

---

## ***The Applications of Geographic Information Systems and Remote Sensing in Environmental Systems and Management***

***Mukul Tyagi<sup>1</sup>, Arvind Yadav<sup>2</sup>, Pankaj Singh<sup>3</sup>***

*Associate Professor<sup>1</sup>, Students<sup>2,3</sup>*

*Department of Civil Engineering*

*Madhepura Engineering College*

***Corresponding Author's Email: pspankaj1@gmail.com<sup>3</sup>***

### ***Abstract***

*Geo Informatics is an interdisciplinary field that deals with spatial information. Geo Informatics is related to Geo Information Science, Geo Information Systems, Remote Sensing, and other fields. In Geo Informatics, which is a blend of Geo Science and Information Science, and in spatial data management, various IT and computing tools such as Database Technology, Network Technology, Web Technology, Multimedia Technology, and so on are employed. Remote sensing is a component of Geo Information Science that is dedicated to gathering information on various types of objects without physical content and is applicable in various areas of geography, land surveying, and various types of geo-related areas such as hydrology, ecology, meteorology, oceanography, and geology, among others. Because of their interdependence and relevance, remote sensing is often known as GIS & RS. Geo Informatics, or Geo Information Science, refers to IT applications in geography and related fields. Similarly, Environmental Informatics or Environmental Information Science refers to the applications and exploitation of IT, Information Science, and computing in the environment and related fields. GIS and remote sensing applications in the environment and ecological regions are quickly expanding, and they comprise a wide range of existing and emerging applications. This paper discusses the use of GIS and RS in environmental applications and management.*

**Keywords:** - *Geo Informatics, Remote Sensing, GIS in Environment, Environmental Informatics, Environmental Management, Sustainable Development.*

## INTRODUCTION

There are numerous visible uses of geographic information systems (GIS) in environmental research; nonetheless, it is addressed as a complicated, comprehensive component. Environmental science is a multidisciplinary field that incorporates aspects of the biological, social, and physical sciences in relation to environmental problems, and GIS is particularly useful in various spatial information-related activities such as organising, analysing, managing, and visualising geospatial data for the purpose of environmental analysis and modelling [1], [5].

GIS in environmental science is concerned with the analysis of a large bibliographic landscape. The field of environmental science was noticeable in relation to ecology, geography, and hydrology throughout the 1960s and 1970s, when the environmental movement was strong. Later, many geo methods and technologies are regarded as vital and easily available tools for analysing and solving complicated environmental problems. GIS and RS are used efficiently in risk

management, pollution control, and environmental monitoring. The advancement of information technology, including data accessibility, visualisation, and software modelling, is viewed as a perfect storm for the adoption of Environmental Informatics, where integrated technology such as GIS may be used to solve a variety of environmental concerns. There has been an explosion of environmental IT usage in water resources, climate change, urban planning, and so on, and GIS is particularly useful in these areas. Today, we are all committed to environmental protection, including features of climate change, such as erratic weather patterns, effective natural environment and crop production, and melting of ice glaciers. In such aspects and monitoring, GIS can be a useful and powerful instrument [7], [17].

## OBJECTIVES

The main objectives of the paper are mentioned as follows (but not limited to)—

- Understand the fundamentals of Geo Informatics and Geo Information

Systems, including features and qualities.

- To learn about the fundamental uses of Geographic Information Systems and Remote Sensing.
- To study the fundamentals of environmental informatics using GIS and RS.
- To learn about the fundamental applications of GIS and remote sensing in environmental and ecological management
- To learn about field-specific applications of GIS, Remote Sensing, and other technologies for healthy environmental monitoring and utilisation.
- To understand the current trends and future potential of GIS and Related Spatial Technologies in the field of healthy Ecology and Environmental Informatics.

### **ENVIRONMENTAL INFORMATICS**

Environmental Informatics is a new field that blends the environment and informatics (i.e., also called Environmental Information Science). In a nutshell, it is

the use of information technology and computing in environmental and ecological elements and themes such as geology, agriculture, forestry, geography, climatology, oceanography, and so on. It is also known as Eco Informatics or Ecology Informatics, but Environmental Informatics encompasses a broader range of topics. Furthermore, another essential term is Environmental Information Technology, while Environmental Informatics may also discuss or deal with manual information management in relation to the environment and ecology. Numerous new technologies are relevant in various environmental domains, such as:

- Environmental Science/Studies
- Environmental Management
- Environmental Engineering, etc [3], [18], [25].

