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EDITORIAL

GIScience applied to soil-agricultural health and environmental risk assessment

Pravat Kumar Shit[1] · Partha Pratim Adhikary[2] · Debashish Sengupta[3]

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Soil and agricultural systems play a vital role in the global environment and the well-being of humanity. They provide essential goods and services that are crucial for sustainable development and benefit people all around the world. However, soil contamination has emerged as a major environmental hazard, posing significant risks to both environmental health and safety (Dash et al. 2016; Bera et al. 2022). In the twenty-first century, the key challenge we face is to reduce the contaminant load in soil and bring it below permissible levels. Soil contamination is not confined to the local areas where it occurs; rather, it can spread to other regions due to the easy transportation of pollutants. This poses a serious threat as it leads to contamination not only of the immediate surroundings but also affects distant areas (Chakraborty et al. 2021). The consequences of soil contamination are far-reaching, impacting not only the land itself but also affecting aquatic systems like surface water and groundwater (Adhikary et al. 2015). Such contamination poses substantial risks to natural ecosystems, disrupting their delicate balance and functioning. Addressing soil contamination is crucial for safeguarding our environment and ensuring a sustainable future. It requires concerted efforts and innovative strategies to mitigate pollution sources and remediate already contaminated sites (Purakayastha et al. 2008). By taking action to reduce soil contamination, we can protect our ecosystems, preserve the quality of our natural resources, and secure the well-being of present and future generations.

This special issue discusses the Soil-Agricultural Health and Environmental Risk Assessment and their relationship through modern geospatial techniques and GIS data management to control and management of soil pollution in order to preserve soil fertility and increase productivity as well as reduce the ecological risk. After a meticulous peer-review process, twenty-four (24) high scientific-level papers have been accepted for publication. They mainly concern sustainable development of soil, water, and environment systems.

In the first paper entitled *Analysis of peri-urban land use/land cover change and its drivers using geospatial techniques and geographically weighted regression*, conducted in the peri-urban areas of Delhi National Capital Region (Delhi NCR), the researchers aimed to analyze the transformation of natural land use land cover (LULC) to built-up areas. The region has experienced significant changes in LULC due to its attraction of a larger population seeking better economic opportunities over the past few decades. Using LANDSAT datasets and extensive literature search, the study examined potential drivers of LULC change in Delhi NCR using ordinary least squares (OLS) and geographical weighted regression (GWR) analysis. The findings revealed a substantial increase in built-up areas from 1.67 to 7.12% of the total area between 1990 and 2018, while other LULC types declined significantly. Migration and employment in the tertiary sector were identified as the primary drivers of built-up expansion in the region based on OLS results. The GWR analysis showed spatial heterogeneity in the coefficients of explanatory variables across the study area. These research outcomes can be valuable for urban policymakers and planners to formulate improved master plans for Delhi NCR and other developing cities, considering the dynamics of LULC change and its drivers.

Responsible Editor: Philippe Garrigues

✉ Partha Pratim Adhikary
Partha.Adhikary@icar.gov.in

Pravat Kumar Shit
pravatgeo2007@gmail.com

Debashish Sengupta
dsgg@gg.iitkgp.ac.in

[1] PG Department of Geography, Raja N. L. Khan Women's College (Autonomous), Vidyasagar University, Midnapore, West Bengal, India

[2] ICAR-Indian Institute of Water Management, Bhubaneswar, Odisha, India

[3] Department of Geology and Geophysics, Indian Institute of Technology (IIT), Kharagpur, India

A tri-country panel analysis encompassing Pakistan, India, and Bangladesh from 1973 to 2020 reveals the alarming rise in population across South Asia, exacerbating challenges related to food security, climate change, and capital-intensive agro-farming techniques. To address these issues, the second paper entitled *The effects of agriculture productivity, land intensification, on sustainable economic growth: a panel analysis from Bangladesh, India, and Pakistan economies* employs modern farm input data and demographic variables using the ARDL (PMG) approach—a dynamic modeling technique for heterogeneous data. The findings indicate that the demographic shift in the three countries has led to decreased crop productivity and land intensification. The study highlights technology innovation as the beacon of hope to meet future food demands, while climate-friendly agricultural practices can mitigate the decline of small farmlands. As the region faces critical threats, innovative solutions are essential to ensure sustainable agricultural development.

