activities of tidal bores into the estuaries, tidal surges along the island fringes, and the impact of storm surges across the shorelines under extreme weather conditions affect the ecosystem services. The present study also considers how human interventions have created disturbances to the natural processes to enhance or accelerate the achievement of natural coastal defence. The present study was conducted in the estuarine fringes of the Indian Sundarban, where the tidal flats have been affected by various hazards in the last few decades. Landsat 8 OLI and Cartosat 2A DEM are used to classify the tidal flats in the region. The impacts of hazards are recorded on the shoreline, along the tidal channel banks, island interiors, and estuary fringes of the region of southwestern Sundarban. The areas of intertidal mudflats are significantly reduced on the seaward side due to the presence of external forces. However, they have increased on the estuary fringes along the sheltered location, particularly in the inner reaches. The tidal flats are also schematically plotted to identify the different coastal environments of the lower Ganga delta with varying sediment input and wave exposure.

Keywords: *Tidal flats, Tidal bores, Ecosystem services, Extreme weather conditions*

Monitoring the spatio-temporal changes of hypersaline blanks using spectral indices with the application of statistical modelling and geospatial techniques: A case study in the coastal fragile parts of Dhanchi Island (L-Block), West Bengal

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Abstract

A large tract of hypersaline tract and salt pan has been developed and expanded in the southwestern parts of Sundarban in the low-lying coastal part of the inner island. The study also highlights the precarious future of the alluvium deltaic parts due to the decrease in health condition of shore fringes and levee margin mangrove swamps in a few areas and the expansion of the hypersaline tracts of the lower part of the L-Block (Dhanchi Island) under the impacts of the global climate change phenomenon, salt water inundation due to high surges or high magnitude cyclonic impact, and human encroachments into the coastal system. The shoreline erosion and bank failures of the forest-covered islands and hypersalinity in the islands' interiors were responsible for the loss of mangrove forests in the previous decades in the Indian Sundarban. The supervised image enhancement filtering techniques were used to extract the hypersaline patches in 2000, 2010 and 2020, respectively. The maximum hypersaline patches were expanded due to the impacts of high magnitude cyclonic landfall. The present study recoded the areas of expansion of the hypersaline patches in 2000 (5.29 km2), 2010 (6.32 km2), and 2020 (6.98 km2). The Mann-Kendall Test with Sen's slope and the Pearson correlation coefficient model were used to justify the relationship and trend of the decadal changes in hypersaline patches and promote the sensitivity indices in the interior parts of the island. The high-sensitive zone is defined in the interior parts of the north-western to southwestern parts of the island, and the shore fringe bank line also indicates a low-sensitive region. The NDVI, NDMI, and NDSI spectral indices are used to investigate the healthier condition of mangrove species in the fringe area and some interior parts of the island, and the multivariate linear regression model is used to determine the strength of the relationship, whether positive or negative, as well as the interior physical condition of the island system. Such hypersalinity will increase in the region with the reduction of fresh water input and sediment discharges into the lower part of the Ganga delta in the Indian Sundarban, and the growth may be enhanced due to the process of sea level rise in the near future.

Keywords: *Hypersaline patches, Supervised image enhancement filtering techniques, Climate change phenomenon, Low-sensitive region*

Abstract Volume

Mapping of Moraine Dammed Lakes of Sikkim and Bhutan Using Satellite Data

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Abstract

A glacial lake is a vast reserve of water in, on or near a glacier formed by glacial processes. Glacier retreat and down wasting, particularly of debris-covered glaciers, leads to the formation of moraine-dammed glacial lakes. Apart from the recent impacts of global warming, the majority of these glacial lakes are formed by unstable moraines damming them. This damming can occasionally result in dam collapse, which can be caused by a variety of factors. The present study thus initiates the appropriate mapping and identification of Moraine Dammed Lakes (MDL) through satellite images for further investigation and prediction of Glacier Lake Outburst Floods (GLOF) beforehand. For onscreen interpretation and mapping of the MDL's Geocoded IRS LISS III data and high-quality cloud-free images with reduced snow cover i.e. IRS AWiFS data (July – September, 2004 – 2007) were employed. The Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) with a spatial resolution of 30 metres were used to derive the elevation of the lakes along with the lake volume and lake depth. The mapping of the MDL's was done for Sikkim and Bhutan glaciers using the image interpretation keys like tone, location, shadow, size and association using the satellite images. The width and length of the lakes were calculated in the ARCGIS (version 10.0) environment. Sikkim and Bhutan both had three MDL's each occupying an area of 3.77 square kilometre and approximately 7.91 square kilometre area respectively. The largest MDL in Sikkim was of 1.70 square kilometre which also had the highest elevation (5290 metres) in comparison to the other 2 glacier lakes. This MDL was oriented in the NE direction. Whereas for Bhutan, glacier with an extent of about 23.30 square kilometre fed the largest moraine dammed lake with an area of 5.41 square kilometre. It had an elevation of 5096 metres and this glacier lake is oriented towards the North. Out of the three MDL's of Bhutan, this lake holds the largest volume of water (1.26 metre3). This information combined with other layers like slope, elevation, curvature, valley type etc. can help us in the delineating the Hazard Zones of MDL's which may benefit in alarming the population residing in the downstream areas in case of any GLOF event.

Keywords: *Moraine Dammed Lake, Glacier Lake Outburst Floods, Satellite Images*

Abstract Volume

Machine learning based algorithms for mapping mangrove cover changes in Mumbai region using Google Earth Engine

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Abstract

Mangrove mapping is considered one of the important aspects of management and monitoring of the Mangroves as they are very important for protecting the areas along the coastal region from winds and currents. Mangroves have a unique habitat consisting of various marine and land organisms which are indigenous to that region and play a key role in maintaining the balance in the ecosystem. Mangrove mapping is difficult to be done because it is located in inaccessible areas. One of the approaches which are followed is Google Earth Engine (GEE). It mainly supports the cloud-based image classifications which make the implementation of machine learning algorithms. Google Earth Engine is a geospatial analytic tool in the cloud that allows users to visualize and analyze satellite photos of our world and includes a series of cutting-edge classifiers for pixel-based classification that can be utilized for mangrove mapping. This study aims to compare the accuracy assessment of the three machine learning classifiers available in Google Earth Engine i.e., Support Vector Machine (SVM), Random Forest (RF), and Classification and regression trees (CART) for mangrove and non-mangrove objects. We used Sentinel 2 scene over the Creeks along the coast of Maharashtra as the main study area acquired from January to March of the years 2018 and 2022. There are three machine learning algorithms used in this study; support vector machine (SVM), random forest (RF), and classification and regression trees (CART). All three algorithms will be tested for suitability and accuracy for mapping mangrove vegetation. The limitation of the study using these three methods is that the parameters used are the default parameters available in GEE. All classifiers in GEE used these training areas to classify the image into specified land cover classes. The classification results demonstrate that all classifiers found mangrove items. The map results were compared to the visually interpreted mangrove map of the research area as references to assess the correctness of the map produced. In this comparison, we discovered that RF greatly exceeded the classification results of CART and SVM. This work demonstrates the capabilities of GEE for mapping mangrove extent.

Keywords: *Google Earth Engine, Machine Learning Algorithms, Mangroves*

Spatio-temporal variation in streamflow and sediment trends in the Krishna River basin, India.

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Abstract

Many rivers around the world have witnessed dramatic changes in hydrology and sediment flux as a result of climate change and anthropogenic activities. Our study aims to investigate the long-term changes in water and sediment discharge in the Krishna basin. We examined time series data of 20 gauging stations for streamflow and 10 gauging stations for sediment discharge to evaluate the trends during the course of 1965-2015. The temporal trends, abrupt change points, and variabilities in the basin for sediment and water discharge were evaluated and assessed through Mann-Kendall non-parametric test, Sen's slope, and Pettit test. The analysis documents the significant decline in most of the stations for sediment discharge with an abrupt downward shift in the mid-1980s and early 1990s. The decreasing trend in sediment load matches quite well with the pronounced decline in the water discharge after 1983. Long-term rainfall and cumulative storage capacity of dams were evaluated in order to understand the complex interrelationship and impact of climatic and anthropogenic activities. Rainfall trends in most of the sub-basins showed an insignificant increase and very slight change basin-wide although the water discharge at the main outlet has been steadily decreasing over the years. The terminal station, Vijayawada showed a noteworthy decline in sediment discharge, from 6.18 × 106 t yr-1 in the period from 1966 to 1985 and 1.75 × 106 t yr-1 from 1986 to 2005. The mean sediment yield for Vijayawada in the Krishna basin was estimated at 15.75 t km-2 yr-1 which is remarkably lower than other gauging stations. This notable outcome in the study emphasizes on the anthropogenic activities playing a prominent role in the sediment decline in the basin.

Examining the mechanical and hydraulic properties of Vetiver grass in providing riverbank stability along an erosion prone sand mining affected river reach in Eastern India

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Abstract

The role of vegetation as a bioengineering tool in mitigating common fluvial hazards like floods and riverbank erosion has long been acknowledged but still remains less understood and inadequately researched. Grasses, in particular, possess unique abilities in combating erosion, by providing dual support. While their aboveground biomass reduces high flow velocity, the underground fibrous root network binds detachable erosive soil particles, thereby consolidating bank slopes. Such grasses are also known to restore unstable riverbanks that are heavily affected by massive sand mining activities, which is another notable anthropogenic hazard causing irreplaceable channel changes, in terms of both the local channel hydro-morphology and ecology. Such activities have also induced and accentuated channel and riverbank instability due to the increased hydraulic effect within the deepened pools that has caused toe-scouring and subsequent bank collapse and loss of arable lands. In this respect, the effectiveness of Vetiver grass (Vetiveria zizanioides) as a soil and water conservation tool has been investigated along the banks of River Ketia, a spill-channel of the River Silai in Paschim Medinipur district of West Bengal. The impacts of this grass' root network on the soil physicochemical properties was studied along with the contribution of the increased root cohesion to slope stabilisation. The mechanical reinforcement properties of roots were also examined using root tensile strength and root morphological parameters. Results revealed that while the uppermost (0–10 cm) layer of the soil showed an increase in its Soil Organic Carbon (SOC) content, the saturated hydraulic conductivity (Ksat), decreased Bulk Density (BD) and increasing size of surface macro-aggregates (>0.25mm) all attested to the increasing stability of soil aggregates, due to the ambient root reinforcement. With an increased root tensile strength in the surface layers, the Root Area Ratio (RAR) was also found to be satisfactorily high and Vetiver roots were also seen to enhance soil cohesion. 1-D hydraulic modelling in HEC-RAS along a particular channel stretch near Garbeta, which is severely affected by mining activities was used to examine the effect of the grass' aboveground biomass in providing bankline protection and to measure changes in the usual flow conditions due to sand mining. Such vegetative buffers have therefore been seen as a promising riparian conservation tool in providing overall channel and riverbank stability in these heavily affected sites.

Keywords: *riverbank instability, vegetative buffers, root-reinforcement, hydraulic modelling*

Abstract Volume

Morpho-tectonic evolution and Basin dynamics of the Cauvery River Basin, South India

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Abstract

Although the Indian Peninsula is generally considered tectonically inactive, it is an amalgamation of transient landscapes evolved from the interactions between tectonics and climate forcings. The present study is focusing on morphometric analysis of the Cauvery basin by using digitized fourth-order sub-basins to get fine information about the topographic matrix. Different morphometric parameters i.e. linear (stream order, length, and bifurcation ratio), and areal (drainage density, circulatory ratio, texture ratio) have been calculated on digitized fourth-order sub-basins. In addition to its relief aspects (basin relief and ruggedness number), SRTM-DEM is used for the calculation of basin relief for all sub-basin. The bifurcation ratio, Drainage density and ruggedness number are very high in the middle and upper Cauvery parts. Extraction of knick points for the trunk and 12 tributaries of the Cauvery River along with the ground truth validation shows the middle part highly active and tectonically triggered. Spatial analyses of these parameters in the light of field mapping were attempted in this study. Which revealed the uniqueness of the Cauvery River Basin in terms of Basin morphology and landscape evolution. This study has shown the significance of morphometric analysis on the evaluation of climate, tectonics and other factors for modelling the landscape development on a Basin scale.

Estimation of soil loss for the Kundka River Catchment, Sindaphana Basin, Maharashtra, using Revised Universal Soil Loss Equation

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Abstract

An accelerated rate of soil erosion is a serious problem in the Marathwada region of Maharashtra. Soil loss estimation and mapping of the spatial patterns of soil erosion are important for soil conservation and management. The present study aims to estimate soil erosion by water in the Kundka catchment of the Sindphana basin. The Remote sensing and GIS techniques are used in the Revised Universal Soil Loss Equation (RUSLE) model for the estimation of soil loss. The study further explores the effects of wet and dry seasons, land use, topography, and soil erodibility on soil erosion rate in the catchment. Twenty years of average rainfall data are used with the RUSLE factor to estimate the soil loss. The estimated soil loss in the catchment is 7043782 t/year and the mean erosion rate was 96.05 t/h/y. It is observed that soil erosion rate is varying in the region seasonally as well as according to the type of land use. About 80% of the total soil loss occurred during the wet season, with a mean erosion rate was 72 t/h/y while, about 20% of the total soil loss occurred during the dry season, with a mean rate was 26 t/h/y. This indicates that soil erosion is highly seasonal. Based on the land use types i.e. agriculture land mean erosion rate was 41 t/h/y, wasteland 199 t/h/y, and open forest with steep slope soil erosion rate was 295 t/h/y. The soil erosion severity map shows about 50.1% of the area having very slight erosion potential (0-5 t/h/y) that contributes only 0.4% of the total soil loss, while 33.4% of the areas in very severe erosion potential with erosion rate was 294.5 t/h/y, that contributed about 97.1% of the total soil loss in the catchment. Areas with very severe erosion are found in the upper catchment area, mostly covered by wastelands and open forests with steep slopes. The analysis shows that soil erosion rate is most sensitive to the topographic factor (LS) followed by the P factor, K factor, C factor, and R factor. The upper catchment has low rainfall but rugged topography shows a very high rate of soil erosion. This is because of the specific land use - wasteland with a steep slope. The lower catchment has high R factor but low erosion rate because of the low LS factor as well as land use such as – agriculture.