### **GIS AND REMOTE SENSING: BENEFITS**

The Geo Information Systems and Remote sensing applications are merging in different areas and it is growing rapidly for various reasons such as—

- For the building of an intelligent Geo Information Systems and Spatial Development including Spatial Management.

- In Collection, analysis, etc of spatial data including in Disaster Management and development.
- In the areas of healthy Public Administration and Disaster Management Geo Information Systems and remote sensing are very much effective and useful.
- Regarding the transferring of the data from hard version to the digital one here GIS and Remote Sensing are required.
- In the areas of mapping including in analyzing of the longitude, latitude, atmosphere measurement also Geo Information Systems and remote sensing are effective tools.
- In Zincography also Geo Information Systems and Remote sensing are being used as it is for spitting map to map with respective layers and here these tools become useful.
- The GIS applications are important in the diverse areas of viz. Environmental Mapping and Monitoring, Environmental Designing such as effective and planned water network, wired system, etc.
- Moreover, in urban and town planning also Geo Information Systems and Remote sensing useful viz. traffic control, pollution control, urbanization and in rural development.
- Geo Information Systems and Remote sensing are useful in Measuring various environmental systems such as water systems, weather management etc. for healthy ecological practice.
- Topographical modelling is important in the environment and here GIS and Remote sensing useful and increasing.

The functions, roles and applications of GIS are increasing day by day and in addition other sustainable technology as well. The next section deals with these diverse areas [9], [19], [24].

## **GIS AND ENVIRONMENTAL MANAGEMENT**

It is vital to emphasise that the challenges of global warming are becoming more severe as the environment deteriorates, including decreased glacier area, increased glacial lake size, heavy rainfall, changes in land, including floods, and so on. Furthermore, the elements of landslides and reduced agricultural crop output can be regarded as significant environmental

changes that require early monitoring. Geospatial technologies, particularly remote sensing and GIS, are effective and valuable in this context for effective monitoring of environmental features [8, 14, 23].

GIS is an excellent environmental data analysis, planning, and management tool that aids in the maintenance of healthy environmental conditions such as slopes, aspects, and vegetation. Using GIS tools, digital information may be provided to offer environmental data, a rapid, comparative perspective of hazards, threats, and regions to be protected. Based on data analysis, GIS is useful in controlling environmental dangers and risks as well as other environmental issues such as planning decisions and mitigation efforts.

GIS also aids in environmental evaluation and the creation of environmental models, where it is quite useful. Thus, GIS is required in environmental management for the following reasons:

- Planning and Monitoring
- Air pollution Management with control.
- Disaster and Recovery Management.
- Forest Management including fire management.

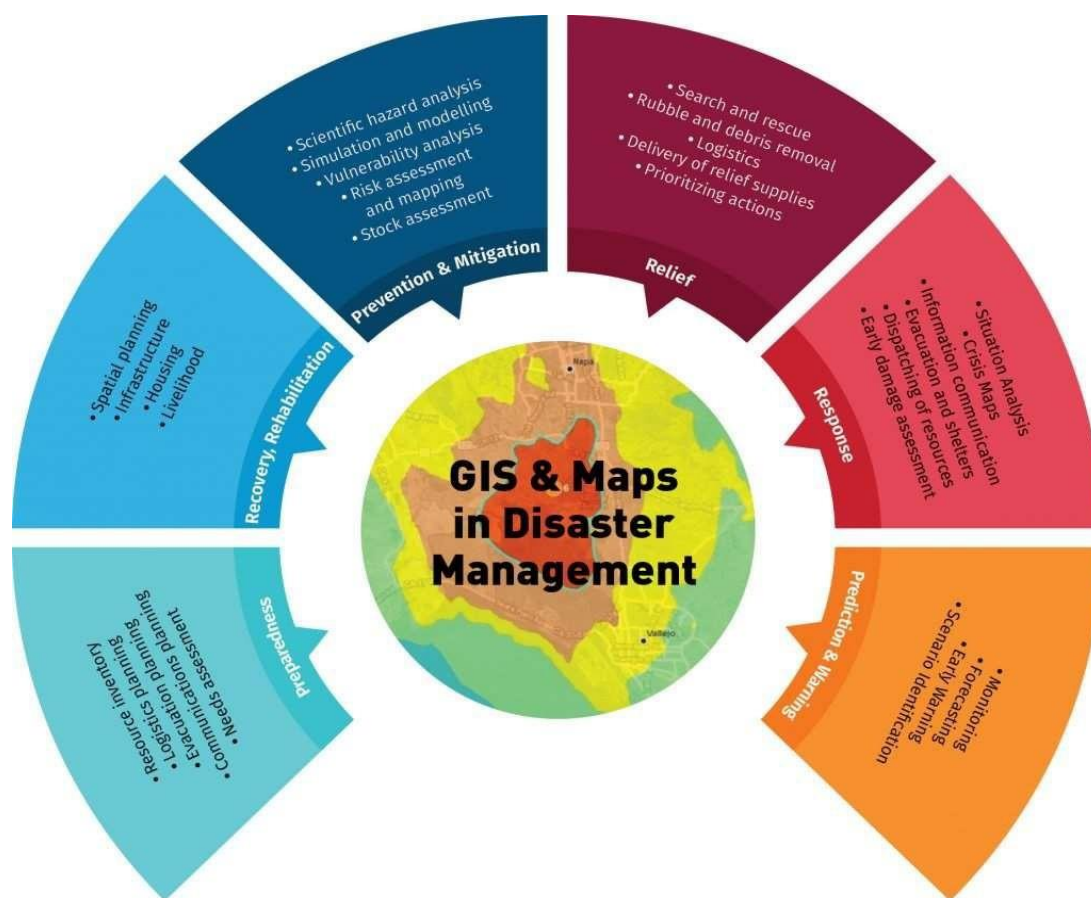
- Managing natural resources.
- Wastewater Management, etc [10], [15], [24].