The third paper entitled *Hyperspectral imaging for small-scale analysis of Hordeum vulgare L. leaves under the benzo[a]pyrene effect* explores the novel application of hyperspectral imaging to assess the uptake of persistent organic pollutants (POP) by plants, with a focus on *Hordeum vulgare* L. The test plants were grown on soil artificially contaminated with benzo[a]pyrene (BaP) at different doses, simulating soil pollution levels near industrial facilities in the Rostov Region, Russian Federation. Various stress-related indexes were analyzed, including broadband greenness, narrowband greenness, light use efficiency, and leaf pigments. The study revealed that BaP had a more significant impact on the photosynthesis process efficiency rather than on chlorophyll content. During the phase of active adaptation to stress in *H. vulgare*, the content of photosynthetic pigments increased. The proposed method of selecting spectral profiles by using NDVI value proved effective in estimating plant stress under BaP contamination. These findings hold promise for the application of plant growth stimulants in the future, contributing to soil and plant ecological state improvement.

Agroforestry plays a vital role in ensuring food and livelihood security and combating climate change. However, its full potential remains untapped due to the lack of precise extent, geographical distribution, and carbon sequestration (CS) assessment. Geospatial technologies, along with free access to spatial data and software, offer a promising solution to assess agroforestry resources, make informed decisions, and develop effective policies despite its small spatial extent, isolated nature, and complexity. The fourth paper entitled *Geospatial technology in agroforestry: status, prospects, and constraints* discusses the current applications of geospatial technologies in agroforestry, including optical remote sensing for mapping spatial extent, tree species spectral signature production, CS assessment, and suitability mapping. The integration of synthetic aperture radar with vegetation photosynthesis algorithms and optical data allows for accurate gross primary productivity estimation. Moreover, unmanned aerial vehicles equipped with advanced sensors offer even higher potential and accuracy than satellite-based datasets. In the future, hyperspectral and thermal datasets could be used for health monitoring of agroforestry systems, analyzing plant biochemistry, chlorophyll fluorescence, and water stress. Notably, upcoming space agency missions hold tremendous promise for shedding fresh light on agroforestry systems, presenting exciting prospects for the future.

Amidst the increasing demand for plastic products, the rising production of plastic waste has become a pressing environmental issue. In this context, plants and their rhizobacteria partners are also exposed to these contaminants. The fifth paper entitled *Biological degradation of polyethylene terephthalate by rhizobacteria* has the primary objective is to investigate the ability of rhizobacteria to biodegrade PET plastic. Researchers successfully isolated three rhizospheric bacteria, *Priestia aryabhattai* VT 3.12, *Bacillus pseudomycoides* VT 3.15, and *Bacillus pumilus* VT 3.16, capable of degrading PET plastic as a sole carbon source in minimal salt media. These isolates exhibited the highest degradation percentage for both PET sheet and powder. Using Fourier transform infrared spectroscopy (FTIR), high-performance liquid chromatography (HPLC), and scanning electron microscopy (SEM), the biodegradation end products were studied. Remarkably, the results demonstrated significant PET plastic biodegradation, accounting for over 65% within 28 days for PET sheet and 18 days for PET powder. This study highlights the potential of soil rhizobacteria in efficiently degrading PET plastic found at waste sites. It also suggests a promising application for rhizobacteria in future PET waste remediation efforts.