Assessment of spatio-temporal dynamics in rainfall, river discharge, groundwater quality and land use/land cover of the Cauvery delta region: Implications for environmental planning and management

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Abstract

Groundwater deterioration is considered to be a major threat to livelihood in the Anthropocene epoch. Cauvery Delta is an important geomorphic landform in south India and is also known as "The Granary of South India". Recent studies reveal that the groundwater resources of this region degrading severely and affects the potable drinking water source of millions of people those depending upon it. Groundwater resources of this downstream region is deteriorating day-by-day and it is highly interrelated with climate, surface hydrology and human activities. Therefore, it is important to study the spatio-temporal variability of groundwater in relation to rainfall, river discharge, land use and land cover of this region for better water resources management. Thirty-five years (1986 to 2020) of groundwater quality data (pre and post monsoon seasons), rainfall, river discharge, and land use/land cover were collected from the Water Resource Department of Tamil Nadu, the Indian Meteorological Department, the Central Water Commission and Landsat images respectively. The data were subjected to Mann-Kendall and Sen's slope test for computing long-term trends. In order to assess the groundwater pollution for drinking standards, the Pollution Index is calculated using physio-chemical parameters such as TDS, Na+, Cl-, SO42-, Ca+2, Mg, pH, HCO3- and Total Hardness of 57 groundwater samples. The spatial interpolated results indicate that the central and northern part of the Cauvery delta region experiences an increase in TDS, Na+, Cl- and SO4 2-values, indicating an increased risk for livelihoods reliant on groundwater for drinking. Although, the annual average rainfall of this region is increasing (7 mm/year), the discharge rate of Cauvery River is gradually declining i.e., 37 MCM per year due to poor basin water resources management. The reduction of water flow in all major distributaries of river Cauvery affects the physio-chemical conditions of groundwater to a greater extent. The increasing trend of salinity in groundwater affects land use pattern and a sizable portion of agriculture land is converted to salt pans and aquaculture practices, especially in the northern confluence region. The results suggest that proper river basin management is essential in addition to strong enforcement of norms to regulate groundwater exploitation in this region. The findings of the study could be very useful for achieving several targets of Sustainable Development Goals (SDGs) of the United Nation Development Programme.

Keywords: *Groundwater, Pollution index, River discharge, Cauvery basin, Hydrogeochemistry*

Abstract Volume

Spatio-Temporal Assessment of Glacier in Kanchenjunga region using a Machine Learning Algorithms in Google Earth Engine

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Abstract

Change in glacier dynamics is a primary indicator of climate change, causing adverse disasters. Therefore, spatial mapping and monitoring of these glaciers is required for understanding the impact of climatic variations. Multi-temporal and spatial remote sensing satellite data is helpful to extract information of glacier change and extent in the Himalayan region. In this present study, deglaciation rate and changes in glacial area in and around Kangchenjunga region (Khangchendzonga National Park of Sikkim, India and Kangchenjunga Conservation area, Nepal) has been taken to identify the spatio-temporal changes of the glaciers to explore the recent variations. In this study, we proposed a Machine Learning method using Classification and Regression Tree (CART) a predictive algorithm in the Google Earth Engine (GEE) to automatically detect spatial and temporal changes in Kanchenjunga glacier and comparison it with supervised classification using Landsat 7 and Landsat 8 Satellite imager for period 2014-2022. Result shows, between 2014-2022 (8 years) total glacial area showed retreating trend, Comparative analysis of supervised and machine learning classification techniques for revealing Spatio-temporal changes in the glacier region of Kangchenjunga massif. We found that the proposed method was reliable and effective to track the spatio-temporal changes in the Kanchenjunga glacier with an overall accuracy of ±85% and it could be used for monitoring and mapping of glaciers in the future.

Geo-Tourism Potentiality of Ahmednagar District of Maharashtra State, India

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Abstract

Geo-tourism is a newly developed concept, based on the geological environment. In the word Geo-tourism 'Geo' presents geology, geomorphology and natural resources of landscape, landforms, fossils of flora and fauna, rocks and minerals with an emphasis on appreciating the processes that are creating and creating such features. Geo-tourism is tourism which focuses on an area's geology and landscape as the basis of fostering sustainable tourism development. Geo-tourism argued that a new form of sustainable tourism which is more holistic than previous niche forms of tourism. In India the concept of Geo-tourism started to develop recently. The main objective of the present research work is to highlight the geo features in the Ahmednagar District of Maharashtra to promote geo-tourism in the study area. Ahmednagar district is one of the biggest districts by area in the state of Maharashtra. Tourism business in Ahmednagar is developing day by day. This study is mainly based on investigation and information. Primary and secondary data area used. The study is both exploratory and descriptive in nature. Primary data is collected from the tourists. SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis method is applied for analysis of potentials to develop geo-tourism places in the study area. In the district there are some places, which have potential to develop as geo-tourism places in the future. It includes Wadgaon Darya (stalactite and stalagmite), Nighoj (potholes), Sandhan Valley, Randha waterfall and Kalsubai Peak. Accommodation, parking, lack of tourist guide and transportations facilities are major problems that require more attentions for development of geo-tourism in the study area.

Keyword: *Geo-tourism, Stalactite and Stalagmite & Pothole*

Abstract Volume

Assessment of hydrological responses in urbanizing environment: A case study of Bhima-Indrayani basin, Pune, Maharashtra, India

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Abstract

Developing economies are often marked with a number of environmental problems that are inevitable outcomes of blooming urbanization and industrialization. Apart from a host of common environmental issues faced by the urban society a much complicated and recent problem experienced is related to the urban flooding. Ever growing impervious surfaces lead to a change in the hydrological responses at the local level that needs to be understood properly before venturing in to any kind of management and planning for such areas. Bhima-Indrayani basin is one of the speedily urbanizing watersheds, that hosts a number of upcoming urban centers and also has an advantage of being closer to Pune and Pimpri-Chinchwad Municipal Corporation. In the recent periods urban flooding especially in the eventuality of high intensity less duration situation has become common within the urbanised sections of this basin. The present work is an attempt at bringing out the changes in Land Use Land Cover (LULC) and Impervious Surfaces (IS) and further analyse their impact on the hydrological units in terms of surface runoff. Landsat TM and OLI data for the years 1991 and 2016 are taken up to produce the LULC and IS maps. In order to analyse the hydrological responses of the basin surface runoff to the changes in LULC and IS within the study watershed, SCS CN method of estimating the runoff was employed. It was observed that within a span of 25 years, the growth in built-up area has almost increased 5 times (5.64% to 25.02%) resulting in a whooping rise in the IS from 10% in 1992 to 60% in 2016. The surface runoff generated for these two years also show an increasing trend. The entire watershed recorded a rise of almost 8.4 MCM in a span of 25 years. Eight hydrological response units exhibited a tendency of increasing surface runoff with increase in built up and IS. Simulations run with constant rainfall and changing built up clearly depicted resultant scenario with increased runoff. A strong and significant positive relationship is established between the imperviousness and the runoff for the present study area. The average runoff coefficients obtained for the gauged basins within the Bhima-Indrayani basin has a strong positive relation with imperviousness of basin with significance level of 0.5. Thus, the present study clearly brings out a strong positive correlation between the built up, IS and surface runoff.

Abstract Volume

Study of Heat Waves in India: A Natural Hazard as an Indicator of Climate Change

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Abstract

A heat wave, considered as one of the most disastrous weather phenomena, can be defined as a period of abnormally hot weather that occurs primarily during summer months worldwide. It affects human comfort, agriculture and water management (particularly when it persists for longer period), thereby, resulting in variety of problems to human beings and /or livestock. Over India, heat waves occur during the summer months of March to July, and in some rare cases even extend till August. With the increase in temperatures as a result of human-induced climate change, heat waves are expected to intensify around the globe. Some severe heat waves occurring within the last few decades made heat waves a hot topic in climate change research. Thereby, the present study aims at understanding the spatio-temporal patterns in heatwaves that occurred in India from 1996-2018. Statistical analyses of maximum temperature observed over few stations recording highest number of heat wave days was also carried out to understand its linkage with the occurrence of heat waves over India. Both parametric as well as non-parametric tests were applied to the climatological series of maximum temperature in order to identify the existence or non-existence of significant increasing or decreasing trends in the data. The study revealed that Jaipur (Rajasthan), Krishna (Andhra Pradesh) and Yavatmal (Maharashtra) districts recorded the maximum frequency of heat waves during the study period. On a regional scale, the south-eastern coastal states and the north western states were found to be most affected by heat waves. Most of the stations experienced significant increasing trends in maximum temperatures, hinting towards overall global warming throughout the country.

Basin-scale landscape development through morphometric analysis- Thamirabarani river basin, Southern India

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Abstract

The river has an important role in the hydrosphere. It shapes the land by erosion and deposition. The evolution of landscape takes place due to five different mechanisms; they are upliftment, deposition, erosion, subsidence, and volcanism. Thamirabarani River originates from Pothigai hills, situated in the eastern part of Western Ghats. This work helps to understand the tectono geomorphic evolutionary history of the Thamirabarani Basin. The internal tectonic process deforms the lithosphere while external climate forcing shapes the surface topography. Perturbations in these processes shift a landscape from its state of dynamic equilibrium to a state of disequilibrium. Morpho-tectonic impressions and their variations in the selected watershed and rivers were assessed using drainage basin symmetry, transverse topographic symmetry factor and stream concavity index derived from Digital Elevation Model (DEM). Different datasets needed for this study were downloaded from the Shuttle Radar Topographic Mission (SRTM) with a resolution of 90m. Morphometric analysis is the quantitative description and analysis of landforms as practiced in geomorphology that may be applied to a particular kind of landform or drainage basin and large regions generally. In the case of the drainage basin, many quantitative measures have been developed to describe valley side and channel slopes, relief area, drainage network type and the extent and other variables. Morphometric analysis of a basin provides important parameters about the basin characteristics. There are three important aspects used for doing morphometric analysis of a basin. These are linear aspects, real aspects and relief aspects. Analysis of river longitudinal profile is one of the best tools to study the landscape evolution of climatic, geologic and tectonic factors. Landscape morphology and drainage evolution of the Thamirabarani Basin can quantitatively describe the distinctive feature of the incision style of the river. This study adopts morphometric analysis for watershed management and it comprises the quantitative morpho dynamics, tectono-geomorphic and climatic change to access the changes or impacts that may occur in the future. The continental-scale landscape development model proposed in a previous study identified general parallel trends of post-breakup basin faults and their differentiation into horsts and grabens with similar trends suggesting the evolution of the east coast basins as inherited and antecedent structural evolution.

Water crisis in Uttar Pradesh: An overview

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Abstract

Water is essential for life on earth. It is unequally distributed over the earth surface. Water scarcity occurs due to both natural as well as anthropogenic causes. One of the major regions behind water scarcity is that its demand has increased twice than earlier as the population growing exponentially. Some of the major causes of water scarcity are overuse of water, pollution of water, drought, ground water pollution. Some problems arise because of water scarcity like lack of access to drinking water, diseases, sanitation issues, destruction of habitats. This paper is an attempt to investigate the causes and consequences of water crisis. The data for the present analysis has been obtained from secondary sources. The main objective of the present paper is to attempt evaluation of the water resources. Study reveals that water is rapidly becoming a scarce resource in Uttar Pradesh because the demand of water is increasing due to pressure of population and changing consumption pattern. For instance, in some parts of the study area, there is evidence of progressive decline in the water table due to over pumping by tube wells. The situation is getting alarming year after year. These problems can be solved by conjunctive use of surface and ground water. There is urgent need for the development of surface water irrigation where ground water utilization is high

Hydrological Analysis and Bankline Shift of the Brahmaputra River along the Majuli Island, Assam

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Abstract

River islands are generally formed by sediment deposits which generally extend above water level specifically in braided rivers. River islands are more stable compare to central bars. Erosion generally occurs in the head part of the island compared to the tail part so generally in this part deposition is observed. The formation of a river island is dependent on the sediment load which is carried by the river. The world's largest inhabited riverine island 'Majuli' is situated on the river Brahmaputra. The landform morphology of the river Brahmaputra is getting affected by severe erosion and flood inundation along its bank. Every year, during monsoon months, the devastating flow of the river and its tributaries results in massive floods and river bank erosion. Although, flooding has been an integral part of the riparian communities of the region for ages, the frequency and intensity of this phenomenon along with the major riverbank erosion has affected the socio-economic backbone of the riparian communities of Assam. The present attempt studied water discharge, silt load, water level, and rainfall in year the 1990-1993 & 1997-2000 and bankline shift over the period of 35 years. With the help of graphical representation, the relationship between water discharge and silt load shows the highest discharge rate during monsoon months frequently in the month of July and August. Utilizing discharge and rainfall data, hydrographs were prepared, displaying peakedness in the lower parts as the upper catchment area's rainfall increases. The flood situation is shown using the data of discharge and water level, highest flood level was recorded in the year 1991 & 1997. The Brahmaputra river's Majuli island, exhibits the highest erosion at the junction of the Brahmaputra and Subansiri rivers. The present study would be of great importance to distinguish the island as a unique landscape in the terms of its geomorphological and hydrological set-up that would open other arenas to continue further studies.

Keywords: *River Island, Erosion, Floods, Bankline shift*

New insights in the 74 ka Toba ash-fall, environmental change, and hominin occupational record from the Barakar Late Quaternary sediments

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Abstract

The Toba super-eruption ~74 ka ago has been reported for a significant impact on the Quaternary environments in the South Asian region. The occurrence of Toba ash at several localities having records of hominin occupation under riverine environments further concerns detailed studies of the impact of volcanism on hominin occupational sites. Here we report the discovery of microscopic glass shards characteristic of the Youngest Toba Tuff (YTT) ashfall from the Barakar (BK) archaeological site in Eastern India, a region in which there is evidence of the complexity of human behavioral responses. The primary air-fall (~2 cm) deposits of the YTT were identified and the changes in terrestrial environments prior to and post-super-eruption are studied. The BK tephra glass shards consist predominantly of bubble wall shards with the co-occurrence of platy and blocky types, although the finer particles could not be investigated which may have impacted the respiratory canals. The geochemical analyses have shown that the ash has SiO_2 contents ranging from ~ 67% - 76% suggesting that they are mainly rhyolitic and formed from melts of siliceous composition. The mineral magnetism showed a low concentration of magnetic minerals, due to the majority of the phyllosilicate minerals behaving paramagnetically and diamagnetically. The archaeological evidence of the post-depositional period in Barakar valley indicates the modern human occupation around ~17 ka when the Indian summer monsoon was reactivated after LGM. These findings suggest that there is a large depositional gap between the ash bed and the cultural layer in the BK region, and its subsequent erosion had local hydro-ecological effects. The discovery of the ash bed and palaeolithic assemblages in the Barakar valley expand our understanding of Late Pleistocene depositional environments, hominin occupations, and possible human movement toward the Eastern coastal region.

