

Geo Information Systems & Remote Sensing: Applications in Environmental Systems & Management

P. K. Paul¹, P. S. Aithal², A. Bhumali³, K. S. Tiwary⁴, R. Saavedra⁵ & B. Aremu⁶

¹Executive Director, MCIS, Department of CIS, Raiganj University, India

²Vice Chancellor, Srinivas University, Karnataka, India

³Vice Chancellor, Raiganj University (RGU), West Bengal, India

⁴Dean (Science & Management), Raiganj University (RGU), West Bengal, India

⁵Director & Chair, International Programs, Azteca University, México, North America

⁶Vice Chancellor, Crown University, Intl. Chartered Inc. (CUICI) Argentina Campus, South America

Corresponding Author Email: pkpaul.infotech@gmail.com

Area/Section: Technology Management.

Type of the Paper: Research Paper.

Type of Review: Peer Reviewed as per [C|O|P|E](#) guidance.

Indexed in: OpenAIRE.

DOI: <http://doi.org/10.5281/zenodo.3976936>.

Google Scholar Citation: [IJMTS](#).

How to Cite this Paper:

Paul, P. K., Aithal, P. S., Bhumali, A., Tiwary, K. S., Saavedra, R., & Aremu, B. (2020). Geo Information Systems & Remote Sensing: Applications in Environmental Systems & Management. *International Journal of Management, Technology, and Social Sciences (IJMTS)*, 5(2), 11-18. DOI: <http://doi.org/10.5281/zenodo.3976936>.

International Journal of Management, Technology, and Social Sciences (IJMTS)

A Refereed International Journal of Srinivas University, India.

© With Authors.



This work is licensed under a [Creative Commons Attribution-Non-Commercial 4.0 International License](#) subject to proper citation to the publication source of the work.

Disclaimer: The scholarly papers as reviewed and published by the Srinivas Publications (S.P.), India are the views and opinions of their respective authors and are not the views or opinions of the SP. The SP disclaims of any harm or loss caused due to the published content to any party.

Geo Information Systems & Remote Sensing: Applications in Environmental Systems & Management

P. K. Paul¹, P. S. Aithal², A. Bhumali³, K. S. Tiwary⁴, R. Saavedra⁵ & B. Aremu⁶

¹Executive Director, MCIS, Department of CIS, Raiganj University, India

²Vice Chancellor, Srinivas University, Karnataka, India

³Vice Chancellor, Raiganj University (RGU), West Bengal, India

⁴Dean (Science & Management), Raiganj University (RGU), West Bengal, India

⁵Director & Chair, International Programs, Azteca University, México, North America

⁶Vice Chancellor, Crown University, Intl. Chartered Inc. (CUICI) Argentina Campus, South America

Corresponding Author Email: pkpaul.infotech@gmail.com

ABSTRACT

Geo Informatics is an interdisciplinary field responsible for spatial information related activities. Geo Informatics is close to the Geo Information Science, Geo Information System, Remote Sensing, etc. Geo Informatics is a combination of Geo Science and Information Science and here different kinds of IT and Computing tools are being used such as Database Technology, Network Technology, Web Technology, Multimedia Technology, etc in the spatial data management. Remote Sensing is considered as a component of Geo Information Science dedicated in gathering of information on the different types of objects without physical content and applicable in different areas of the geography, survey of land and different type of geo related areas viz. Hydrology, Ecology, Meteorology, Oceanography and Geology, etc. The term remote sensing is also called as GIS & RS due to their relationship and their importance. The applications of the IT in Geography and allied areas are called as Geo Informatics or Geo Information Science. Similarly, the applications and utilization of IT, Information Science and Computing in Environment and allied areas are known as Environmental Informatics or Environmental Information Science. The GIS and Remote Sensing applications in the environment and ecological areas are increasing rapidly and it includes various existing and emerging applications. This paper talks about the applications of the GIS and RS in Environmental Applications and Management.

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

1. INTRODUCTION :

There are various applications of the geographic information systems (GIS) in environmental science that are noticeable; however, it is treated as a complex, multifaceted aspect. Environmental science is a multidisciplinary field incorporating aspects of the biological, social, and physical sciences regarding the environmental problems and importantly GIS is useful indifferent spatial information related activities such as organize, analyze, manage, visualize geospatial data management for the purpose of the environmental analysis and modeling [1], [5]. The GIS in environmental science deals with the macros a broad bibliographic landscape. During the 1960s and 1970s when environmental movement held strongly the field of environmental science was noticeable in relation to ecology, geography, and hydrology. Later various Geo techniques and technologies consider as important and accessible tools to analyze and solve complex environmental problems. In the areas of risk management, pollution, and monitoring of the environment, GIS and RS are applied effectively. The Information Technology development including data accessibility,

visualization, software modeling treated as a perfect storm for the adoption of Environmental Informatics where integrated technology like GIS is applicable in solving various environmental issues. There was an explosion of Environmental IT uses in the water resources, climate change, urban planning, etc. and here GIS is very much effective. Today all of us are dedicated in protecting the environment including the aspects of the Climate change, i.e. erratic weather patterns effective natural environment and crop production, melting of ice glaciers and in such aspects and monitoring GIS can helpful and a powerful tool [7], [17].