In the era of Anthropocene, groundwater contamination has emerged as a significant global environmental threat. The sixth paper entitled *Geospatial assessment of groundwater quality using entropy-based irrigation water quality index and heavy metal pollution indices* focuses on assessing groundwater quality for irrigation purposes using the entropy method and heavy metal pollution indices in the Damodar fan delta (DFD), India—a region dominated by agriculture. The researchers used various physicochemical parameters, irrigation indices, and heavy metal concentrations from 37 sample wells in the DFD to compute the entropy-based groundwater irrigation quality index (EIWQI). Shannon's entropy method was applied to assign weights to different parameters for constructing the EIWQI. The results demonstrate spatial variations in irrigation water quality across the DFD. The EIWQI analysis

indicates that a small percentage of sample wells have excellent (27.03%) and good (59.46%) water quality, while others have moderate (8.11%), poor (2.7%), or very poor (2.7%) quality. Additionally, the study reveals that 15–20% of the sample wells are contaminated by heavy metals, with the highest concentration of pollution in the southwestern, northeastern, and central areas of the DFD. Factors such as higher sodium concentration, carbonate weathering, and the expansion of agricultural and urban-industrial areas were identified as key contributors to the spatial variation in groundwater quality. This study highlights the critical need for monitoring and managing groundwater resources in the DFD and other agriculture-dominated regions to address the growing environmental challenge of groundwater contamination.

With population growth, urbanization, and climate change, the demand for food and water has increased, leading to environmental pollution and mismanagement of water resources. Groundwater, a valuable natural resource, is heavily used for various purposes, especially irrigation. However, natural and human-induced factors have impacted groundwater quality, necessitating its monitoring and suitability assessment for sustainable management. The seventh paper entitled *Prediction of irrigation water suitability using geospatial computing approach: a case study of Agartala city, India* collected groundwater samples from 35 stations and tested them for irrigation water quality parameters. The researchers employed the hybrid MCDM (fuzzy-AHP) method to determine groundwater suitability for irrigation. A suitability map was created, classifying areas into low, moderate, and high irrigation water suitability zones. Additionally, the study utilized regression-based machine learning models such as multiple linear regression, random forest, and artificial neural network to predict irrigation water suitability. The artificial neural network model outperformed others with a high R^2 value of 0.990 and minimal RMSE value. This methodology offers a valuable tool for predicting irrigation water suitability, especially in regions where regular sampling and analysis are challenging. It aids in sustainable water resource management and addresses the pressing environmental concerns associated with groundwater use for irrigation.

The rapid growth of human populations and development has led to a significant depletion of natural resources and environmental degradation worldwide. However, humans have become more aware of the consequences of their actions and are now seeking eco-friendly and innovative solutions to address environmental challenges. The primary focus of the eighth paper entitled *Removal of organic and inorganic contaminants from the air, soil, and water by algae* is on conservation issues like environmental pollution, carbon neutrality, wastewater treatment, and xenobiotic contamination. One promising approach to reduce environmental contamination is the use of algae for bioremediation. Algae, both macro and microorganisms, have significant biosorption capacity to neutralize hazardous chemicals, making them ideal candidates for phytoremediation to combat pollution safely. Recent advancements in technology, such as synthetic biology and high-throughput phenomics, have enhanced the use of algae for environmental problem-solving, leading to a greener and more sustainable future. Algae hold the potential to not only preserve healthy ecosystems but also serve as a valuable resource for creating new products. As research progresses, algae may emerge as a key tool in achieving environmental sustainability and resource preservation.

The ninth paper entitled *Characterization and ecotoxicological risk assessment of sewage sludge from industrial and non-industrial cities* focuses on the analysis of sludge from sewage treatment plants (STPs) in industrial and non-industrial cities of Haryana, India, to understand its physicochemical properties and heavy metal content. The sludge was found to have varying pH levels, ranging from acidic to neutral, with a mean electrical conductivity (EC) of 7.4 dS m^{-1}. In the sludge from industrial sites, prominent heavy metals like Cd, Ni, and Cr were present in relatively high concentrations. The contamination and enrichment factors were used to explain the accumulation of Ni, Cr, and Cu in the sludge from industrial sites. The study identified pH, total carbon, phosphorus, and several water-soluble anions as significant factors controlling the binding and removal of metals during phase separation in STPs. The sludge from the non-industrial site posed a lower ecological risk compared to the high risk associated with sludge from industrial sites. The study suggests that using enrichment factors and ecological risk indices can effectively categorize sludge. However, to ensure safe agricultural use, further research on bioaccumulation, bioaccessibility, and biomass quality under different agroecologies is needed.

