



Application of GIS in Aquatic Environment Management

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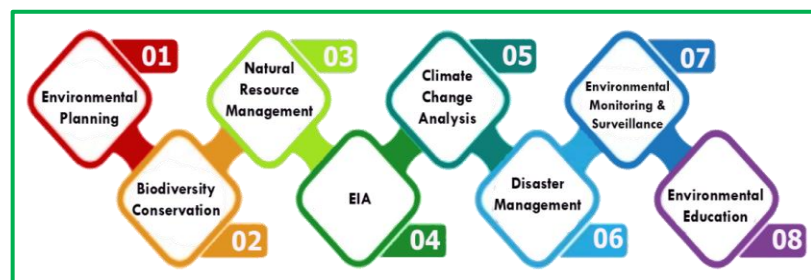
This article explores the critical role of water routing in influencing river, lake, and wetland ecosystems, mainly how rainfall, runoff, and subsurface inputs affect species distribution and abundance. Geographic Information Systems (GIS) is an essential environmental management tool enabling effective data collection, analysis, and visualization. The integration of GIS enhances planning, monitoring, and decision-making related to natural resource conservation. Applications of GIS include land use planning, biodiversity conservation, and natural resource management, all contributing to sustainable practices. Additionally, GIS supports environmental impact assessments, climate change analysis, and disaster management. It also plays a crucial role in monitoring vital ecological parameters, such as temperature and salinity, essential for understanding aquatic systems. Overall, GIS empowers stakeholders to manage aquatic environments effectively, promoting the sustainable use of these critical resources for future generations.

Keywords: Geographical information system, Biodiversity, EIA, Climate change

Introduction

The routing of source waters has a strong influence on river, lake, and wetland ecosystems because of the relative contributions of rainfall, runoff, through-flow, chemical composition, thermal characteristics, and, ultimately, the character of aquatic life (Dunne and Leopold, 1978; Wiley and Seelbach, 1997; Winter, 2001). Due to their high dissolved mineral content, relatively cold summer temperatures, and stabilizing effect on water levels during decreased precipitation, subsurface water inputs can significantly impact local biology (Wiley and Seelbach, 1997; Winter, 2001). Hence, geographical variance in subsurface water sources is essential for GIS-based sustainable utilization of aquatic environments. Geographic Information Systems (GIS) have become invaluable tools in the field of environmental management. GIS technology allows for spatial data collection, storage, analysis, and visualization. Integrating GIS in environmental management practices has revolutionized understanding, monitoring, and making ecological decisions. Environmental management involves the planning, monitoring, and decision-making processes that aim to protect, conserve, and sustainably use natural resources while mitigating the negative impacts of human activities on the environment. GIS serves as a robust framework for achieving these goals.

Here are some critical applications of GIS in environmental management:



- a. **Environmental Planning and Land Use Management:** GIS enables the analysis of land cover, land use patterns, and environmental characteristics to support effective planning and management of natural resources. It helps identify suitable areas for various land uses, such as agriculture, urban development, and conservation, considering factors like slope, soil type, hydrology, and habitat suitability.
- b. **Biodiversity Conservation:** GIS plays a crucial role in biodiversity conservation by mapping and analysing species distributions, habitats, and ecological corridors. It helps identify priority areas for conservation, assess the impact of land use changes on biodiversity, and support the design of protected areas and wildlife corridors to maintain ecological connectivity.
- c. **Natural Resource Management:** GIS is widely used for managing and monitoring natural resources such as forests, water bodies, wetlands, and coastal zones. It aids in assessing the extent and condition of these resources, monitoring changes over time, and guiding sustainable resource management practices.
- d. **Environmental Impact Assessment (EIA):** GIS is employed in the EIA process to assess the potential ecological impacts of development projects. It helps analyse and visualize the spatial relationships between project activities and sensitive environmental features, identifying potential impacts and supporting the decision-making process for project approval.
- e. **Climate Change Analysis and Adaptation:** GIS assists in understanding the spatial patterns and impacts of climate change. It enables the analysis of climate data, including temperature, precipitation, and sea-level rise, to assess vulnerability, identify at-risk areas, and develop strategies for climate change adaptation, such as identifying suitable locations for renewable energy installations or implementing coastal protection measures.
- f. **Disaster Management:** GIS is critical in disaster management by supporting emergency response planning, risk assessment, and post-disaster recovery efforts. It aids in identifying areas prone to natural hazards, assessing vulnerability, and facilitating efficient resource allocation and evacuation planning during emergencies.
- g. **Environmental Monitoring and Surveillance:** GIS helps monitor and track ecological parameters by integrating data from various sources, such as remote sensing, field surveys, and monitoring stations. It enables the visualization and analysis of spatial and temporal trends in environmental variables, such as air quality, water quality, deforestation, and land degradation.
- h. **Environmental Education and Public Awareness:** GIS can be used to create interactive maps and visualizations to communicate environmental information effectively. It helps raise public awareness about environmental issues, supports environmental education initiatives, and facilitates public participation in decision-making.

By leveraging the power of spatial analysis and visualization, GIS contributes significantly to environmental management by providing valuable insights, supporting evidence-based decision-making, and promoting sustainable practices.

Applications in habitat mapping and change detection

Remote sensing offers several advantages, including a comprehensive overview, access to multispectral data, capturing data over different periods, and cost efficiency. These features are crucial for monitoring changes and mapping habitats. This approach allows data to be collected from diverse and challenging ecosystems, making it easier to analyze complex geographic terrains. Integrating GIS and remote sensing is effectively used for monitoring and mapping coastal and marine ecosystems. Since the launch of LANDSAT by the USA in 1972, satellite imagery has been accessible for much of the globe. This valuable resource allows us to track and map changes occurring in coastal regions, such as mangrove

destruction, land reclamation, and the reduction of lakes, estuaries, and other water bodies, all closely connected to the fisheries sector.

Monitoring of environmental parameters

Environmental factors such as temperature, salinity, dissolved oxygen, and nitrate levels play a crucial role in determining the distribution and abundance of species within aquatic ecosystems. GIS facilitates the analysis and creation of depth and time profiles for various aquatic environmental variables, enhancing our understanding of the studied system. For instance, contour plots illustrating temperature and salinity profiles in coastal waters can provide valuable insights into coastal upwelling processes.

Management of Marine Fisheries & Coastal Regulation Zone

The GIS-based study will illustrate how fish are distributed over time and space in the selected region, helping identify vital fishing areas crucial for marine biodiversity and fisheries. GIS is employed to identify fish habitats, manage living marine resources (such as the behavior of marine species), track marine mammals, and study their migratory and hunting patterns. These applications assist in evaluating the effectiveness of marine protected areas and addressing challenges related to environmental degradation.

Conclusion

In conclusion, using Geographic Information Systems (GIS) has significantly transformed the management of aquatic environments and marine ecosystems. GIS effectively monitors habitats, biodiversity, and resource distribution changes by enabling detailed spatial analysis and data visualization while considering various ecological factors. Critical applications, such as land use planning, biodiversity conservation, and environmental impact assessments, emphasize GIS's vital role in advancing sustainable practices. It is also essential for disaster management and climate change adaptation, aiding in identifying vulnerable areas and enhancing decision-making processes. Overall, GIS equips stakeholders with the tools needed to understand better and manage aquatic environments, promoting the protection and sustainable utilization of these critical resources for future generations. By harnessing this technology, we can tackle environmental challenges and strengthen the resilience of our ecosystems.

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