2. OBJECTIVE :

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

- To learn about the basics of Geo Informatics and Geo Information Systems with features and attributes.
- To get knowledge about the basic applications of the Geo Information Systems and Remote Sensing.
- To learn about the basics of Environmental Informatics with reference to GIS and RS.
- To learn about the basic applications of the GIS and Remote Sensing Applications in Environment and Ecological Management.
- To learn about the field specific applications of the GIS, Remote Sensing, etc. for the healthy Environmental Monitoring and Utilizations.
- To get the current trends and future potentiality of the GIS and Similar Spatial Technologies in the healthy Ecology and Environmental Informatics practice.

3. ENVIRONMENTAL INFORMATICS :

Environmental Informatics is emerging and combines with the Environment and Informatics (i.e. also called as Environmental Information Science). In a simple sense it is the applications of Information Technology and Computing in Environment and Ecological aspects and subjects viz. Geology, Agriculture, Forestry, Geography, Climatology, Oceanography, etc. It is partially also called as Eco Informatics and Ecology Informatics; however, Environmental Informatics is broader than these. Moreover, another nomenclature called Environmental Information Technology is another important one though Environmental Informatics may also additional talks/ deals with manual information management in respect of the environment and ecology. Here various emerging technologies are applicable in different sectors of the environment such as—

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

4. 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].

5. GIS AND ENVIRONMENTAL MANAGEMENT :

It is important to note that the issues of the global warming are increasing day by day with the environmental degradation including decreasing glacier area, increasing the size of the glacial lake, heavy rainfall, changes in lands including floods, etc. Moreover, the aspects of the landslides, limited agricultural crop production can also be considered as important environmental changes and these need timely monitoring. In this context for Effective monitoring of the environmental aspects here geospatial technologies including remote sensing and GIS are effective and useful [8], [14], [23].

GIS is effective environmental data analysis, planning and management tool and helps in healthy environmental conditions viz. slopes, aspects, and vegetation and so on. Digital information is possible using GIS tools to provide environmental data, quick, comparative view of hazards, risks and also areas to be safeguarded. Based on Data Analysis, GIS is helpful in managing the environmental hazards and risks and other environment related problems including planning decisions and for mitigation activities. GIS also helps in environmental assessment and in the generation of the environmental models and here is GIS is an effective very much. GIS is thus needed in environmental management for the following concern—

- 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].

6. GIS APPLICATIONS IN DISASTER MANAGEMENT :

GIS systems are used in integrated, well developed disaster management and mitigation systems with risk management and analysis. This is required in natural or artificial disaster management including in identification, preventive measures, etc.

In early warning systems, GIS and RS are used including in decision support systems towards a healthy disaster is management with mitigating the risks of a disaster. Further GIS and RS are useful in better, responsive, and faster GIS based systems. The tool is useful in affected areas, recovery becomes easier and faster. Therefore, in cyclone alerts, regional tsunamis, heavy rainfall, in the coming flood alert system GIS is effective for complete disaster management.



Fig. 1: GIS in Disaster Management [18]

7. GIS AND ALLIED TOOL IN AIR QUALITY MONITORING :

In Air quality monitoring GIS and RS are very important; here the integrated platform supported by the leveraging sensors and ultimately it is required in monitoring, analysis and planning, within a territory/ city. The systems therefore can predict the most hazardous or most dangerous areas and it may be helpful for the health of the human being viz. asthma patients. This analysis supported by the GIS and RS can be helpful in improving the air quality. Such GIS and RS based tools may be incorporated as a mobile app, and here the citizens can get immediate attention on the quality of air [4], [13], [21].

8. FIRE MANAGEMENT AND GIS :

GIS and RS tools are useful in general fire management and specifically in wildfire management. GIS is potential in forest fire management due to the different applications of GIS which may also helpful in hazard map development, forest fire simulation including resource management. Simulation by itself has a main role in the management of forest fire. In this respect, various other allied technologies and systems can be helpful viz.—

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

9. GIS IN MANAGING NATURAL RESOURCES :

GIS and RS are helpful in the diverse areas of natural resource management viz. agricultural, water and forest management. Here easily monitoring of the forest condition become possible including the managing and monitoring crop and its rotation, in analyzing geographic distribution of water systems, forest related aspects viz. cover reduces, also flood, landslide, soil erosions, drought, earthquake, etc. can be effectively managed with GIS and RS.

Therefore, using GIS and RS natural resource related data could be collected through aerial photography, satellite imagery using GIS technology. Hence in the aspects of climate change, population, pollution, etc. it is a worthy tool. GIS is helping to study specific monitoring including environmental conditions and policy, including conservation programs. Maps in GIS provide the information of location and current resources. GIS is required in wastewater management, oil spilling, sewage treatment, etc. As GIS helps location information thus also required in various types of decision-making, policy making, etc and helpful in environmental management. Therefore, GIS basically responsible for collects, analyzes, stores and disseminates Geo Spatial Information which helpful in environmental development and agricultural management [6], [16], [20].