Abstract Volume

Potential glacial lake outburst flood assessment in a changing environment, Chhombo Chhu Watershed, Sikkim Himalaya, India

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Abstract

The Sikkim Himalaya, similar to other mountain regions, has lost considerable ice cover over the years owing to the changing climatic factors leading to enlargement of glacier-fed lakes and thus posing a potential threat to downstream communities in the mountain and Tarai (foothills) region in case of breach anytime in the future. The Chhombo Chhu Watershed of Tista basin in Sikkim Himalaya, located between the Greater Himalayan range and the Tethyan Sedimentary Sequence, is the storehouse of number of glacial lakes with large areas and volumes. In this study, the glacial lakes changes were mapped between 1975–2018 and also assessed its dynamics based on manual analysis of optical satellite images using KeyHole-9 Hexagon (~4 m), Landsat Series (~15-30 m), and Sentinel 2A-MSI (~10-20 m) imagery and verified during field surveys. The results show that the number of lakes has increased from 62 to 98, and its total area expanded significantly by ~34.6 ± 5.4%, i.e., from 8.5 ± 0.2 km2 in 1975 to 11.4 ± 0.6 km2 by 2018, at an expansion rate of 0.8 ± 0.1% a−1. Lake outburst susceptibility result reveals that a total of twenty-seven potentially dangerous glacial lakes exist in the watershed; 5 have a status of 'high' outburst probability, 17 'medium' and 5 'low'. The majority of the proglacial lakes in the watershed have significantly enlarged due to the faster melting and calving processes as a result of accelerating increasing long-term average annual trend of temperature (+0.283° Ca−1; 95% confidence level) and homogeneous or slightly declining precipitation.

Abstract Volume

Bio-geomorphological Study of Bhimashankar Wildlife Sanctuary: A Geospatial Approach

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Abstract

Geomorphic processes and landforms influence the biota's distribution. In contrast, biota alters geomorphic processes and landforms. The relationships between geomorphic and ecological elements are becoming more circular and developmental. Geomorphological processes create and alter habitats, and influence environmental conditions for organisms. India is divided into 10 biogeographic zones, amongst them, the Western Ghats is a major hotspot and declared a world heritage. Bhimashankar is one of the five wildlife sanctuaries of the Northern Western Ghats in Maharashtra. Bhimashankar Wildlife Sanctuary is a major biodiverse part, situated on the crest line of the Northern Western Ghats showing the endemism of the Indian Giant Squirrel. A practically unbroken high ridge of the Western Ghats passes north-south through this sanctuary. Due to undulating physiographic features, this forest is not uniform and shows great variations. The vegetation is divided into Evergreen, Semi-Evergreen and Moist Deciduous Forests. The study thus tries to understand the relationship between the Bio-geomorphology of the area and the distribution of forest types in Bhimashankar wildlife sanctuary. The variable density of forests is also correlated with the Geomorphology of the area. The wildlife distribution also changes with Biogeography as animal habitats are not only related to food availability and safety. The Giant Squirrel census data is used to understand the distribution of major wildlife in the sanctuary. Such relationship study further helps in Species distribution modelling, which has emerged as a vital tool for predicting, on a spatially explicit basis, the likely impacts of climate change on natural and human-managed ecosystems. The goal of biogeographic modelling is to forecast and identify species distributions in new or altered habitats, including invasions into new regions and responses to expected environmental alterations associated with climate change. The use of species distribution models (SDM) to map and monitor animal and plant distributions has become increasingly important in the context of awareness of environmental change and its ecological consequences.

Keywords: *Bio-geomorphology, Bhimashanakar, Species Distribution Model*

Abstract Volume

Spatio temporal changes in the area, braiding index and planform index along the Majuli island

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Abstract

Majuli is the world's largest river island; it is situated to the north of the Jorhat in India. The island is formed by the Brahmaputra river in the south and the Kherkutia Xuti an anabranch of the Brahmaputra joined by the Subansiri river in the north. The island is about 200 kilometers east of the state's largest city - Guwahati and is accessible by ferries from the town of Jorhat. The main thrust of the present study is to quantify the area of the Majuli Island and the area of the midchannel and lateral sand bars along the Brahmaputra River and also to measure the Braiding Index and Planform index for Pre-Monsoon & Post-Monsoon seasons from 1986 to 2021. The present approach employs LISS-3 satellite imageries to investigate spatial changes over 35 years which is often beyond the scope of empirical observations. It is found that the Majuli island area shows a decreasing trend from 507.26 km² to 421.69 km². The average annual rate of erosion was found as 2.45 km²/years for the selected period of time. Generally, the large number of islands are seen in the post-monsoon period due to a series of flood episodes that deposited abundant sand during the monsoon season. As per the Planform Index in parts of the Brahmaputra River along the Majuli islands the middle part has low braiding meaning high erosion whereas upper and lower portion has higher braided river channel over the period of time.

Keywords: *flood, riverbank erosion, braiding index, planform index*

Abstract Volume

Land Degradation Process and wasteland Management at Sasurkhaderi River Sub Basin, Yamuna Basin

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Abstract

Today India is suffering from various land related problems. Changing landuse pattern affect the quality of land and soil in a variety of ways e.g. urbanization, industrialization and deforestation. Land degradation in a region is assessed by considering the important factors of physical attributes like terrain, climate and anthropogenic activities e.g. urban rural settlement, deforestation and industrialization. The present paper tries to investigate various anthropological factors responsible for land degradation and waste land management. This paper also highlights the increased vulnerability and innate exposure of the river basin to land degradation. Field survey has been conducted to determine the nature of land in the region. Satellite imageries, SOI toposheet, survey records of the changing landuse, soil surveys reports, cadastral maps are used to prepare the land degradation map of the study area.

Abstract Volume

Changing Hydrological Conditions and Its Effects on Fisheries of a Waste Water Distribution Canal of East Kolkata Wetlands, Kolkata: A Case Study on Ghosher khal

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Abstract

The East Kolkata Wetlands is the largest Swage fed wetland in the world. Now it is a semi-natural system but earlier it was a natural wetland between the Ganges and Bidyadhari Rivers. The East Kolkata Wetlands treats around 750 million liters of urban wastewater in and around the Kolkata Municipal area every day. Number of tributaries canals distributes waste water within the fish ponds in these Wetlands. If the waste water is not distributed through these canals in a coordinated manner, the entire wetland will be threatened. About 18 main canals and many tributary canals were surveyed by the Creative Research Group in 2000. Ghosher Khal is the most popular, important and old canal which is supplying the waste water to the fishponds in the northwestern part of the wetland. The aim of the present study is to identify the changing hydrological conditions occurring during the twenty years from 2000 to 2019 and the current situation of wastewater distribution in this particular canal. The present observations based on intensive field work and various hydrological conditions are determined by empirical equations. The threat zone and continuity of flow condition identified from the field data. The maximum part of the canal has come under the danger zone due to heavy sedimentation in the canal bed, uneven distribution of waste water, irregularities in water control and blockages in the canal. The hydraulic efficiency of the Ghosher Khal decreases rapidly from source to mouth. Human intervention plays an important role in changing the continuity of flow conditions in canals and entire wetland systems.

Keywords: *Waste Water, canals, hydrological condition, hydraulic efficiency*

Identification of Major Geomorphic Divisions and Their Impacts on Channel Behaviour in Haridwar District, Uttarakhand

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Abstract

The present paper is concerned with identification of major geomorphic divisions and their impacts on channel behaviour in Haridwar district, Uttarakhand, India. Undoubtedly, geomorphic surfaces have significant influence on channel-forms and processes of an area. The present worker has prominently identified major geomorphic surfaces which have important role to control the channel behaviors of the area. The present researcher has divided the study area into four major physiographic divisions depending on major breaks in the longitudinal profile drawn from extreme north to south of the district. The divisions are like; higher Siwalik ridge zone, dissected lower Siwalik, Bhabar, Terai. The work has also focused salient channel characteristics of the rivers and associated problems or hazards which are faced by people of the area. The area consists of significant landforms (alignment of river channels, channel escarpments, incised meander, river terraces etc,) under megafan, piedmont fan, river valley terrace and active flood plain surfaces, that indicate strong tectonic influence on the channels. The area is characterized with various types of channel forms like; gorge, dry channel, channel with alternating bars and mid channel bar, meandering, abandoned channel, wide braided channel, channel avulsion, channel aggradations, widening etc. Different physiographic divisions have distinct impacts on channel forms.

Land Use Changes in Alaknanda River Basin with special reference to Badrinath and Kesabprayag (Mana village) area

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Abstract

The present work is concerned with the study on land use characteristics of Badrinath and Kesabprayag (Mana village) area with a correlative and integrated approach on Mana village and its adjacent area. Mana village is the end village of India on the holy confluence of river Alakananda and Saraswati river, which is ventured as one of the five sacred confluence or the "Pancha Prayag". Badrinath is of immense significance for the pilgrims of Char Dham Yatra. The study area is located between 30°00' N to 31°00' N and 78°45' E to 80°00' E, covering an area of about 11,396 Km2. The basin 433 km2 is under glacier landscape and 288 km2 is under fluvial landscape. Mana village is located the South-east part of Chamoli district. The river Alakananda flows from South-west to South-east and Saraswati flows from North-east to South-east part of Chamoli district. The primary objective of this research is to study the land use characteristics of Alakananda and Saraswati river basin with special reference to Badrinath area. The land use pattern of Mana village is generally influenced by the landform characteristics of the study area. The major land use elements of the village are settlement, agricultural land, road, fallow land, vegetation area, etc. Most of the part of the village covered with waste land. Agricultural land is situated on the southern portion of the study area mainly along the left side of the river. In Mana village here, we find a variety of cast structure. There has mainly 2 type of cast structure. More people are belonging in ST categories than general categories. Most of the people are mainly agricultural farmer and handicrafts maker. The people who are engaged to the tertiary activity they have mainly business. The low-income groups are mainly labourers of agricultural field. Chamoli District is known for its holy sites, temples, snow clad mountain peaks and beautiful scenic beauty. Most of the observations in this research project sponsored by ICSSR, New Delhi, have been based upon intensive field work in the area under consideration. The study area is blessed with diverse species of flora and fauna and natural splendour. From the basis of different type of soils and geomorphic processes (glacial, glacio fluvial and fluvial) of the region, it is clear to us that the entire study area is representative of a polygenetic landscape.

Abstract Volume

Community Based Landslide Vulnerability Assessment in Kurseong Sub-division, Darjeeling District, West Bengal, India

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Abstract

Landslide is one of the most hazardous phenomena in the Eastern Himalayan region. The present research is focused on community-based vulnerability assessment and addressing the risk reduction strategies on a scientific, evidence, and community knowledge basis. The study has been carried out on some selected landslide-prone areas of Kurseong Sub Division, Darjeeling District, West Bengal, India. In order to identify the most vulnerable community in the study area, a regional-scale landslide hazard assessment has been carried out. The regional scale hazard assessment has been done by considering geo-environment factors (slope, geology, geomorphology, drainage, land use/ land cover, road) and landslide inventories. The study reveals that 14.8% of the total area is under a very high-hazard zone. Moderate Hazard Zone is found in the north-western, central, and north-eastern parts and comprises 21.02% of the study area. From the hazard map, most exposed communities have been identified and physical, social, and economic vulnerability has been assessed following a prioritizing list. A household survey indicates that 16.93% of the population has not received formal education. Most of the population belongs to the lower-income group (40%) to the highly low-income group (7.5%) category. It is found that distance is a major issue to access the market, healthcare facilities, and schools. Based on hazard and vulnerability assessment at the community level, some risk reduction strategies have been suggested.

Keywords: *landslide inventories, hazard, vulnerability, risk reduction*

Relation between Tidal Asymmetry and Suspended Sediment Concentration at Some Selected Brick Kilns on the Left Bank of River Hugli, South 24 Parganas, West Bengal

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Abstract

In South 24 Parganas district 189 brick kilns are found on the left bank of Hugli river. From North to South 3 distinct zones of concentration of brick kilns are selected for the present study, namely — Akra, Acchipur and Kulpi. Brick kilns operate using suspended sediment of Hugli deposited in its reservoir for a period of five to seven months, starting with the onset of monsoon season. The sediment deposited in this time period is excavated and used for brick making. The process of brick making depends on the amount of suspended sediment supply. Pilot survey in these zones revealed that there is variation in the rate of sediment deposition. In a macro-tidal estuary like Hugli, the nature of tidal wave affects the sedimentary behaviour to a large extent. As the tidal wave moves upstream through the Hugli estuary, the waves become asymmetric. To assess the impact of tidal asymmetry on sediment deposition water level was measured at an interval of 5-10 min and hourly water samples are collected for a span of 10 hours during spring tide condition in both pre and monsoon seasons. Predicted and observed published tidal data of Kolkata Port Trust were used to adjust the tide levels recorded in field with the chart datum. Spatial and temporal fluctuation in the amount of suspended sediment concentration was observed during the study. Among the three zones Kulpi registers highest concentration of suspended sediment, while Akra had the lowest concentration. Disparity in duration and velocity of tide and resultant hydraulic gradient are mainly responsible for the variation in suspended sediment concentration.

Site-Suitability Analysis of the Solar Farms in Beed District, Maharashtra, India: A Geomorphic Approach

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Abstract

Energy has become one of the essential needs of mankind. Today's economic activities, directly and indirectly, depend upon the availability of energy. With increasing development in a region, energy consumption also increases. In the present situation, most of the energy requirements bear out with the help of non-renewable sources such as coal, oil and natural gas. These sources were not economic and environmentally friendly when compared to renewable energy sources. Therefore, to suffice the requirement of sustainable energy, we need to opt for advanced technologies and renewable approaches. Geomorphology plays an important role in the determination of suitable site to install solar power plants. Particularly slope of the area, slope aspect and elevation are the important factors that decide the suitable sites for solar power plants. In the present study, the main focus is on combining the use of GIS and spatial multi-criteria decision analysis in order to select feasible locations for the development of solar farm projects. For the present study solar irradiance data, slope, elevation, aspect, land use and land cover, the proximity of rural, urban and industrial areas, proximity of roads, transmission lines, and available area for solar farms were selected as criteria for solar farms. Solar energy potential zones were clubbed into four suitability groups i.e. highly suitable, moderately suitable, low suitable and not suitable. This scientific approach will help the resource planners during the planning process.