## **GIS APPLICATIONS IN DISASTER MANAGEMENT**

GIS systems are utilised in well-developed integrated disaster management and mitigation systems that include risk management and analysis. This is essential in the management of natural or man-made disasters, including detection, preventive actions, and so on.

GIS and RS are utilised in early warning systems as well as decision support systems to promote good catastrophe management by mitigating disaster risks. Furthermore, GIS and RS are effective in creating more responsive, responsive, and speedier GIS-based systems.

The gadget is beneficial in damaged areas, making healing easier and faster. As a result, GIS is useful for total disaster management in cyclone alerts, regional tsunamis, high rainfall, and the impending flood alert system.



*Fig. 1: GIS in Disaster Management [18]*

## GIS AND ALLIED TOOL IN AIR QUALITY MONITORING

GIS and RS are especially important in air quality monitoring; in this case, the integrated platform is supported by sensors and is eventually required in monitoring, analysis, and planning within a territory/city. As a result, the systems can predict the most hazardous or harmful regions, which may be beneficial to human health, such as asthma patients. This analysis, which is assisted by GIS and RS, may be useful in improving air quality. Such GIS and RS-based techniques can be integrated into a smartphone app, allowing

citizens to receive immediate attention on air quality [4], [13], and [21].

## FIRE MANAGEMENT AND GIS

GIS and RS tools are useful in both general fire management and wildfire control. Because of the various applications of GIS, it has potential in forest fire management. It may also be used in danger map generation, forest fire simulation, and resource management. Simulation plays a significant part in forest fire management. In this regard, numerous additional associated technologies and systems, such as

- Big Data Systems and Technologies
- Cloud Computing and Systems
- Human Computer Interaction and Systems
- AI and Robotics, etc.

## **GIS IN MANAGING NATURAL RESOURCES**

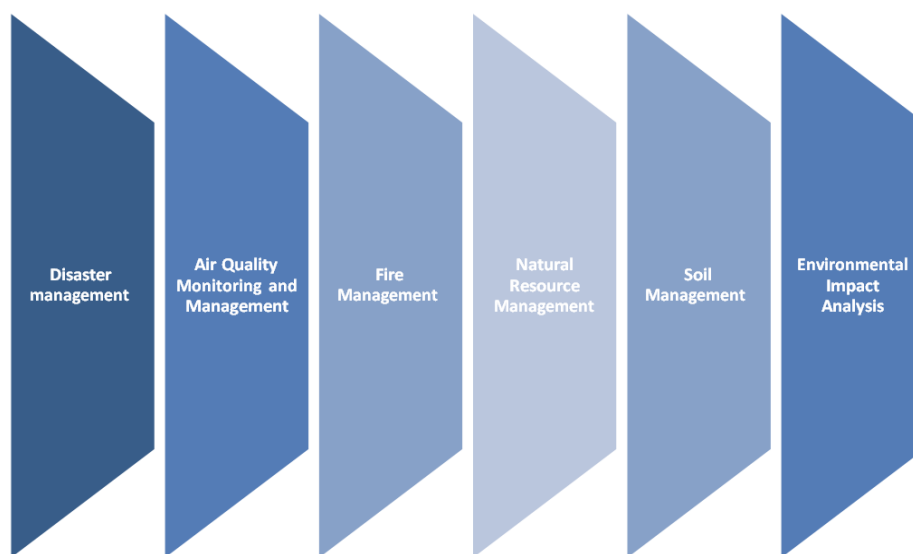
GIS and RS are useful in a variety of natural resource management fields, including agricultural, water, and forest management. Here, simple monitoring of forest state is possible, including crop management and rotation, in assessing the geographic distribution of water systems and forest-related elements such as cover reduction, flood, landslide, soil erosion, drought, earthquake, and so on. 10. As a result, utilising GIS and RS, natural resource data might be obtained by aerial photography and satellite photos using GIS technology. As a result, it is a valuable instrument in terms of climate change, population, pollution, and so on. GIS is assisting in the study of specialised monitoring, such as environmental conditions and policies, as well as conservation efforts. GIS maps provide information about a location and current resources. GIS is necessary in wastewater management, oil spill cleanup, sewage treatment, and other fields. Because GIS