In the tenth paper entitled *Machine learning-based time series models for effective CO_2 emission prediction in India*, the focus is on analyzing and predicting CO_2 emissions in India, a country with high energy consumption and harmful CO_2 emission levels. The study utilized data from 1980 to 2019 and employed various statistical and machine learning models for prediction. The authors used three statistical models, namely, ARIMA, SARIMAX, and Holt-Winters, and two machine learning models, linear regression and random forest. Additionally, they utilized a deep learning–based LSTM model for their analysis. The performance of all models was evaluated using nine performance metrics. The results revealed that LSTM, SARIMAX, and Holt-Winters were the most accurate models among the six tested models. Particularly, the LSTM model outperformed others, with a MAPE value of 3.101%, RMSE value of 60.635, and MedAE value of 28.898, as well

as other favorable performance metrics. A comparative study also supported the superiority of the LSTM model. Thus, the deep learning–based LSTM model was recommended as the most suitable model for predicting CO_2 emissions in India over the next 10 years, allowing for better understanding and potential mitigation of its detrimental effects on the environment and living beings.

The issue of air pollution and its impact on public health has garnered global attention, yet the connection between atmospheric environmental policy (AEP), air pollution, and public health remains relatively unexplored. The eleventh paper entitled *The spatial impact of atmospheric environmental policy on public health based on the mediation effect of air pollution in China* utilizes panel data from 30 provinces in China to construct spatial econometric models, analyzing the interplay between AEP, air pollution, and public health. The study reveals a significant positive spatial spillover effect of soot and dust (SD) emission intensity and overall air pollution levels, as measured by the air pollution index (API). AEP demonstrates significant inhibitory effects on sulfur dioxide and SD emissions, as well as overall air pollution. Notably, an increase in overall air pollution negatively impacts public health, leading to reduced average life expectancy. Moreover, the research highlights air pollution (API) as a mediating factor between AEP and public health. These findings underscore the potential to effectively combat air pollution and promote public health by enhancing regional pollution prevention mechanisms, strengthening policy formulation at the central government level, and improving policy implementation at the local level.

Wetlands play a vital role in providing ecosystem services for communities living in underdeveloped semi-arid landscapes. However, land use changes, ecosystem degradation, and declining water quality have severely impacted wetland health and services over the past few decades. In the twelfth paper entitled *Wetland health, water quality, and resident perceptions of declining ecosystem services: a case study of Mount Abu, Rajasthan, India*, the Mount Abu wetlands in Rajasthan, India, were assessed to understand the changing nature of wetland health and declining ecosystem services. Remote sensing data from 1992 to 2020 was used to analyze changes in wetland extent. Water samples were collected and tested in the laboratory to assess biophysical parameters. A household survey was conducted to understand the wetland communities' perception of the loss of ecosystem services over three decades. The results revealed deteriorating conditions of wetland health and declining ecosystem services over time. The study emphasized the need for a wetland management plan to conserve the Mount Abu wetlands and support the livelihoods of the affected communities. Implementing such a plan is crucial for long-term conservation and sustainable management of wetlands and the communities relying on them.

The rapid growth of populations, economies, industrialization, and urbanization in developing countries has created a challenge for waste management. However, their current waste management methods are not as efficient as those in developed countries, leading to an increased focus on improving waste management practices in these regions. The thirteenth paper entitled *Waste management practices in developing countries: a socio-economic perspective* explores the socioeconomic aspects of waste management in developing countries by analyzing existing literature, policies, and information. The findings emphasize the significant influence of key socioeconomic factors such as finances, population density, per capita income, education level, policies, and technology on waste management processes, including waste generation, collection, composition, and disposal/treatment. Despite the challenges, proper waste management offers several economic benefits, such as financial stability, job creation, and community cohesion. The study advocates for further research on the socioeconomic advantages of effective waste management in developing nations and emphasizes the need for policy planning to harness these benefits. By considering the economic advantages, developing countries can foster sustainable waste management practices and promote overall socioeconomic progress.