Keywords: *Renewable energy, solar farm, GIS, multi-criteria decision analysis.*

Geomorphic evolution of Vaigai river basin, South India; Implications of tectonics and climate

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Abstract

The geomorphologic processes and tectonics settings are the leading drivers in regional monsoonal flow control and river system. The Vaigai river system is aggravated in the case of ephemeral-monsoon flow controlled river system which covers an area of 7380 sq.km with its apex at the Manamadurai. Drainage morphometry analysis of Vaigai river basin was carried out to study the drainage pattern and morphometric characteristics of basin using Survey of India (SOI) toposheet and geoinformatics techniques. The entire study area was delineated from the SOI toposheet having a scale of 1:50,000 and features were digitized. Extraction of the sub-basin and stream network model has been developed to quantify the drainage parameters in the study area. The basin includes eighth order stream and mostly dominated by lower stream order. The presence of Western Ghats is the chief controlling factor for slope variation. Moreover, the slope variation is controlled by the local lithology and erosion cycles. Tectonic control, followed by climate and lithology were identified as possible controls over landscape evolution. Inheritance of river valleys, synonymy of river basin responses to intrinsic and extrinsic geomorphic processes are the other characteristics observed. Seven geo-morphometric parameters were used in this paper such as longitudinal profile (Lp), stream length gradient (Sl) and shape factor (Shp), Stream order, Perimeter (P), Basin Area (A) Drainage Density (Dd) The morphometric parameters show a transient response of the landscape to disequilibrium initiated by active tectonic forcing.

Keywords: *Vaigai river basin, Morphometry, Landscape evolution*

Land Suitability Analysis for Rihand River Basin of Chhattisgarh State: Using Remote Sensing and Geographical Information System

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Abstract

The Land suitability analysis is one of the best techniques for the evaluation of soil quality for a particular study area. This technique was first developed by the Food and Agriculture Organization of the United Nations (UN-FAO). It is possible to evaluate the land based on different periodic conditions. The use of modern techniques, such as Remote Sensing and Geospatial Technique, helped the categorize land suitability assessments. In the present study, Rihand river basin areas were categorized according to the land suitability for defined land uses using the method of land suitability classification. The Land Suitability Analysis is one the most useful application for land use planning and sustainable resource management. The land suitability analysis of the Rihand river basin has been carried out in different classes to better understand land. The suitability of land has been categorized as S1 (highly suitable - no significant limitations), S2 (moderately suitable - having few limitations), S3 (marginally suitable - having most of the limitations), N1 (presently not suitable, but potentially is suitable for futures; uneconomical for land use), and N2 (permanently is not suitable). These suitability classes refer to the effects of the individual land qualities on the engendering of the different crops.

Keywords: *Rihand River Basin, Soil Prosperities, Land Suitability, LULC.*

Abstract Volume

Urban Morphology from the Lens of Urbanisation in Pune Municipal Corporation

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Abstract

There is a close relationship between urbanisation and urban morphology. As the process of urbanisation takes place in a particular manner, it shapes the urban morphology with a different pattern. The progressive growth of population and excessive urbanisation in the major cities across the world has changed the development strategies since last two decades. The ever-increasing urban population leading to numerous challenges to the local administration in the million plus cities in India and the world. Pune is one of the important cities in the State of Maharashtra after Mumbai. Being an IT hub, it has a lot of potential for employment opportunities that attracts people from all over the State and other regions of India. Pune's geographic area is consequently expanding at an exponential rate. In 2011, PMC had 78.92% built up area and less forest area i.e. 4.59% only. The addition of villages from the peripheral area in last decade made PMC the largest Municipal civic body of the State in terms of total geographical area accounting approximately 518 Sq. Km. In PMC, as of now, there are 564 slums, out of which 353 notified and the government does not notify 211 slums. Most of the slums in PMC are near to the riverbank resulted in encroachment over riverbeds. The population is therefore playing a crucial role in the urbanisation of the city and changing the urban morphology. The present study assesses the pattern of urbanisation in PMC and relates it with the changing urban morphology considering the land use pattern and population characteristics.

Short-Term Trends in Tide Levels Along the Central Konkan Coast of Maharashtra

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Abstract

Tide levels often depicts the changes in sea level at the local scale that are obtained on a daily basis. This paper attempts at obtaining the short-term changes in the tide water levels along the central Konkan coast of Maharashtra. The study area encompasses seven stations running from Murud-Janjira in the north to Dabhol in the south and includes the data sets for almost 30 years. The tide level data that was procured in the form of tide tables was initially digitized and further subjected to statistical analysis. The time series plots were obtained for Mean Monthly High Tide Water (MMHW), Mean Monthly Low Tide Water (MMLW), and Mean Monthly Tide Range (MMTR). The trend of tide levels was calculated and confidence interval was obtained by linear regression method. All the trends obtained for MMHW, MMLW and MMTR were observed to be statistically significant. Dighi, Agardanda and Shrivardhan with almost two-decade data displayed two trends. The stations with data spanning almost three decades (Bankot and Harnai) displayed a cyclic trend with three limbs, each limb roughly coinciding with a decade. Whereas the stations with data of more than three decades (Murud-Janjira and Bankot) displayed a cyclic trend with four limbs. It was observed that the MMHW was increasing significantly at all these stations while the MMLW showed a decreasing trend. Overall, it was observed that the tidal range was high in the decades of 1987-1994 and 2005-2015 that was indicated by a positive trend. Since in the recent decade it is observed that all the stations have rising high water level and falling low water level this has definitely led to increase in tidal range. Increase in tidal range will directly influence the portion of land that will be nomenclated as intertidal zone. With an increase in intertidal area more land is susceptible to the processes of wetting and drying. Moreover, increased high tide waters will also put the coastal areas at risk of inundation and subsequent flooding.

Keywords: *Mean Monthly High Tide Water, Mean Monthly Low Tide Water, Mean Monthly Tide Range*

Abstract Volume

Assessment of Mangrove Spatial Variability over Bi-decadal timeframe: Case study of Sonakothakar Mangrove patch in Alibag

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Abstract

The present study aims at assessing the spatial variability of Mangroves in Sonakothakar mangrove patch in Alibag over the bi-decadal timeframe, by adopting Geostatistical approach. Landsat TM/OLI data for the year 2000 and 2019 were employed for the study. Methodology adopted, involve delineation of mangrove patch through segmentation method and computation of Semi-variogram (in 'R') with NDVI data. Semi-variogram pattern for the year 2000 revealed a low range and high sill, indicating greater variation in the dataset that was correlated for a shorter distance. While in the year 2019, the Semi-variogram obtained for the same mangrove patches, exhibited high range and low sill. This clearly indicates a high spatial correlation associated with relatively low variation within the data. During the year 2019, evidences of exponential growth of mangroves were observed which was represented by higher NDVI values. Values were more similar, correlated and dependent. Overall rise in NDVI value indicates that the health status of mangroves has increased in 2019 along with natural expansion of mangrove colony. Over bi-decadal time span, mangrove ecology has also improved corresponding to higher NIR reflectance. The present research can be implemented to mangrove management and conservation purpose as this technique reveals the spatial dependency in the dataset.

Keywords: *OBIA segmentation, Semi-variogram, Spatial Dependency, Dendrogram and Mangroves.*

Urban morphology analysis, case study: Mira-Bhayander Municipal Corporation

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Abstract

Urban morphology is the study of urban areas that has underwent the changes by the new formation and transition in the urban forms of cities, towns and villages over a period of time. In general, it majorly focuses on the study of the changes in the spatial patterns in the particular place. It further helps in further framing the development programmes and also helps in intervening and promoting environmental friendly growth. Rapid growth of population has led in rapid change in the urban morphology. It is an urgent need to study the change in the morphology as these changes has claimed the environment. Henceforth in order to take the necessary decisions towards environment protection such study may play a vital role in having the appropriate development. The study primarily aims to find out changes and their impact in the upcoming region of Mira-Bhayander Municipal Corporation (MBMC) in Thane District. Mira-Bhayander is selected, as it shares the boundary with Greater Mumbai and it is part of Mumbai Metropolitan Region. Rapid unplanned urbanization is taking place in this region. Geo-spatial technology provides the authentic, practical and flawless platform to study the changes in urban morphology. The present study is exercised on the basis of secondary data obtained from credible online sources like Bhuvan of year 2005 and 2015 and further it is been processed in the geospatial software. The study mainly focuses on the decadal change in the MBMC. Demographic data is obtained from census data and mapped to understand the relation of between population pressure and the transformation of urban landuse which also helps to study the further challenges in attainment of sustainable development. Key concepts: MBMC, Urban morphology, Geo spatial technology, Sustainable development.

Drainage morphometric analysis of Mula-Mutha river basin in a hardrock basaltic terrain in India

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Abstract

The Mula-Mutha originates in the Sahyadri mountain range and is a major tributary of the Bhima River. The city of Pune is located on the banks of Mula-Mutha river and water supply to this city is from the dams built on these rivers. The main objective of this study is to know the changes in the flow system to combat the future crises as the effect of the change in the flow system is important for human life. Morphometric analyses have the ability to provide substantial evidences of drainage evolution, hydro-geomorphic, denudation, and tectonic characteristics that are essential for sustainable watershed management and planning. The aim of this study is to investigate different morphometric parameters of Mula-Mutha basins though geographic information system (GIS) techniques. Utilizing high-resolution satellite images, conventional datasets, and relevant field data. We analysis of different morphometric parameter which include stream order, number and length, mean stream length, mean bifurcation ratio, drainage density, stream frequency, drainage texture, circulation ratio, elongation ratio, form factor, relief, relief ratio and hypsometric integral. The morphometric analysis is carried out for basic, linear, areal, shape and landscape aspects using GIS tool. The application of Remote Sensing (RS) technique in conjunction with Geographic Information System technique is found to be more efficient for morphometric studies and prioritization of watersheds. Results obtained from the study would be useful in categorization of river basins for future water resource development and management, and selection of suitable sites for water conservation structures such as check dam, percolation tank, artificial recharge of groundwater through MAR technique etc.

Keywords: *Morphometric analysis, Mula-Mutha, GIS, India*

Flood mapping and Estimation of agricultural losses using geospatial technique: A case study of Krishna flood 2019 Maharashtra.

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Abstract

Flood is the most significant natural hazard in India in terms of its frequency, flood extent, flood duration, population affected and socio-economic damages. Spatial information on flood risk and crop losses is important in flood mitigation and risk management in agricultural watersheds. Flood commonly affects the human lives, property damage, and economic losses to the country particularly when it occurs in a rural area where the main source of income totally depends on the agriculture. This study focuses on flooding in agricultural area near chute channels of upper Krishna River basin. HEC-RAS software was used to map the flood to study the inundation area of flooding. In this, the case study of assessment of flood damage to different crops grown near chute channels in the Upper Krishna River basin of Maharashtra are discussed. For the assessment of agricultural land use and flood effect, surveyed data from the field through 502 questionnaires has been used. The agricultural land use pattern has been identified during field. A digital questionnaire has been prepared for the data collection using Kobo Toolbox software. This study revealed a flood damages considering the agriculture in Upper Krishna is Characterized by different cropping patterns which have crops like sugarcane, Soybean, tobacco, wheat, Gram, oilseed and pulses. Among these Sugarcane is perennial crop and has grown on major scale. Wheat, Groundnut, Gram and tobacco are being cultivated in Rabi and Soybean, Sorghum and Pulses are cultivated in Kharif. Vegetables, orchards and fodder crops are also being cultivated in different parts of Upper Krishna River. The data analysis shows out of the total surveyed Farm Land i.e., 1495.7 acre about 1476.45 acre is flood affected and it account 98.71% of the total surveyed land. It indicates flood is dominant impact factor for agricultural land use in the study area. Also, from the total Farm Land (1494.7 Acre) about 61 Acre is prone to Erosional land and it is 4% of the total land. It indicates, an erosion is less dominance factor with regards to flood conditions. On an average 74,000/Acre economical loss occurred during flood condition but it varies according to land holdings and type of crop grown in the farmland.

Keywords: *Upper Krishna River, Agricultural losses, Flood mapping, HEC-RAS.*

Graph theory based assessments of braided river planform alterations: insights from the Brahmaputra and Teesta Rivers

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Abstract

Braided rivers exhibit numerous channels that split-off and rejoin. Their channel junctions/confluences signify longitudinal increases in sediment runoff and water, whereas the bifurcations/diffluences represent partitioning of the flow downstream and decrease in discharge as water passes through separate channels. Knowing how these planform changes occur across a temporal scale in braided rivers is of utmost importance due to the livelihoods as well as the ecosystem services offered by it and its riparian zone, which are dependent on its longitudinal connectivity component. This longitudinal connectivity facilitates the downstream transfer of discharge and sediment and any alterations to it can potentially impair/block sediment movement, resulting in deposition and planform alterations. In this study, we use Graph Theory to analyze the impact of the big July 2019 flood event on the channel planform configuration of the Brahmaputra River in Assam using Sentinel images. Alongside this, multiple examinations at different time slots are undertaken using this Graph Theory to discern channel planform alterations in a section of the Teesta River in West Bengal from 1995 to 2020 based on Landsat images. The structure of the system is first represented as a network comprising source or storage points as nodes that are linked or connected by paths of potential transport which are the links connecting the nodes. These nodes are pixels that depict the network junctions while the links (channel segments) denote their connecting links graphically. The links so formed in the network structure can be defined in terms of direction, distance and transport-related factors concerning adjacency of nodes. The system needs to be defined spatially and dynamically before using statistics or other mathematical frameworks for quantifying connectivity between the network elements, and this was done using customised python-based codes. For both the studied rivers, the in betweenness centrality and structural sediment connectivity of the nodes (channel confluences/diffluences) and links were computed using the relevant indices, while the node accessibility was enumerated using the Shimbel Index. Our results reveal that significant changes in the channel planform were caused by the flood event in the Brahmaputra, which repositioned mid-channel and bank-attached bar deposits and realigned the river's entwined multiple threads, with alterations in the existing channel bifurcations and inter-node connections and impacting on how the sediment was transferred and its pathways. For the Teesta, multiple overlays of the centrality values denoted the thalweg changes over time, providing an easy method of ascertaining its variations.