facilitates location information, it is also essential in numerous sorts of decision-making, policy-making, and environmental management. As a result, GIS is primarily responsible for collecting, analysing, storing, and disseminating geospatial information that aids in environmental development and agricultural management [6, 16, 20].

## **SOIL MANAGEMENT AND GIS**

Land management, i.e., the degree of real or possible threat from landslides, is the focus of Geo Spatial Information Technology. This system could be useful in hazard zonation since it collects and manipulates spatial data such as geological, structural, and surface data using GIS and RS. GIS technology, on the other hand, is valuable in land cover applications such as land cover patterns across time.

In terms of soil mapping, GIS gives resource information, which aids in soil feature analysis and may be valuable in preventing environmental deterioration; in forest management and agriculture, GIS and RS are useful in understanding the properties of the soil.



**Fig.2: GIS in Diverse Environmental Areas**

### **IN ENVIRONMENTAL IMPACT ANALYSIS (EIA)**

GIS and RS are useful in environmental impact analysis (EIA), as well as in policymaking concerning natural resources and the environment. Human intervention may have an environmental impact on roadways and railroads, public places, pipelines, airports, and so on. Environmental impact statements are typically necessary to learn about environmental impacts. GIS techniques and technology are extremely valuable in this situation [2], [11].

### **IN RESPECT OF FLOOD DAMAGE AND MANAGEMENT**

In terms of Flood Damage and Management, GIS and Remote Sensing tools aid in disaster relief money and can

be used by administrators, policymakers, and others. Furthermore, GIS is important in Irrigation Management; it is useful in determining water availability and may be required in water management, crop production, farm management, and so on. Geo Spatial Technologies are crucial and useful for the optimal control of water consumption.

### **WETLAND MAPPING AND IN VOLCANIC HAZARD**

Wetland is an important aspect of the environment because it aids in improved land management, including flood reduction. Wetland mapping and design are aided by GIS and RS. Volcanic hazard is concerned with particles, gas clouds, lava flows, and flooding, and here too, GIS-based impact assessment will be

useful. Finally, it may be useful in the management of volcanic hazards, including a reduction in economic loss and loss of life in different settings [9], [22].

## CONCLUSION

The environment is very important regarding development, and in environmental and ecological management it helps in a sustainable world. And in all of these, GIS technologies are important and required. The subjects, viz., Environmental Science, Environmental Technology, Environmental Management, Environmental Engineering, etc., are helpful in environmental assessment and management. Areas such as GIS and remote sensing have become important in environmental management. Here the GIS and RS dealing subjects such as Geo Informatics, Geo Information Systems, Geo Information Science, etc. play a leading role. Moreover, in the development environment and disaster management-related affairs, GIS and GPS tools are important and increasing rapidly

## REFERENCES

1. Al-Adamat (et.al) (2012). The combination of indigenous knowledge and geo-informatics for water harvesting siting in the Jordanian Badia. *Journal of Geographic Information System*, 4(4), 366-376.
2. Altbach, P. G. (1993). The dilemma of change in Indian higher education. *Higher Education*, 26(1), 3-20.
3. Dayal, I. (2002). Developing management education in India. *Journal of management Research*, 2(2), 98-106.
4. Dong, B., Andrews, B., Lam, K. P., Höynck, M., Zhang, R., Chiou, Y. S., & Benitez, D. (2010). An information technology enabled sustainability test-bed (ITEST) for occupancy detection through an environmental sensing network. *Energy and Buildings*, 42(7), 1038-1046.
5. DU, P. J., LI, J., ZHANG, H. R., & CHEN, Y. H. (2007). Discussion on Specialty Education of GIS based on UCGIS Geographic Information Science and Technology Body of Knowledge. *Geomatics World*, 4.
6. Ehlers, M. (2008). Geoinformatics and digital earth initiatives: a