The fourteenth paper entitled *Gully erosion vulnerability modelling, estimation of soil loss and assessment of gully morphology: a study from cratonic part of eastern India* focuses on gully erosion, a visible and significant form of soil erosion causing land degradation in arid and semi-arid environments. The research is conducted in the lateritic terrain of Rupai watershed in the eastern plateau fringe of India, where water erosion is a serious concern. To create a gully erosion vulnerability map, the researchers use the analytical hierarchy process (AHP) model combined with geospatial technology, considering thirteen bio-physical factors. The mapping reveals that 49% of the watershed falls into the high to very high gully erosion vulnerability zone, followed by a moderate-risk zone of 31.64%. The model is validated with an accuracy assessment of 90.91% and a Kappa coefficient of 0.86. Additionally, the study estimates average annual soil loss using the revised universal soil loss equation (RUSLE) model with geospatial technology, showing variations from < 15 to 431 t ha^{-1} $year^{-1}$ across the watershed. Around 29% of the area experiences high to very high soil erosion risk, while 68% faces low soil erosion risk. The study's results offer valuable insights for land use planning and soil erosion conservation in the region.

In the fifteenth paper entitled *Comparing Delphi–fuzzy AHP and fuzzy logic membership in soil fertility assessment: a study of an active Ganga Delta in Sundarban Biosphere*

Reserve, India, conducted in the active Ganga deltaic region of Sundarban Biosphere Reserve, India, researchers aimed to establish a grid-based soil fertility map using various physical, chemical, topographic, and nutrient element parameters. They collected soil samples from 30 grids, focusing on the 0–15-cm soil depth, which contains essential elements influencing soil fertility. Two methods, fuzzy-AHP-Delphi (FAHP) and fuzzy logic-Delphi (FL), were employed to determine the soil fertility zones. These methods utilized expert opinions and literature to set weights and desirable limits for each criterion. The resulting soil fertility maps were classified into five classes: very high, high, moderate, low, and very low fertility. Both models indicated higher soil fertility near the Hooghly River bank. While FAHP and FL produced similar results in many cases, significant differences were observed in specific grid numbers. The fuzzy logic model showed an overall accuracy of 82.16% and a kappa coefficient of 0.82, outperforming the FAHP model with 79.62% accuracy and a kappa coefficient of 0.79. The success rate curve validation further confirmed the superiority of the fuzzy logic model for soil fertility analysis in each grid.

In the sixteenth paper entitled *Spatiotemporal evaluation and assessment of shallow groundwater quality for irrigation of a tropical coastal groundwater basin*, the focus is on analyzing both the quantity and quality of groundwater to assess its availability and suitability for irrigation purposes. The researchers employed various water quality indices to evaluate different aspects, including the origin of groundwater sources, salinity, alkalinity, sodium hazard, magnesium hazard, and carbonate and bicarbonate hazard. Using diagrams like Gibbs diagram, Piper diagram, and Expanded Durov diagram, the researchers identified hydro-chemical facies, chemical evolution, and spatial distribution of groundwater samples. Results indicated that the groundwater quality is primarily influenced by rock-water interaction and revealed the presence of suitable hydro-chemical conditions for irrigation. The principal component analysis (PCA) and cluster analysis (CA) were applied to establish statistical relationships among variables, sample sites, and spatiotemporal groups. The findings confirmed the groundwater quality is controlled by rock-water interaction, with carbonate dissolution contributing to increased hardness. Based on the results, an irrigation water quality suitability map and groundwater potential zone map were developed to aid in making informed decisions about tube well location, pumping schedule, and crop planning to ensure agricultural sustainability. Furthermore, implementing these activities could help prevent seawater intrusion and be applicable to other coastal groundwater basins worldwide.