Ascertaining topographic form based on multi-resolution mapping of surface curvature and elevation variation with implications for simulated flow directions

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Abstract

The characterisation of the overall topographic surface and identification of an individual landform depends on ascertaining the local elevation changes within and adjacent to a target feature, with it being composed of a complex arrangement of slope facets varying in both amount and aspect. Thus, lends to each topographic feature being representable and feasibly extractible from digital elevation models (DEM) by discerning and mapping the elevation and gradient changes along, across and around the target object. Such computations are however, influenced not only by the DEM resolution but also the distance to the local neighbourhood that is taken as the threshold. It is within this pre-determined and user-specified neighbourhood that cells adjacent to the central pixel are considered in terms of gauging their elevation difference and gradient variations, and thus the extent of the neighbourhood distance specified and the manner in its areal coverage is defined (as a circle, square or any other shape), can greatly influence the type of landform identified and the nomenclature assigned to a target feature. Such neighbourhood extents are also influential while computing the local surface curvature, another crucial component of landform identification, which has ramifications for flow routing and accumulation and thereby the alignment, order and density of the drainage network derived. In this study, the changes in the landform type, identified using the topographic position index (TPI), is examined by using DEMs of different resolutions and employing varying neighbourhood distances and demarcation forms. The steadfastness (repeativity) with which a certain pixel continues to be classified as the same landform element, irrespective of the DEM resolution or neighbourhood distance form, would allow it to be ascertained as that particular topographic feature with greater certainty, lending enhanced credence to the eventual geomorphic map generated. The surface curvature is also dependent on the DEM resolution, neighbourhood distance and form, and changes in its shape and value as a result of variations in these factors is also ascertained by repeatedly deriving it in multiple directions, providing insight into semi-automated methods of characterising terrain like Pennock's and Dikau's classes or Geomorphons. Finally, comparison is made of single flow direction-based drainage line generation versus that employing multiple flow partitioning algorithms in such repeatedly classified landscapes using different neighbourhood parameters to discern how user choices in this regard skew the derived networks, which can over- or underestimate stream densities in a particular direction, thereby influencing subsequent hydrological modelling.

Estimation of land degradation due to open cast bauxite mining in Western Maharashtra

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Abstract

Opencast bauxite mining is one of the most important economic activities of western Maharashtra which has significant impact on land degradation. Mining results in alteration of land structures due to excavation, stacking of top soil and loss of land due to dumping of mine waste and overburden soil. The present research work is based on primary and secondary data of bauxite mines from western Maharashtra and analysed in the laboratory. Various factors such as excavated area, depth and volume of the mine, excavated earth material, etc. are calculated and measured through field work, satellite images, EIA and inspection reports. Twenty-eight bauxite mines from Western Maharashtra have been observed which covers an excavated land area of 76,97,076.5 Sq. Mtrs. Out of this 22,08,702 Sq. Mtrs. and 54,88,375 Sq. Mtrs. of excavated land belongs to Konkan and Sahyadri regions respectively. The average depth of mine pit from western Maharashtra is up to 5.7 meters and total volume of excavated landmass is 41,029,443 m^3. Bulk density of mine land materials of Konkan region is 1670 kg/m3 and in Sahyadri it is 1676 kg/m^3. The present data has resulted in to the excavation of 68,696,115.41 tons of earth materials from Western Maharashtra. Out of this, excavated material from Konkan region is 19,269,078 tonnes and 49,427,037.5 tonnes from Sahyadri region.

Keywords: *Opencast mining, land degradation, Western Maharashtra, excavated earth material.*

Quantitative Geomorphic Analysis of Upper Nira River Drainage Basin

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Abstract

Characteristics of river basin are controlled by nature and its hydro-climatic parameters. Watershed managers require understanding and synthesizing hydrologic response of basin for which they have started looking into its basin morphologic features. The objective of this research is to analyze fluvial environment of Upper Nira Basin for watershed management. In that relief, linear and areal aspects are analyzed. The study area Upper Nira River basin falls under heavy rainfall region but water scarcity occurs during summer season. In the present research, the morphometric assessment is performed which is basically the quantification of the watershed parameters. A large number of factors such as watershed area, perimeter, circularity ratio, elongation ratio, drainage density, stream frequency etcetera for the upper Nira basin are computed in GIS environment. SRTM DEMs are used for this purpose. The topographical maps are geo-referenced in ArcGIS 10.1 software and watershed delineation has digitized manually. After that the streams are digitized and classified according to the Strahler's method of stream order. Later the basic quantitative data are exported from ArcGIS to excel for further computation of different morphometric parameters. Bifurcation ratio of upper Nira River (3.81) indicates natural drainage system characteristics. It drains over an area of about 1750 km^2 and a length of about 63 km. The perimeter of the upper Nira basin is 224 km and it is having elongated shape (circularity ratio = 0.44 and elongation ratio = 0.75). The stream frequency for the upper Nira basin is 4.96 per km2 indicates good groundwater potentiality. Drainage density value (3.47 km per km2) of the basin shows impermeable subsurface material and mountainous relief. Vegetation cover and agricultural activities have a great influence in controlling drainage texture parameter. The drainage texture for the upper Nira basin is 38.74 which indicate fine drainage texture. The basin shows a length of overland flow of 63.08 km. The form factor value of 0.4 in upper Nira basin denotes shape between narrower and wider. The infiltration number of basin is 17.21 which is high. The slope of the basin is between 10° to 30°. Conclusion of this research is that basin experiences high rainfall but shape, slope, relief, drainage density and texture of basin effect on water availability.

Keywords: *stream frequency, drainage density.*

Abstract Volume

Lithology and Geomorphic Control on Slope Stability in Konkan areas of Maharashtra, India

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Abstract

Landslides are common along Western slopes of Sahyadri ranges and isolated hills of coastal plains in Konkan region of Maharashtra. Numerous landslides with low magnitude is an important characteristic of slope failures in this region. Though the magnitude of landslides in this region is low, they result in huge losses in terms of property damage and even loss of lives especially those occur along major communication routes. Present paper deals with the spatial distribution of landslides in Raigad District of Konkan region of Maharashtra State in India based on the historical landslide records and field investigations. The landslide occurrence and its relationship with the rainfall have been assessed to determine the role of rainfall in slope failures. The results of the study revealed that the concentration of landslides in Raigad District is observed in the South and South Eastern hilly tracts of the District. Magacryst basaltic flows at the elevation up to 350 m are susceptible to debris slides in the foot slope areas of Western Ghats escarpment whereas rock fall and wedge failures are caused by numerous joints and fractures on slope faces covered by simple to compound flows above the elevation of 450 m from mean sea level. Besides, weathering of the upper mantle of the road cut slopes often cause slope failures at places on the western slopes of Western Ghats. It is observed that the landslide process in this area is also influenced by geo-environmental factors such as slope, aspect, structure, drainage, roads etc. Most of the slope failure sites are situated on the slope range between 25° to 35°. Proximity to drainage and structurally weak zones also play important role in the initiation of slope failures in this area.

Keywords: *Landslide Inventory, Landslide Geometry, Rainfall intensity, Landslide frequency*

Abstract Volume

Comparative Analysis of ASTER DEM and SRTM DEM Resolutions in Morphometric Analysis of Koyna River Basin

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Abstract

The purpose of this study is to investigate the morphometric properties of the Koyna River in the Satara District of Maharashtra in greater depth. The study employed SRTM DEM and ASTER DEM data to create a digital elevation model (DEM), and a geographic information system (GIS) to assess linear and aerial morphometric parameters. Arc Hydrology Tool was used to create the watershed border, flow accumulation, flow direction, flow length, and stream ordering; and Surface Tool in ArcGIS-10.3 software was used to create the slope-aspect Hill shed, as well as SRTM and ASTER data (DEM). Using ArcGIS software, different themed maps such as drainage density, slope, relief, and drainage intensity were created. For all parts of this study, 35 morphometric parameters were computed. The erosional development of the area by the streams has gone well beyond maturity, and lithology has had an influence on the drainage development, according to all morphometric parameter's investigation. These studies are extremely beneficial in terms of rainwater harvesting and watershed management planning. It was started in order to figure out how various morphometric parameters and watershed characteristics interrelate. The drainage map is made from the topo sheet of the 2010 Survey of India (SOI). The different factors related to perimeter, area of sub-basin, basin length, number of streams and drainage density, drainage pattern, and elongation ratio were estimated using Arc GIS 10.3 Software and Landsat 8 data to generate the LULC of Koyna River basin for that par interval.

Abstract Volume

Identification of the Wetland Influence Zones based on Soil Moisture Characteristics with TVDI and NDWI using Remote Sensing Technique: A Case Study of Gad Estuary

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Abstract

The coastal wetland zones are most important for the environment biodiversity. The Mangroves vegetation areas are most dominant part in wetland zones. The value and importunateness of Mangroves in the wetland zones are very species. This research tried to analysis of wetland zones of Gad Estuary, Maharashtra, India from the advance satellite data like e.g. Sentinel 2 and Landsat 8. The Multi Spectral Instrument (MSI) datasets Sentinel-2 was used to calculate Normalized Difference Water Index (NDWI) (10m resolutions) and Temperature Vegetation Dryness Index (TVDI), calculated from Landsat-8 datasets (Downscaling at 10m). Using these two datasets developed the nine zones base on soil moisture characteristic. The land use land cover classification through Sentinel 2 data with six major categories. Entire land use recalculated by each zone with Pre and Post monsoon seasons of 2016, 2018, 2020 and 2021respectively. The total area under research work is 3800 hectors which cover sea level to maximum 15 m height. Taking in to consideration of each year with individual zone can be matching each one. Negligible distortions were found in the graph. The analysis of all zone wise area shows similar trend.

Predicting Land use and Land cover Change using Integrated Cellular Automata Markov-Chain Model: A Case Study of Parner Tehsil, Maharashtra

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Abstract

The agriculture is the major economic activity in the study area and it has gone through changes in terms of land use/ land cover, cropping patterns, cultivation practices, productivity and intensity of cultivation. Land cover change is a complex interaction of environmental and socio-economic factors. The purpose of this study is to determine changes in land cover using satellite imagery data and to predict the future land use/land cover in the next 3 years and to determine the factors that affect land cover changes. The Markov Chain and Cellular Automata (Markov-CA) approach have been applied to create land-use change modelling dynamics in Parner tehsil, Maharashtra. The multi-temporal remotely sensed data, LISS-3 in 2013 and Sentinel2 in 2016, 2019, 2022, were used to produce the land use land cover maps. As a result of the CA-Markov model, agriculture, built up area, fallow land expansion will occur in the future, while barren land will decline due to this expansion. The combination of the satellite image, GIS, and Markov models provides useful information on land cover change trends in the future, which can be used to make a better decision by policy makers in Parner tehsil can construct a spatial prediction of land cover change in 2022-2025 in Parner tehsil.

Keywords: *GIS, LISS, spatial, Markov Chain*

Prioritization of Sub-Watersheds in Semi Arid Region: A Case Study of Shevgaon and Pathardi Tahsils in Maharashtra

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Abstract

Prioritization of sub-watershed plays important role in watershed management. It shows the requirement of watershed to give a treatment for the green growth of the region and conservation of the sub-watersheds. There are number of factors like topography of the region, climatic characteristics like rainfall and runoff, land-use land-cover, social factors which are related to the development of watershed for agricultural and domestic purpose in the region. The present research is throwing a focus on how morphometric parameters in association with GIS analysis will help in identifying the ranking of sub-watersheds for further development with the help of suggested watershed structures. Shevgaon and Pathardi tahsils are known drought prone tahsils of Ahmednagar district in Maharashtra. These tahsils comes under semi-arid region. Sub-watershed prioritization is necessary for proper planning and management of natural resources for sustainable development of the study area. Less rainfall and increasing population pressure on the land as well as water resources. Hence, researcher has selected Shevgaon and Pathardi tahsils for sub-watershed prioritization. There are seven sub-watersheds selected for the present research paper, namely, Kasichi sub-watershed (Bodhegaon), Chapadgaon sub-watershed (Chapadgaon) and Erandgaon sub-watershed (Erandgaon) from Shevgaon tahsil and Chandani sub-watershed, (Pathardi), Tarak sub-watershed (Yeli) and Erdha sub-watershed (Karanji) from Pathardi tahsil. Linear aspects, aerial aspects and relief aspects are considered for the prioritization analysis. The largest sub-watershed is Erdha sub-watershed (Karanji), in Pathardi tahsil having an area of 145.06 km^2 and smallest sub-watershed is Erandgaon sub-watershed in Shevgaon tahsil having an area of 40.143 Km^2. The drainage density of sub-watersheds varies between 1.83 to 2.80 p/km^2 it indicates coarser drainage and low drainage density value is found in Chapadgaon sub-watershed. The elongation ratio varies from 0.32 to 0.70. It indicates that all sub-watersheds have elongated shape. The high value of circularity ratio of Erandgaon watershed which is 0.64. The compound parameter values are calculated. Lowest compound parameter value is given the highest priority. In this research Erandgaon sub-watershed has a lowest compound parameter value which is 2.99 and Chandani sub-watershed has a highest compound parameter value which is 5.38. All seven sub-watersheds compound values are grouped into three groups such as, high priority, moderate priority and low priority. At the end we can say that 3 sub-watersheds come under high priority, 2 sub-watersheds in moderate priority and 2 sub-watersheds are in low priority group.

Keywords: *Morphometric Analysis, Prioritization, Sub-watersheds, Compound parameters value.*

Abstract Volume

Impact of Bio-physical Parameters on Land Surface Temperature in Different Agro-climatic Zones of Satara district, Maharashtra

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Abstract

Alteration in land use and land cover pattern is the most driving anthropogenic activities of climate change which leads to changes in weather conditions. Various bio-physical parameters such as Land use/ land cover, NDVI, and NDWI in four different agro-climatic zones have been analyzed to observe the impact on LST over the Satara district. The Satara district consists of four agro-climatic zones, i.e., Western Ghats, transition zone-1, transition zone-2, and scarcity zone. In the present research work, land surface temperature has been studied with the help of MODIS satellite data over the last two decades (2001-2021). It has been observed that the land surface temperature varies over the years. The maximum temperature was observed in 2001 over the scarcity zone, and the minimum temperature was found in 2021 over transition zone-1. Further, it has been observed that these variations directly correlate to rainfall patterns. In the year 2021, annual rain affects the summer season land surface temperature. As the rainfall increases, the temperature decreases. Transition zone-1 and Western Ghats have observed the maximum rainfall, which runoffs at faster rates due to the hilly terrains. The scarcity zone also receives a sufficient amount of rainfall due to the penetration capacity of the surface is limited, impermeable surfaces developed by people, and the flat lands of the scarcity zone are unable to hold rainwater, resulting in drought-like conditions in the region. Lastly, LST and other spatial indices like NDVI and NDWI are directly correlated to each other's, which highlights that if LST increases, the NDVI and NDWI decrease and vice-versa.