- German perspective. International journal of digital earth, 1(1), 17-30.
7. WANG, J. X., & GUO, H. L. (2010). The Characteristics and Teaching Methods of High-tech Disciplines of GPS, GIS and RS—Taking the GIS majors of Zhengzhou University as an example. Geomatics World, 6.
  8. WU, Q., & LI, X. Y. (2015). Remote sensing dynamic monitoring of mining geo-environment based on computational geometry and information TUPU. Journal of China Coal Society, (1), 26-34.
  9. Li, T. S., & Li, B. (2007). Research on Data Model and Query Optimization of Electronic Map in Embedded GIS. Aeronautical Computing Technique, (2), 26-35.
  10. Moqi, J. H. L. (2010). Application of Geographic Information System in Digital Mining Information System. Standardization of Surveying and Mapping, 3.
  11. Paul, P. K. (2013). MSc-Information Science [Geoinformatics]: Overview emphasizing twoproposed curriculum for sophisticated Geo Spatial development. International Journal of Pharmaceutical and Biological Research (IJPBR), 4(5), 218-227.
  - 1 Paul, P. K., & Ganguly, J. (2013). Green computing: The emerging tool of interdisciplinary environmental sciences-problems and prospects in Indian scenario. International Journal of Pharmaceutical and Biological Research (IJPBR), 5(04), 210-214.
  - 1 Paul, P. K., Kumar, A., Poovammal, E., & Dangwal, K. L. (2014). Information Science: A Potential interdisciplinary field with Historical Perspectives and Future Potentials. Educational Quest, 5(3), 211.
  - 1 Paul, P.K. Aithal, P.S. (2017). Informatics as a Branch in Indian Academics with Case of Private Universities: Emphasizing Biological Information Sciences. Current Trends in Biotechnology and Chemical Research, 7(1-2), 37-42.

- 1 Paul, P. K., & Ghose, M. K. (2018). Why Green Computing and Green Information Sciences Have Potentialities in Academics and iSchools: Practice and Educational Perspectives. In *Advances in Smart Grid and Renewable Energy* (pp. 103-112). Springer, Singapore.
- 1 Paul, P. K., Ricardo, Saavedra, Aithal, P. S., Bashiru, Aremu., & Baby, Pappachan. (2020). Environmental Informatics: Potentialities in iSchools and Information Science & Technology Programs— An Analysis. *International Journal of Management, Technology, and Social Sciences (IJMTS)*, 5(1), 238-250.
- 1 Paul, P. K. and Aithal, P. S. (2020). Environment and Studies related to Environmental Sciences: The Overview of Allied Areas. *Educational Quest: An Int. J. of Education and Applied Social Science*, 11(1), 01- 05.
- 1 Paul, P.K., Bhuimali, A., Aithal, P. S., Tiwary, K. S., Ripu Ranjan Sinha (2020). Environmental Informatics: Educational Opportunities at Bachelors level— International Context and Indian Potentialities. *International Journal of Applied Engineering and Management Letters (IJAEML)*, 4(1), 243- 256.
- 1 Paul, P.K., Aithal, P.S., Bhuimali, A. (2020). Environmental Informatics and Educational Opportunities in Post Graduate level—Indian Potentialities based on International Scenario. *IRA- International Journal of Management & Social Sciences*, 16(2), 45-58.
20. Li, M., & Ye, L. R. (1999). Information technology and firm performance: Linking with environmental, strategic and managerial contexts. *Information & Management*, 35(1), 43-51.
21. Sandler, S. I. (1996). Infinite dilution activity coefficients in chemical, environmental and biochemical engineering. *Fluid Phase Equilibria*, 116(1-2), 343-353.
22. Tochtermann, K., & Maurer, H. A. (2000). Knowledge management

and environmental informatics.

Journal of Universal Computer Science, 6(5), 517-536.

23. Thompson, S., Treweek, J. R., & Thurling, D. (1997). The ecological component of environmental impact assessment: a critical review of British environmental statements. Journal of environmental Planning and Management, 40(2), 157-172.
24. Yakhou, M., & Dorweiler, V. P. (2004). Environmental accounting: an essential component of business strategy. Business Strategy and the Environment, 13(2), 65-77.
25. You-yi, J. I. A. N. G. (2012). Teaching of GIS Course for Surveying and Mapping Engineering Specialty in Universities. Technology and Innovation Management, (5), 28-37.