Hyperspectral imaging technology has enabled the biochemical analysis of Earth's surface by leveraging the spectral reflectance signatures of different materials. The Italian PRISMA hyperspectral satellite, launched by the Italian space agency (ASI), offers a unique opportunity for mapping various materials and facilitating resource management and sustainable development. In the seventeenth paper entitled *Satellite hyperspectral imaging technology as a potential rapid pollution assessment tool for urban landfill sites: case study of Ghazipur and Okhla landfill sites in Delhi, India*, PRISMA hyperspectral satellite imagery was utilized to generate multiple spectral indices for rapid pollution assessment at the Ghazipur and Okhla landfill sites in Delhi, India. The combined risk score for the Okhla landfill site was found to be higher than that of Ghazipur landfill site. Using hyperspectral imagery and spectral signature libraries, the study identified various man-made materials, including highly saline water, plastics, asphalt tar, black tar paper, kerogen BK-Cornell, black paint, graphite, and chalcocite minerals, in significant quantities at both landfill sites. This methodology provides a rapid pollution assessment tool for municipal landfill sites, aiding in efficient management and environmental monitoring.

In the eighteenth paper entitled *An integrated approach for the assessment and monitoring of land degradation and desertification in semi-arid regions using physico-chemical and geospatial modeling techniques*, the researcher highlights the significance of addressing land degradation (LD) and desertification as critical threats to the environment, ecology, and socio-economic well-being worldwide. The researchers aimed to develop reliable techniques to assess LD and desertification at different scales using remote sensing (RS) and geographical information system (GIS). Over a period of 29 years, from 1990 to 2019, the severity of LD and desertification was quantitatively evaluated by collecting soil samples in the study region and analyzing eleven soil physicochemical parameters. These values were then correlated with digital number (DN) values obtained from LANDSAT 8 OLI/TIRS satellite images. The results of land cover analysis revealed a concerning trend: water bodies slightly increased, built-up land expanded significantly, while vegetation drastically decreased. Notably, fallow land, degraded land, and desertified lands increased at alarming rates over the same period. The study also emphasized the effectiveness of multi-temporal change detection analysis in assessing ecosystem health and variation.

The nineteenth paper entitled *A holistic approach for understanding the status of water quality and causes of its deterioration in a drought-prone agricultural area of Southeastern India* delves into the groundwater quality assessment in the Kadiri Basin, Andhra Pradesh, India. Researchers collected groundwater samples from 77 locations and analyzed various physicochemical parameters. To estimate groundwater quality for drinking and irrigation,

they developed a groundwater quality index using an information entropy–based weight determination approach (EWQI). Water quality maps demonstrated a clear trend of groundwater contamination in the study area. The study also investigated the influence of different physicochemical parameters on groundwater quality using machine learning techniques, including artificial neural network (ANN), deep learning (DL), random forest (RF), and gradient boosting machine (GBM). The ANN model showed highly effective performance for the dataset (MEA = 11.23, RSME = 21.22, MAPE = 7.48, $R^2 = 0.91$). The researchers identified excess turbidity and iron concentrations as the primary contributors to groundwater deterioration, along with relatively higher levels of sulfate and nitrate significantly impacting groundwater quality. The study's broader implications extend to modeling groundwater quality assessment in similar drought-prone agricultural regions, facilitating better understanding and management of groundwater resources.

The twentieth paper entitled *Spatio-temporal analysis of rainfall in relation to monsoon teleconnections and agriculture at Regional Scale in Haryana, India* investigates the long-term spatiotemporal trends, variability, and teleconnections of Indian summer monsoon rainfall (ISMR) in all districts of Haryana, India, and its impact on agricultural productivity. The researchers utilized gridded datasets from various sources, including India Meteorological Department (IMD), European Centre for Medium-Range Weather Forecasts (ECMWF), and National Oceanic and Atmospheric Administration (NOAA). The analysis focused on rainfall distribution, trends, coefficient of variation, intensity, and El Niño–Southern Oscillation (ENSO) influences. The results showed that districts in the eastern agroclimatic zone (EAZ) received more ISMR throughout the monsoon season compared to those in the western agroclimatic zone (WAZ). Some districts exhibited decreasing trends in rainfall, while others showed increasing trends. During El Niño years, most locations experienced deficient to large deficient ISMR, while during La Niña episodes, they received excess to large excess rainfall. The study also explored the impact of ISMR on bajra productivity in WAZ and rice productivity in EAZ. The findings of this study provide valuable insights into the impacts of climate change and variability on ISMR dynamics in Haryana, which can guide policymakers and stakeholders in optimizing the use of hydrological resources and mitigating potential agricultural risks.