Keywords: *Bio-physical, NDVI, NDWI, Land Surface Temperature.*

Detection of flood hazard zones in urban areas using multiple parameters - A study concerning Periyar river basin

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Abstract

It is evident that the frequency of floods and flood-related natural disasters is rising in recent years. Natural catastrophes are happening more frequently than ever, especially in the southern region of India, and because they have such a negative influence on people's lives, they must be avoided or at least lessened. The goal of the current study is to locate flood-prone locations in the Periyar River Basin, which is regarded as Kerala and Tamil Nadu's lifeline. The study focused on locating the susceptible areas surrounding the basin, particularly in the low-lying urban areas using the Multi-Criteria Decision Analysis (MCDA) and Analytical Hierarchy Process (AHP) method. The drainage density, Rainfall Map, Slope Map, Elevation Map, Distance from River, TWI (Topographic wetness Index), Soil Map, LULC (2021), and Distance from Road are the main parameters used for weighting and making the susceptibility map. The map is classified on the basis of the risk zones like Very High, high, moderate, low and very low according to the AHP weights calculated by using the weighted overlay method using the ArcGIS pro software. The main products used include SRTM Dem from the USGS earth explorer for the production of the drainage network, drainage density, slope, elevation, distance from the river, slope and elevation, the Sentinel-2 LULC is used for the land use land cover, IMERG GPM data for the rainfall data and FAO soil data for the soil maps. The majority of the study area lies under the moderate risk zones ie.52%. The very high and high-risk regions cover an area of 4% and 14% which is present in the built-up regions of the basin. Out of a total of 15% of built-up, 15.31% are under very-high-prone regions and 42.15% are under the high flood-prone regions. The main regions under built-up facing the flood includes the talukas of Aluva, Paravoor, Kodungalloor, Perumbavoor and Kothamangalam taluk of Ernakulam district with Irrinjalakuda of Thrissur district. The validation is done by taking flood points from KDMA. It was found that a total of 80.7% were correctly overlaid above the resulting susceptibility map showing the validation proved correct.

Keywords: *Flood, Risk, AHP, Multi-criteria*

Identification of Ground Water Potential Zone (GWP) using GIS Techniques-A case study of the Godavari River basin in the Nanded District region of Maharashtra State

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Abstract

Groundwater plays a significant role in industrial development and farming activities and helps maintain ecological balance. However, overexploitation has depleted groundwater resources considerably and led to some land subsidence. Groundwater recharge zones must be assessed to protect water quality and manage groundwater systems. This research paper aims to locate high to low groundwater potential sites of the Godavari River basin in six tehsils regions of the Nanded district. Geographic information system (GIS), remote sensing (RS), and analytical hierarchy process (AHP) methods were incorporated to conduct this research. The ArcGIS Pro software is used to prepare eight thematic layers, including drainage density (DD), slope, topographic wetness index (TWI), land use land cover (LULC), lineament density (LD), geology (GG), geomorphology (GM) and soil (SS) that are used to identify groundwater potential zones. For drainage density, slope, and topographic wetness index (TWI), SRTM Dem from the USGS earth explorer is primarily employed. In addition, Sentinel-2 Land Use Land Cover image data is utilized for Land Use Land Cover, Landsat 9 image data is used for Lineament density, FAO soil data is used for soil maps, and Bhukosh data is used for Geology and Geomorphology maps. The analytical hierarchy process gives weightage to thematic layers based on their relationship to GWP zone identification. The final map of the GWP zone is classified into five classes Poor to Excellent. Almost 3% of the site has a Poor and Low GWP zone. Nearly 28% have a Moderate GWP zone, 47% have a Good GWP zone, and 22% have an Excellent GWP zone. The given study's validation is performed using groundwater depth data from Water Resources Information System (WRIS) portal. By validating 40 station data with an accuracy of 82.5%, this observation proves that the approach taken to characterize the GWPZs in this study were correct.

Keywords: *Groundwater potential Zone (GWP), WRIS, AHP, RS, GIS*

Natural calamities, internal migration and migration policies

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Abstract

Millions of people will be exposed to the impacts of anthropogenic climate change, with projected increased duration, frequency and magnitude of extreme weather events. Climatic changes are expected to have serious impacts on land loss, with consequences on crop production, livelihood diversification and food security. Migration is one adaptive response to these impacts. Seasonal migration has long been a key livelihood strategy and a tradition for many communities. One of the reasons for migration is natural calamity in India, however, the migration due to natural calamities is increasing in recent past. An attempt has been made here to analyse the migration due to various natural calamities in India. Secondary data has been used to study. Last 50 years data has been taken into consideration for research. An appropriate statistical method has been used to see the factors affecting the natural hazards and migration. The study will be further focused on vulnerable groups among the migrants.

Abstract Volume

Health risk assessment of anomalously high concentration of chloride and nitrate in groundwater associated with proposed water harvesting structure in Gokak taluka of Karnataka state, India.

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Abstract

In the present study, an attempt has been made to identify possible groundwater potential zones in terms of quantity and quality from Gokak tehsil, Belgaum district of Karnataka state, India. A comparison between the secondary data, i.e., GIS-based map of the prioritisation zone prepared by KR-SAC with the physio-chemically analysed data of thirty (30) groundwater samples of pre-monsoon-2022 has been done. Groundwater samples were collected and analysed using standard methods prescribed by the American Physical Health Association (APHA). Anions, such as nitrate (NO3-) and chloride (Cl-), are important ions in terms of water quality. The NO3- concentration ranges from 8.28 mg/l to 118.87 mg/l, while the range of concentration of Cl- in groundwater is from 106 mg/l to 1043 mg/l. It is observed that 26 % and 33.33% of samples had a concentration of NO3- and Cl- more than the permissible limit prescribed by the World Health Organization (WHO) for drinking purposes, i.e., 45 mg/l and 250 mg/l, respectively. The categorisation of spatial variation in concentration of NO3- into, high (46 mg/l to 100 mg/L) and very high (> 100 mg/L) reveals that 23.3 % and 03.3% of samples, respectively, are unsuitable for drinking. An excess of ions, i.e., more than the allowable limit, can cause acute chronic disease in humans, such as methemoglobinemia (blue baby syndrome) in infants, as well as harmful effects on biota. So, in a proper groundwater management scenario, quantitative as well as qualitative aspects of groundwater potential zones are a need of the hour. This study demonstrates the potential applicability of the methodology in other areas with similar climatic and geologic setups on a regional scale.

Keywords: *Health risk assessment, chloride, nitrate, groundwater, water harvesting structure, Gokak*

Abstract Volume

A GIS-based approach for identifying potential sites for Rainwater harvesting in the District of Purulia, West Bengal

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Abstract

People livinginaridandsemi-arid areas with highly variable rainfall and unforeseeable periods of droughts or floods are severely affected by water shortages and often have insecure livelihoods. The building of dams in a suitable place to capture water from limited watersheds and create artificial groundwater recharge is one of the solutions available to overcome water shortages in the district of Purulia of West Bengal. The technical design of rainwater harvesting (RWH) systems and the selection of appropriate locations are crucial to their effectiveness. Our main objective was to locate dam-ready locations using a suitability model created using Model Builder in ArcGIS10.8.1. Slope, runoff depth, land use, soil texture, and stream order were some of the bio-physical characteristics that were integrated with the model. Hydrologists, decision-makers, and planners should find the suitability map helpful for swiftly identifying regions with the greatest potential for collecting rainwater. The application of this technique should also help any changes in policy aimed at encouraging the widespread use of RWH.

Abstract Volume

Channel dynamics of the Matla estuary, Indian Sundarban, Ganga–Brahmaputra–Meghna Delta

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Abstract

The Malta Estuary is located in the Indian Sundarban of the western Ganga–Brahmaputra–Meghna Delta. At present, the length of this estuary is 96 km. The main objective of this work is to monitor the channel dynamics of Malta Estuary using RS/GIS. To do this, we have extracted the land-sea boundaries (coastlines) of the estuary from Landsat scenes of 1975 (MSI), 1990 (TM), 2005(TM), and 2022 (OLI) using unsupervised image classification. Based on accretion and erosion patterns, the Malta Estuary can be divided into two parts —Upper (From Canning to Herobhanga Island: 51 km) and Lower (From Herobhanga Island to Bay of Bengal: 45 km,). Two different processes dominate these two sections. Net accretion has occurred at a high rate of 0.62 km2/yr in the Upper Malta whereas net erosion has occurred at the rate of 0.68 km2/yr in the lower Matla during the last 47 yr. Tidewater of the Bay of Bengal is the main source of sediments for this estuary as it does not connect to any up-country river. As one goes towards the land from the sea, the intensity and effect of the tidal prism decrease. The sediments that get transferred with water to upper Matla during the high tide, does not return during the low tide due to time-velocity asymmetry in the tidal currents (flood dominance). It is expected that sediment accretion will continue to occur in the upper reaches of the Matla Estuary in the future, which will further reduce the length of the estuary and increase its tidal range.

Abstract Volume

Use of Geo-Spatial Techniques in Analyzing Morphometric Parameters: A Case Study of River Sina

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Abstract

Morphometric analysis is important aspect while studding the drainage basin. In present time GIS and Remote Sensing are the technique which are very supporting and useful for morphometric analysis. Before 1980 it was very difficult to measured morphometric ratios from the toposheet. The present paper aims to attempt morphometric analysis of river sins from tis source to mouth. Sina has it source at Sasewadi at the height of 956 meters with the stream order 7th. And the total length is 339km. For the morphometric analysis SRTM data with 30 m resolution is used. With the help of Arc Map software DEM is prepare for river Sina basin.1 Other linear and areal aspect are measured. According to the Geomorphologist mean bifurcation ratio 2. In the case of River Sina it shows 4.76 so it shows that the region is neither hilly nor dissected. The total number of streams are 18444. Regression Equation and coefficient of co-relation is calculated. There is positive relationship between mean stream length and stream order. Mean stream length increases with stream order. The sinuosity index of the stream is 1.5 is shows the characteristics of plateau area. Circularity index 0.3 shows highly elongated shape of the basin. Drainage texture value for Sina river basin is 2.65 which falls in coarse texture Drainage basin. The present research paper focus on the information about morphometric setting of river Sina. Morphometric analysis of any river is required because it gives the information of total basin for example Bifurcation Ratio gives the drainage pattern development. Morphometric analysis also gives the hydrological characteristics of the river and also useful in flood control Planning. All the above analysis geo- hydrological characteristics of rivers Sina drainage basin in relation to its terrain are quantified with respect to soil erosion, flood characteristic etc.

Keywords: *Geo-spatial, Morphometric Parameters, Hydrology, Drainage Basin*

Abstract Volume

Assessment of Chute Channel Morphology in Krishna River and Its Tributaries

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Abstract

River channels reveal a diverse range of channel forms. The dynamic nature of the river is the reason for an important focus of attention in surface water studies. The study of channel morphology plays a vital role in knowing the nature of river channels. Numerous studies have been carried out to study the morphology of the channel through the analysis of cross-sections of the river channel. The present work aims at studying the cross-sectional areas of the chute channels of the Krishna River and its tributaries. The study area lies on the boundary between Maharashtra and Karnataka states. A total of six chute channels are identified in the study area. The study is based on geospatial techniques. The chute channels are identified by using Google Earth images and a digital elevation model (DEM). The cross-section was taken using the Arc GIS platform. In general, the river channel shows great variations in the characteristics of the morphology, like the shape and size of the channel. The most significant attributes of the channel form are the width and depth of the channel. The width-depth ratio and channel width are found to be the most variable parameters in the morphological studies of a channel. The morphological parameters in the given study reveal that there are variations in the width of the chute channel from the area of chute channel separation to the confluence, and this is because of the change in lithology of the area or because of active agricultural activities. The wide channels are observed in the middle part of the chute channels. This widening of the channel increases the cross-sectional area of the channel and lowers the velocities, which results in the deposition of bed material within the channel. This condition is observed in the chute channels near Akiwat, where we can witness a central bar like formation and some rocky outcrops are also observed.

Spatio - temporal Analysis of Groundwater Contamination in Kolkata

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Abstract

Groundwater is a vital resource for survival, livelihood, food security, agricultural and industrial purposes in India, yet a range of land and water-based human activities damage this critical resource. In India, achieving sustainable growth and efficient water management is becoming a more difficult task. The purpose of this paper is to establish a relationship between the spatial and temporal analysis of groundwater contamination in the Kolkata region of West Bengal, India, using a variety of primary and secondary sources (Central and State Government data) on groundwater availability, contamination, and utilization. A primary survey was conducted utilizing Google Forms-based structured questionnaires and schedules to collect data from people in the study region using the random sampling approach. The minimum depth to water level in Kolkata, West Bengal has increased from 0.55 to 1.32 mbgl (pre-monsoon) but the maximum depth has decreased from 20.75 to 19.55 mbgl. The results showed that bicarbonate pollutants are prevalent in the groundwater in the western and south-central parts of the city. The total hardness of the groundwater in the southern section was found to be 150 mg/lt, which is within the WHO and BIS permitted limits. The 'high-risk zone' in Kolkata has resulted in a decrease of subterranean piezometric level as low as 12 metres due to uncontrolled removal of groundwater compared to its recovery. The number of wards at risk of arsenic poisoning has risen, and the situation in most areas of Kolkata has deteriorated.

Keywords: *groundwater contamination, critical resource, deteriorated*

Application of Spatial Technology in Malaria Information Infrastructure Mapping with climate change perspective in Maharashtra, India.

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Abstract

The present research paper proposes Malaria Information Infrastructure Mapping in Maharashtra, India. using Cloud Spatial Data Infrastructure (SDI) Model with a perspective on Climate Change. In m-cloud, a geospatial health database has been developed for positive cases and that the number of deaths due to Malaria from 2001 to 2014 in Maharashtra, using Open Source GIS software; Quantum GIS, and Map Window GIS. Transmission windows (TW) months for malaria were identified for all 35 districts in the state using climate data on temperature, rainfall, and humidity. Overlay analysis was carried out using the cloud model and different graphs were generated. Mosquitoes are active between 20°C and 34°C.window. However, peak transmission can extend up to 29°C. Observations of climate data during the last 100 years, over India, show a rising trend in surface temperature by 0.3°C. As a result, there is a growing concern about the possible resurgence of vector-borne diseases, such as malaria, in some parts of India. Regression analysis of simulated mean temperature based on CORDEX data for the period 2015-2050 over Maharashtra shows an increasing trend over Maharashtra until 2050.