The Hindon River, a crucial tributary of the Yamuna River in western Uttar Pradesh, India, plays a significant role as a source of surface water for major cities in the region. However, the unregulated growth of industries, urbanization, and rapid population increase have led to the introduction of various pollutants into the river. To address these concerns, in the twenty-first paper entitled *Comprehensive spatio-temporal benchmarking of surface water quality of Hindon River, a tributary of river Yamuna, India: adopting multivariate statistical approach*, a comprehensive study was undertaken to assess the spatial-temporal variability of the river's water quality over 5 years. Seventeen physicochemical parameters and eight heavy metals were analyzed, and indices were computed to accurately determine the risks associated with using the water for drinking and irrigation. The study found that only four sites exhibited safe Water Quality Index (WQI) values during both pre- and post-monsoon seasons. The mean concentrations of heavy metals followed the order: Zn > Fe > Pb > Cu > Cr > Cd > Ni > Mn. Given the findings related to spatial and temporal distribution, the study emphasized the urgent need for prioritizing improvements in the water quality of the Hindon River.

In the twenty-second paper entitled *Suitability of the Lower Ganga basin groundwater for irrigation, using hydrogeochemical parameters and land-use dynamics*, focusing on the densely populated northern Ganga basin, researchers examined the accumulation of agricultural and industrial contaminants in the lower part of the basin. They utilized ten parameters from 495 sampling locations and long-term climate data (GLDAS_NOAH025_M) to assess irrigation suitability using the TOPSIS model, a multi-criteria decision-making approach. The study found that the irrigation suitability parameters, such as electrical conductivity, sodium adsorption ratio, and groundwater level fluctuation, had varying levels of influence on water quality for irrigation in the Lower Ganga basin. Among these, SAR, Cl−, and GWLF were identified as particularly influential due to their relatively higher entropy weights. The computed performance index indicated that approximately 77.03% of the area had very good groundwater quality for irrigation, while 22.97% had good quality. Additionally, land-use change dynamics between 2000 and 2015 showed positive percentage changes in settlement, wetland, and bare areas, but negative trends in agriculture, forest, grassland, sparse vegetation, and water areas. The study's findings have potential applications in the planning and management of water resources for sustainable development in the region.

The twenty-third paper entitled *An integrated investigation of hydrocarbon pollution in Ahoada area, Niger Delta Region, Nigeria* focuses on hydrocarbon pollution in the Ahoada community within the Niger Delta region of Nigeria. The researchers employed a geographic information system (GIS) to map oil spill hotspots in the area. Using the resistivity method, they determined the extent of hydrocarbon pollution up to a depth of 19.7 m in

Ahoada. Soil samples from three categories — impacted soil (IMS), remediated soil (RS), and control soil (CS) — were collected and analyzed for BTEX, PAH, TPH, TOC, and TOG presence. Comparing the concentrations of IMS and RS with CS allows for assessing pollution extent. The GIS mapping identified Rivers, Bayelsa, and Delta states as the most polluted areas in the Niger Delta Region. Geophysical images revealed contaminant presence beyond 20 m in some locations, with the highest depth found in Ukperede. Soil analysis showed higher concentrations of pollutants in IMS and RS compared to CS. The study suggests substantial decomposition of hydrocarbons based on TOC results.

Mountains play a crucial ecological role, offering a wide range of ecosystem services (ESs) to nearby communities. However, these mountainous ESs face vulnerability due to land use and land cover (LULC) changes and climate shifts. To inform policy decisions, it becomes essential to assess the nexus between ESs and mountain communities. In the twenty-fourth paper entitled *A socio-ecological and geospatial approach for evaluation of ecosystem services to communities of the Eastern Himalayan Region, India*, a mountainous city in the Eastern Himalayan Region (EHR), India, was evaluated by analyzing LULC in three ecosystems: forest, agriculture, and home garden, using participatory and geospatial approaches over the last three decades. The findings reveal a significant loss of ESs during this period. Notably, there were considerable variations in the importance and dependency on ecosystems between urban and peri-urban areas. Peri-urban areas displayed higher importance in provisioning ESs, while urban areas relied more on cultural ESs. Among the ecosystems, forests were found to strongly support peri-urban communities. The results underscore the communities' heavy reliance on various ESs for their livelihoods, but the impact of LULC changes has led to substantial ES loss. Therefore, effective land use planning strategies, ecological security, and livelihood sustainability measures must be implemented, with active involvement from mountainous communities.

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Pravat Kumar Shit (Ph.D.) is an Assistant Professor at the Postgraduate Department of Geography, Raja N. L. Khan Women's College (Autonomous), situated in West Bengal, India. He has achieved remarkable milestones in his academic journey, specializing in various aspects of Geography and Environmental Sciences. He earned his M.Sc. and Ph.D. degrees in Geography from Vidyasagar University, and he also holds a PG Diploma in Remote Sensing & GIS from Sambalpur University. With a vast range of expertise, his research interests span across various areas, including applied geomorphology, soil erosion, groundwater, forest resources, wetland ecosystem, environmental contaminants and pollution, and natural resources mapping and modeling. He has published twenty-two books (Springer-17, Elsevier-04, CRC Press-01) and more than 90 papers in peer-reviewed journals and 85 book chapters. He is also the guest editor of *Environmental Science and Pollution Research* and *Applied Water Science*. Furthermore, Dr. Shit currently holds the prestigious position of being the editor of the GIScience and Geoenvironmental Modeling (GGM) Book Series, a significant responsibility under the Springer-Nature publication.

Partha Pratim Adhikary (Ph.D.) is a Senior Scientist at ICAR-Indian Institute of Water Management, Bhubaneswar, India. He obtained his Ph.D. in Agricultural Physics from ICAR-Indian Agricultural Research Institute, New Delhi, India. His research interests delve into diverse realms including solute transport, water pollution, soil and water conservation, pedotransfer functions, and geospatial modeling of natural resources. Dr. Adhikary has published more than seventy-five research papers in peer-reviewed journals and twelve books. His other publications include book chapters, popular articles, technology brochures, technical bulletins, and scientific reports. He is the associate editor of Indian Journal of Soil Conservation. He is also the guest editor of *Environmental Science and Pollution Research* and *Applied Water Science*. Currently, he is the editor of Springer-Nature book series GIScience and Geo-environmental Modeling.

Prof. (Dr.) Debashish Sengupta is working as Professor, Higher Administrative Grade, and Former Head of the Department of Geology and Geophysics in Indian Institute of Technology (IIT) Kharagpur, West Bengal, India. Prof. Sengupta has more than 30 years of teaching and research experience. He has completed his Ph.D. in 1987 in Applied Geophysics. His areas of interests are nuclear geophysics including petroleum logging using subsurface nuclear data, radioactive methods and geochronology, radon emanometry and its applications, applications of isotopes and radionuclides in earth and environmental geosciences, heat flow, and geothermics. Prof. Sengupta has 110 research publications in international journals and more than 60 papers in Conference Proceedings apart from a large number of Invited Talks delivered both in India and abroad. The research work has been seminal and resulted in the formulation of Environmental Regulation policies in various countries both in India and countries like USA, South America, and the European Union. Prof. Sengupta had also been a Visiting Professor at the University of Sao Paulo, Brazil and as Senior Visiting Professor at the University of Salamanca, Spain, earlier, while on a sabbatical leave from the institute. He has received Society of Geoscientists and Allied Technologists (SGATs) Award of Excellence in Earth Sciences for the year 2003. Prof. Sengupta has published four (04) books.