Erosion and accretion assessment along Hatnur dam reservoir of Tapi and Purna rivers, North Maharashtra: A geospatial approach

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Abstract

The Tapi River rising in the Gawilgarh Hills of the central Deccan plateau in central India. The Purna River confluences with the Tapi River at Changdev village of Jalgaon District in Northern Maharashtra. The rivers are having the bedrock channel and under the present hydro-geomorphic conditions the dominant fluvial activity is not directed towards the channel bed, but towards the banks, hence the attempt has been made to evaluate the temporal variations in erosion and accretion for the Tapi River and Purna River, at backwater region of Hatnur dam in Jalgao district. In the present study, we assessed erosion and accretion of 31 years. Satellite images of Landsat MSS and TM and ETM acquired from the year 1989, 2000, 2010 and 2020 have been used. Demarcation of bank lines done for each year. In order to measure the bank line migration, the shape files of bank lines of two consecutive years were taken, pattern of decadal changes of river bank line analyzed using GIS techniques and estimation of erosion and accretion areas for different time periods were done by using ArcGIS. The study reveals that for period 1989-2020 the river has experienced differential amounts of erosion and accretion. From the observation and analysis of temporal changes, it is shows that for period 1989-2000 near Balwadi village the channels of Tapi River and Purna River showing more erosion i.e 320 hectares and 366 hectares respectively. For period 2000-2010 also channels show more erosion, 437 hectares for Tapi River and 164 hectares for Purna River near Muktainagar region. From 2010-2020 channels of Tapi River and Purna River shows more accretion i.e. 977 hectares and 850 hectares respectively and less amount of erosion observed. For 31 years of span 1989-2020, channels showing more accretion 591 hectares for Tapi River and 551 hectares for Purna River and shows some amount of erosion near Muktainagar.

Identifying Groundwater Potential Zone using Remote Sensing and GIS – A case study of Shirur Taluka

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Abstract

Groundwater is considered as the source of water for meeting domestic, industrial and agricultural requirements, due to longer residence time in the ground, low level of dirt, wide distribution, and availability within the arrival of the end user. Even the existing wells are getting dried-up due to reduce of ground water. Groundwater potential is a basic pre-requisite for efficient groundwater resource development and management, which is important for India with widely prevalent semi-arid and arid climate. Using remote sensing and geographic information system (GIS) it is possible to take number of different thematic maps of the given study area and overlay them on top of to each integrated layer. This study was aimed to identify the groundwater potential zones, to be used for better and improved groundwater resources. The thematic layers considered in this study are geomorphology, soil, land use land cover, slope (%), drainage density, which are prepared using satellite imagery and other conventional data. The thematic layers were first digitized from satellite imagery, supported by ancillary data such as Top sheets and field investigation data; it is then integrated with weighted overlay in ArcGIS. Suitable ranks are assigned for each category of given parameters. For the different geomorphic units, weight factors are decided based on their capability to store groundwater. This procedure is repeated for all the layers and consequently layers are reclassified. The groundwater potential zones are classified into five categories like poor, moderate, very high & excellent.

Abstract Volume

Coal Mining and its Impact on Surrounding Environment: A Geographical Assessment in Dudhi Tehsil

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Abstract

Mining refers to the extraction of geological materials of the earth surface. Coal mining has always been a backbone of economy as it provides base for industrial setup. Coal mines in the study area are part of Singrauli coal series. This series bears bituminous type of coal formation. The coal from these mines is supplied to numerous thermal power plants located in the nearby areas. The major coal mines in these areas are Kakri, Bina, Kharia and Krishnshila. These are open cast mines. Physiographically, it lies in Chhota Nagpur Plateau. The area has thick forest cover. It is a tribal dominated area. The major tribes of these areas pahariya, baiga, gond, chero etc. These tribes derive their livelihood from the forest product. The unplanned growth of coal mines has brought a significant change in land use pattern and its utilisation. It has adversely affected socio-economic status of the native people who are mainly tribals and have led to degradation of surrounding environment. Hazardous coal mining and consequent industrialisation have led to issues of livelihood, displacement, rehabilitation, and environmental sustainability. This work deals with assessing the impact of coal mining on land use pattern, utilization, landscape change health issues being faced by the people in that area. It takes into consideration socio-economic ramification of changed land use pattern and utilisation. The work's centrality revolves around life, livelihood, residence, occupational structure and way of life and how mining activities have impacted them. The work is based on both primary and secondary data source. GIS and remote sensing techniques been used for land use change detection. Questionnaire, schedules, and surveys have been prepared to asses impact of mining activities on the socio-economic conditions of the tribal population living in this area. The result shows that there has been a significant change in life, livelihood, residence, and environmental quality.

Keywords: *Coal, Environment, Mining, Tribes, GIS,*

Abstract Volume

Flood-Prone Zone Delineation in the Indian Ganga Delta Based on the Major Flood Events between 1995 and 2020

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Abstract

The Ganga–Brahmaputra–Meghna Delta (GBMD) is the world's largest in respect of area (c. 120 × 103 km^2) as well as annual discharge of sediments (c. 109 t). The southwestern part of the GBMD, known as the Ganga Delta, is contributed by the Ganga River and its numerous distributaries. It spans over a number of districts in Bangladesh and India. The western portion of the Ganga Delta is located in the Indian state of West Bengal, which accounts for 42,371 km^2 area in 14 districts. The estimated population residing in this region in 2021 is ~76 million. The Ganga Delta is completely enveloped by the alluviums deposited by the fluvial processes during the Holocene. Practically every major river in the region is embanked on both flanks to prevent overspilling during the floods. Floods occur because of extremely high rainfall events during the monsoon season (June–September), and due to tropical cyclones, when these embankments are breached or overtopped. This study aims to delineate the flood-prone zones of the Gangetic West Bengal (GWB) based on the highest inundations that occurred between 1995 and 2020. Besides, it attempts to extract land use and population data of the flood-prone area on different administrative levels. Using the highest-magnitude flood events for five overlapping zones, it is found that about one-third area of the GWB is susceptible to inundation by floodwater, thereby affecting about 18 million people. Overlying the inundation area over 226 administrative blocks of the region reveals that 51 highly populated blocks located close to the principal rivers are more susceptible to flooding. The deepest flood localities of the east–central GWB noticeably coincides with the blocks having highest percentage of inundated area (>50%) and considerably large population size. 34% of the concerned blocks are susceptible to inundation of 50% or more with respect to their total area. The districts of Nadia and Murshidabad are found to have relatively more inundation area, with almost 16% of the total flood-susceptible area of the GWB lying within each of these districts. The study connotes that floods and the region's cultural landscape consisting of habitations, farmlands, and communication lines are closely related.

Keywords: *Ganga Delta, flood, embankment*

Abstract Volume

Evolution of Channel Bars in the Bhagirathi-Hugli Course from 1972 to 2022 based on Satellite Images

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Abstract

The Bhagirathi-Hugli is the largest distributary of the Ganga River and it traverses through the southern part of the West Bengal state till it reaches the Bay of Bengal. This 466 kms. long channel has more than 112 channel bars in its non-tidal to meso-tidal reach. This work analyses the morphodynamics of these channel bars on a multi-temporal time scale through geo-spatial data visualization on GIS platforms. The intent of this paper is to explore the fluvial dynamics in the region and bridge any existing research gap. Channel bars have been delineated by registering and digitizing Landsat images from 1972 to 2022. Channel bars of different shapes and sizes have been found at distinguishable locations along the non-tidal and tidal regimes of the river. Channel bar activity fosters a unique sequence of bar evolution incipient from mid-channel sand bars to full floodplain integration, thus catalysing a 'Bar life-cycle'. An aggregate increase of 62% of channel bar area has been detected over the study timescale. The impact of the Farakka Barrage Project has also been assessed in the evolution of these channel bars. The occurrence and development of these channel bars spark research interest from geomorphological aspect as these bar lands not only act as sinks for agriculture/farming activities, but also acts as a crucial sediment reservoir within the river system.

Mission Planning for Drone based Exploration of Geomorphology

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Abstract

Applications of UAV technology in geomorphology are rapidly increasing. This paper describes the detailed planning required for drone-based exploration of geomorphology in terms of vehicle selection, sensor selection, path planning, algorithm selection, and safety considerations. The types of UAVs are to be selected based on various factors such as specific terrain, weather conditions, and specific mission requirements. In this paper, we have described the different trade-offs among fixed-wing, multi-rotor, and VTOL vehicles for different geomorphologic missions. Most UAVs currently used in the geomorphologic mission are commercial drones with limited capability and are not suitable for complex missions. UAVs need to have the capability to handle the altitude variation of terrain, obstacle avoidance, and flexibility of carrying a different type of sensors for general use in geomorphology. We have discussed the general design architecture of UAVs by analyzing the different requirements of major geomorphologic missions such as glacier tracking, landscape monitoring, host-rock mapping, and river bed mapping. For an efficient mission, the UAV paths need to be planned considering the overlap, camera field of view, desired frequency, illumination and incident angle of the camera. Existing single drone-based geomorphological missions will have limited application for a larger terrain; we have discussed the framework required for multi-drone operations for important morphological missions. Specific mission planning and algorithms required for developing high-quality point cloud, DEM and orthomosaic are developed. The latest advancements in sensor technology have furnished the scientific community by providing several high-resolution images (RGB, multi-spectral, thermal). The relevancy of these sensor advancements has opened up several research perspectives in geomorphological analysis. Such kind of analysis needs to be automated to have a large-scale exploration of a particular terrain. This paper discusses a decision-making platform related to sensor selection, pre and post-data processing, and suitable algorithmic analysis for geomorphological exploration with UAV imagery. Instead of a time-consuming and laborious small-scale field study, UAV imagery can provide the small-scale automated primary study of geomorphology that can be further integrated for large-scale analysis with satellite imagery. These aspects of the integral study are also addressed in this paper. To a larger extent, this kind of study can help efficient urban planning and flood management in a highly populated country like India which emphasizes the importance of scientific exploration with UAV imagery.

Landscape Changes and Environmental Auditing of Mumbai Metropolitan Region

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Abstract

With changing landscape, the impacts on the environment are increasing. On one hand technological and industrial advancement is a boon for the human race, on the other hand it is a bane for the environment. It must be understood that if man is the cause of environmental damage he is the primary victim too! With this background, environmental auditing of the ever-increasing urban space viz. Mumbai Metropolitan Region is undertaken. Therefore, the underlying objectives of the research are to analyse the changing land use and land cover of the study area over 30 years between 1997 and 2017, to record the levels of air, noise and water pollution in the study area, to understand the scenario of solid waste management in the study area and to analyse its impact on the health of people and environment. The research methodology includes collection of primary data using appropriate tools like AQI monitor, decibel meter, water sampling and testing pH levels and observation of waste management techniques. It also includes extraction of satellite imagery from BHUVAN website and creation of land use maps. The land use and land cover maps are created using supervised classification in ArcGIS. Ground truthing has been undertaken for selected points. The major findings highlight that the land use has changed drastically in several areas in the region to become urban areas from vegetation and the levels of pollution are higher near the urban areas and lower near rural areas. This is an indication that urbanization is a major cause of environmental damage. The main recommendation is to undertake planning and public awareness to minimise pollution. Overall it is concluded that the expanding region is becoming environmentally fragile which must be stopped.

Keywords: *land use change, environment, auditing, urbanization, pollution*

Abstract Volume

Mangrove Cover Change Detection in Mhasla Creek, Maharashtra, using Multitemporal Satellite Data

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Abstract

Mangroves along the coast are always of great ecological and economic importance. Their economic importance for the livelihood of local people has damaged and cleared off mangroves in many parts of the world, Indian subcontinent is not an exception to that. Monitoring the changes in mangrove cover is possible and economically feasible due to the remote sensing technology. The database on the spatial extent of coastal vegetation especially of mangroves and their conditions has been created using USGS-LANDSAT data. Change in mangrove cover with respect to high and low water line of the Mhasla creek is obtained and mapped with the help of temporal satellite data using NDVI technique by using Arc-GIS and ERDAS. Based on this study, it is observed that the estimated area under mangrove in the study area was 21.68 km2, 22.92 km^2, 23.09 km2, and 25.09 km^2, in 1989, 1998, 2008 and 2015 respectively. During 1989 to 2015 coastal vegetation cover has been increased by 3.41 km^2 indicating 1.44 % rise in last four decades. It has been observed that the quantitative increase in mangrove is attributed to changes in the shoreline, and the spreading of saline water over agricultural and coastal land. This study would of an enormous assist in finding out the changes in mangrove of Mhasla Creek as its past and present situation and distribution. This would also aid in monitoring and management of coastal vegetation as well as mangrove resources. The investigations would greatly help in understanding and proposed planning for environmental characteristics and productivity of the coastal ecosystems. The standard and truthful mapping of this land resource is essential due to various advantages are given by it, particularly for the farmers and livelihood of fishermen in Mhasla creek area.

Keywords: *Coast, Mangrove, Mhasla Creek Multitemporal Satellite Data*

Extent and Type of tidal flats in Sagar and Nayachar Islands of the Hugli Estuary

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Abstract

The origin, process, ecology, and geomorphology of the tidal flats on Sagar Island and Nayachar Island in the Hugli Estuary in West Bengal are the key topics of the geomorphology research. In the Hooghly estuary, where tides are dominant, tidal current energy outweighs wave energy. Riverine energy weakens the estuary because it is opposed by tidal energy. Regardless of estuarine hyper-synchronicity, friction inside the estuary causes the tidal energy to diminish after a certain distance. This friction is made worse by the presence of char lands, island margins, emergent tidal flats of sand bars, and estuary bank tidal flats. The zoning map was created on the coastal areas of Sagar and Nayachar Islands using various Google Earth images from previous years, field research, photography, a dumpy level, measuring tape, and other tools. The several feature types were digitalized from runnel map 1776, SOI Toposheet, satellite image, and Google Earth. The tidal flat's altitude was measured using a dumpy level, and its slope was determined using a clinometer. Important creeks have been digitally preserved from the 1965 toposheet, and ERDAS and ARC GIS were used to measure each watercourse individually. Sagar Island 2019 sentinel data was used to create a digital elevation model to identify the coastal elevation. It has been determined how the seashore of Sagar Island has changed during the past 32 years. The Survey of India and satellite images from the years 1990, 2002, and 2020 were used to calculate the island's land area. Using image processing software, topographic sheets were georeferenced and used as basis data. In the broader tidal flat, open and protected tidal flats play an important role in maintaining the ecological and morphological stability, which is greatest in South Sagar near Simaphari. The beach has a modest slope, with a maximum slope of 18 degrees and a minimum slope of 2 degrees, according to the slope profile. Sagar Island's northern portion is roughly 8 metres above sea level, which makes it taller than the remainder of the island. As a result of the constant accumulation of silt, Nayachar Island's surface was eventually covered in salt marshes, whose species associations underwent various types of succession in response to the shifting bio-tidal environment brought on by geomorphological dynamism.

Keywords: *Sagar Island, geomorphology, marshes, ecology, estuarine*

Abstract Volume

Application of Geospatial Techniques for Identifying Issues and Challenges of Chitrakoot District

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Abstract

The present study is for Chitrakoot, one of the backward districts of Uttar Pradesh, located in the Bundelkhand region. This region suffers from issues like water scarcity and land degradation. For the identification of these issues and challenges modern techniques of GIS can be utilized to provide feasible solutions. GIS is one such tool that can handle spatial information and analyze various attributes of data. With its help several task like drought prone areas analysis, degraded land areas could be identified. Along with it the physical features of the area could be studied. The aim of the present study is to see the possible GIS applications with respect to identifying issues and challenges of Chitrakoot. The application of Geospatial techniques for identifying problems of Chitrakoot shall go a long way in paving the way for development of this region.

Keywords: *geospatial techniques, backward areas, sustainable solutions.*

Abstract Volume

Morphometric Analysis of Muchkundi River Basin, Ratnagiri District, Western Ghat, India: Implications to Neotectonic Response

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Abstract

The morphometric analysis to determine the spatial variations in drainage characteristics of Muchkundi River Basin (MRB) and its 33 sub-basins based on topographic maps and IRS P4, LISS IV MX imagery. The area is selected from the Muchkundi River basin, central west coast of India, Ratnagiri district of Maharashtra state; bounded by Lat. 16° 40' to 16° 57' N; Long. 73° 18' to 73° 52' E. The area is covered in the Survey of India topographic sheet numbers 47H/5, 47H/6, 47H/9 & 47H/13, on a scale of 1: 50,000. The study revealed that the Muchkundi river basin is a sixth order basin and its geomorphic evolution is greatly controlled by neotectonics activities. This study exhibits the linear, areal and relief aspects of the 33 sub-basins and highlight the genesis of landforms and fluvial processes. In Muchkundi River Basin (MRB), seventeen third-order, nine fourth-order and seven fifth-order sub-basin are present. The morphometric parameter has been carried out, mainly bifurcation ratio, drainage density, stream frequency, constant of channel maintenance, drainage texture, elongation ratio, circularity ratio, form factor, relief ratio, length of overland flow, infiltration number and asymmetric ratio. In the study area, the majority of the sub-basins are structurally controlled development of drainage networks, mainly Dhulapwadi, Natunda, Vatul, Satavli, Dhangarwadi, Vankad, Khandwadi, Borthad, Dasur, Panore, Hasaldevi, Kotapur, Desaibandh, Kondaya, Vaniwadi, and Shivne, Prabhanwalli and Hardkhale sub-basins are structural control. The drainage density is low to moderate for Dhulapwadi, Vatul, Nanarkewadi, Satavli, Budhwada, Bhavudwadi, Agrewadi, Borthad, Dasur, Panore, and Hasaldevi sub-basins indicating moderate to high infiltration rate, permeable sub-soil material and dense vegetation cover. Prabhanwalli, Lanja, Hardkhale, Aregaon, Kotapur, Kondaya, Vaniwadi and Dhulapwadi sub-basins are elongated shape basins. Panhale, Lavgaon, Katalwadi, Jambuwadi, Manekundawadi, Budhwadi and Vankad sub-basins are oval in shape. The lineament has controlled the N-S stream segments of tributaries of the Muchkundi rivers west of the Lanja area. The knickpoints and V-shaped valleys along these lineaments are indicative of the rejuvenation stage of the Muchkundi river. Overall, the systematic morphometric study demonstrates a neotectonics of MRB.

Land Reclamation in the Meghna Estuary Region, Bangladesh

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Abstract

Land loss due to riverbank and coastal erosion and conversion of farmlands to other landuse are common in the densely populated and low-lying Bangladesh. Coastal land reclamation has also been practiced here for centuries, in various forms. Possibility of submergence from global warming-induced accelerated sea level rise has rendered a sense of urgency into this. Being the current depocenter of the Ganga–Brahmaputra–Meghna system, land reclamation from the Meghna Estuary region is one of the best possible ways to compensate the land loss, expand the farmlands, and ease population pressure. Here we describe the history of land reclamation in the Meghna Estuary region and its related consequences by using early documentary records, neoteric information available in the public domain, Survey of India topographical maps, and Resourcesat-2 LISS-4-fmx images. We also look into the resource-perception of the Government of Bangladesh (GoB) on sediment discharge of the Lower Meghna and its proposals on land reclamation from the estuary and the sea. Land reclamation of the Meghna Estuary region was started by constructing the first cross-dam (Noakhali-1) in 1957 on the eastern branch of the Meghna joining the North Hatiya Island (now Ramgati, 22°49' N, 90°48' E) with the mainland at Lakshmipur (22°56' N, 90°50' E). The second cross-dam (Noakhlai-2) was placed in 1964 and connected Char Jabbar Island with the Noakhali mainland. About 1320-km^2 of land was reclaimed due to construction of these dams, as former islands like Noakhali, North Hatiya, and Siddi became part of the mainland. Consequently, the left bank of the Meghna shifted 37 km towards the sea and its main flow was diverted towards the west. Recently, The GoB has planned to construct several cross-dams and to accelerate the process of deltaic accretion by trapping the Meghna sediments for land reclamation in the coastal areas. Among these, the Sandwip–Urir Char, Noakhali–Swarna Dwip, and Swarna Dwip–Sandwip cross-dams are notable.

Keywords: *Meghna Estuary, Sediment discharge, Cross dams, Land reclamation*

Application of Schmidt Hammer for Appraisal of Micro-Weathering Index and Weathering Grade of Diverse Geomorphic Features of Cratonic West Bengal

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Abstract

The cratonic part of West Bengal is developed through polyphase deformation and metamorphic evolution. The region is characterized by denudation ridges and undulating plains along with several erosive geomorphic landforms, which are largely consisted of intrusive granite and granite gneiss. These diversifications of geomorphological landforms are formed due to numerous natural processes dominated by lithological control. This Proterozoic (1.72 to 1.87 Ga) terrain had have experienced intensive weathering processes over the long period under different climatic conditions. The rock mass properties change with the degradation of mechanical integrity of minerals over time, varying with different meteorological and petrological conditions. Degree of weathering is denoted as the percentage of deterioration of rock surface from its intact conditions. A new approach to assess the degree of rock-surface degradation in its natural environment, is the application of different kinds of rebound devices like Schmidt hammer. In the present study, an attempt has been made to assess the rock surface hardness of the Upper Subarnarekha Kangsabati Interfluve (USKI) using Schmidt hammer and synthesize the history and variation in intensity of weathering A total number of 965 Rebound (R) values were collected from deeply weathered (DW) and relatively less weathered (RLW) rock surfaces of eight geomorphic features located in the USKI. The degree of weathering and weathering grade of landforms are computed using micro-weathering index and weathering grade index respectively. The results of the study revealed the different responses of diverse types of rock to the geomorphic processes. The weathering grade index of eight identified features depicts that seven features belong to moderately weathered (grade III). In the present study, in situ assessment of exposed rock surface weathering of studied region using Schmidt hammer is a unique attempt to understand the degree of weathering and weathering grade of studied features in quantitative way. The present study can also be linked to the weathering variability and its intensity of various geomorphic features, scientifically and systematically.

Keywords: *Schmidt Hammer; Micro-Weathering Index; Rebound Value; Weathering Grade*

Assessing human control on planform modification over floods: a case study on Lower Mahananda-Balason River System, Darjeeling, India

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Abstract

An indicator-based assessment, using 5 indicators each on anthropogenic interventions and channel planform, for 3 major flood events in 1968, 1993, and 2017, was carried out to identify the predominance between floods and human activities in modifying the planform of the Mahananda-Balason system (MBS). Initially, the unconfined stretches of the studied system were segmented into 20 equidistant reaches; and used as the assessment units. The landuse landcover practices of the study region were classified using the Support Vector Machine algorithm. The impact of human activities on channel planform was quantified through panel data regression. Planform attributes, measured for pre and post-flood for the selected years, were tested using the two-tailed 't-test'. A total of 4 cross-sections were measured and the flood level of 1968 was superimposed to assess if that level of discharge can cause flooding or not. Results showed that built-up areas had expanded by 197.85% during these 49 years, for the entire area, at the expense of agricultural land or grassland and river. Accordingly, embankments increased from 2.63% in 1968 to 51.85% in 2017, and almost the entire channel bed (82%) was experiencing large-scale sediment extraction and significant portions of the adjoining floodplain were concretized (24.10%). Following that, CA, CW, CL and BI were reduced significantly by ≥ 40%. The reduction of CCB was also significant but relatively lower in percentage (10.69%). All these fluctuations in channel planform properties were well explained by anthropogenic interventions since the R^2 values were measured > 0.70 indicating a strong correlation between the anthropogenic intervention and channel planform alterations. Increased human activities had impacted the channel planform in such a way that except in 1968, no significant inter-seasonal fluctuations regarding channel planform were measured. A few channels and planform properties responded to the occurrence of floods in 1993 and 2017. Conversely, a few reach even experienced channel narrowing after the flood discharge. Embanking was done on such a large scale that in most areas, even the floods like that of 1968 could not overtop it. Coupled effect of these anthropogenic interventions is converting this river system into a controlled river system where natural channel forming factors have limited roles in reshaping channel planform, which in return is causing socio-hydrological hazards in the form of undersupply of sediments, lack of groundwater, and destabilization of bridges. This cost and time-effective methodology can be adopted in other rivers also to assess the extent of anthropogenic interventions and planform alteration along with identifying the responsible factors behind the planform adjustment, however, more in-depth and long-term study is required to fully understand the interrelationship among the anthropogenic interventions and change in channel planform.

Keywords: *Anthropogenic interventions, High Flood Level, Planform alterations, Sub-Himalayan foothills*

Analysis of Current Direction in a Tropical Fluvial System: A Study of Ajay River Basin

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Abstract

River is a ubiquitous geomorphic agent in tropical areas and is considered as the most influential process in shaping the fluvial architecture. The Ajay is an ephemeral, monsoon influenced river, originated from the Chhotanagpur plateau at Batpar of Jamui, flowing through heterogeneous lithology and finally meets with the river Bhagirathi. The Ajay River is meandering in nature but range of sinuosity varying at reach scale. Depending on altering sinuosity, different types of bars are developed. Bars are important alluvial signatures which provide detailed information about river behavior. Here an attempt has been made to study the palaeo-flow direction of nine point bars and compared with the present water flow direction of the Ajay river within West Bengal. Palaeo-current data help to reconstruct the details of fluvial system, especially the sedimentary environment. The present work was carried out on the basis of detailed field work at different segments of the Ajay river within West Bengal. Point bar of Palashdanga, Illambazar, Kotalghosh, Kogram (Left Bank), Kogram (Right Bank) i.e. Kunur-Ajay confluence, Mangalkote, Nutanhut, Kowarpur, and Chakdaha sections were mapped by Total Station survey. In this work palaeo-directional data were obtained from the primary sedimentary structure by using Brunton compass and Clinometers by maintaining an equal interval method and also collected from the first cross-bedding below the point bar top surface and from the vertical section of the old bar. Present flow direction data of channel water were collected using floats, microform developed in active channel and also from sand grain orientation. By using collected directional data, vector mean of palaeo-and present flow direction were computed. Analytical results revealed that difference is minimum between present and palaeo-flow direction in middle to lower reach of the Ajay river. The directional relationship between the palaeo water flow and the present water flow direction was divergent in two segments, convergent in four segments and almost parallel in three segments within the studied stretch of the river channel. The results help us to understand the sedimentary environment and changing flow regimes of the Ajay river, which can be used for better river basin management.

Keywords: *Ephemeral; Palaeo-current; Vector mean; Flow regimes*

Abstract Volume

Pleistocene–Holocene Transition: A Sedimentological Reconstruction from the Sediment Succession of the Eastern Subarnarekha Coastal Region, West Bengal and Odisha

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Abstract

The Eastern Subarnarekha Coastal Region (ESCR) revealed a significant change in facies character at the depth of 30 mbgl. Granulometric investigations in 28 borehole sediment samples indicate that the upper sandy intervals are marine with some aeolian inputs in the topmost intervals while multiple gravel beds alternating with sporadic coarse sand interlayers in the basal part of the section are fluvial deposits. The depositional hiatus at 30 mbgl at the ESCR, marks the transition of early Holocene marine deposition subsequent to the end Pleistocene fluvial deposition. Published data on sediment succession in the region also records similar facies change at comparable depths suggesting Pleistocene–Holocene facies transition not earlier than 10,000 years BP.

Keywords: *Granulometry, borehole data, Pleistocene–Holocene boundary, depositional environment*

Geomorphosite evaluation for geotourism development using geosite assessment model (GAM): a study from a Proterozoic terrain in Eastern India

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Abstract

Geotourism is nature-based tourism of the landscape and landforms, which emphasizes the sustainable use of geomorphosites. Geological and geomorphological landforms getting scientific, aesthetic, cultural, and economic value from human perspective is considered as geomorphosites. The objective of the study is geotourism potentiality of the Proterozoic terrain of eastern India is evaluated through the generalization and identification of the Geomorphosites using 10-digit geo-coding scheme proposed by V.S. Kale in 2015 and geosites assessment model (GAM). The studied region has vast richness in diversified landforms due to multi-phase evolution history and wide range of geomorphological events occurred on the terrain. A total number of twelve geomorphosites have been identified to evaluate the geotourism potentiality. The structure of GAM has been modified in this study by add a secondary indicator (ecological interest) in scientific value and a primary indicator (cultural value) in additional value. The results revealed that top five geomorphosites have high geotourism potentiality such as Ajodhya, Dalma, Gar Panchakot, Joychandi, Susunia, whereas Dhangikusum and Jharnakocha have low potentiality. The improvement of infrastructure and accessibility to geomorphosites will be increase the additional value of the site and also increase geotourism potentiality. The development of geotourism on geomorphosites emphasizes the economic and cultural utilization of landforms and geo-conservation of features of the geosphere which will yield better the socio-economic condition of the region.

Keywords: *Geomorphosites; Geotourism; Chhotanagpur Plateau; GAM*

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