10. SOIL MANAGEMENT AND GIS :

Geo Spatial Information Technology is dedicated to Land Management i.e. the degrees of actual or potential hazard from landslides. With GIS & RS it collects, manipulates spatial data viz. geological, structural, surface, etc. and therefore in hazard zonation, this system could be useful. On the other hand, the role of GIS technology is also useful in land cover applications including land cover patterns within time. As far as Soil mapping is concerned GIS provides resource information and thus it helps in soil feature analysis and may be helpful in preventing environmental deterioration; in forest management and for agriculture to understand the characteristics of the soil; GIS and RS are useful.

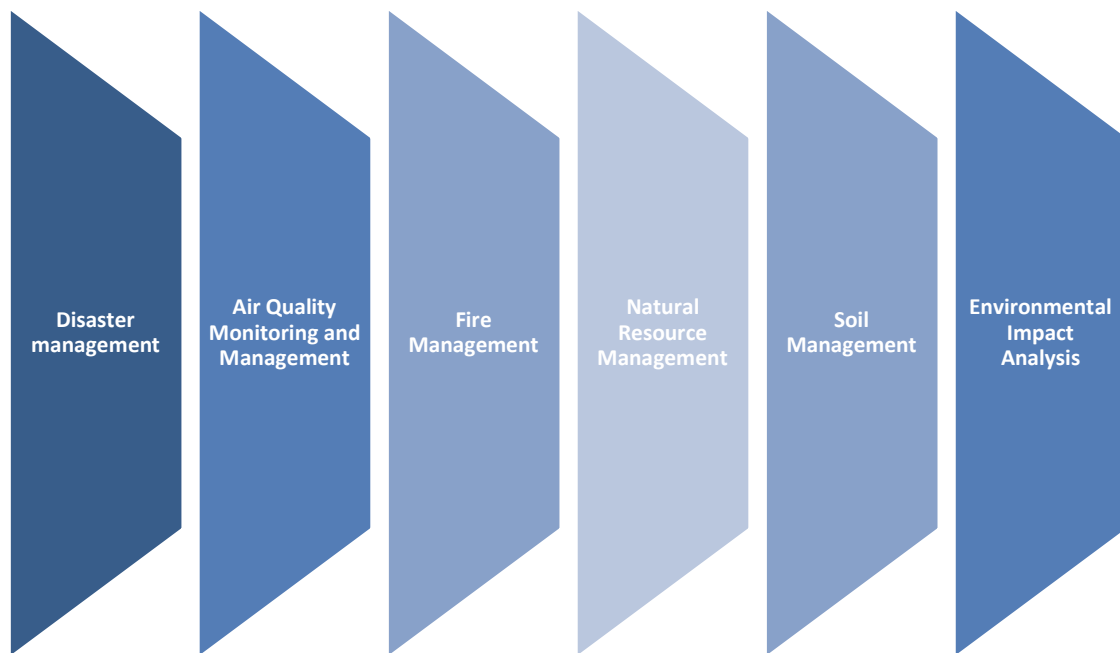


Fig.2 : GIS in Diverse Environmental Areas

11. IN ENVIRONMENTAL IMPACT ANALYSIS (EIA) :

GIS & RS are helpful in Environmental Impact Analysis (EIA) and also, it will be helpful in policymaking regarding the natural resources and environment. Due to human interference, the environmental effect may be noted with highways and railroads, public areas and pipelines, airports, and so on. And here Environmental impact statements are usually required to learn environmental impact. Here GIS tools and technologies are useful effectively [2], [11].

12. IN RESPECT OF FLOOD DAMAGE AND MANAGEMENT :

As far as Flood Damage and Management is concerned the GIS and Remote Sensing tools help in disaster relief funds and can be utilized by administrators, policy makers, and so on.

Furthermore, in Irrigation Management also GIS are useful; it is helpful in knowing water availability and may be needed in water management, crop production, agriculture management, etc. For the effective management of the utilization of water, Geo Spatial Technologies are important and useful.

13. WETLAND MAPPING AND IN VOLCANIC HAZARD :

Wetland is an important part of the environment and it helps in better land management including reducing flood levels. GIS and RS helps in wetland mapping and design. As far as Volcanic hazard is concerned that deals with the particles gas clouds, lava flows and flooding and here GIS based impact assessment will be helpful. Ultimately it may be helpful in volcanic hazards management including in partial helpful in economic loss and loss of lives in a different context [9], [22].

14. CONCLUSION:

Environment is very much important regarding development; and in Environmental and Ecological Management it helps in a sustainable world. And in all 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. The areas such as GIS and Remote Sensing 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 also 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 [Geo Informatics]: Overview emphasizing two proposed curriculum for sophisticated Geo Spatial development. *International Journal of Pharmaceutical and Biological Research (IJPBR)*, 4(5), 218-227.
- [12] 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.
- [13] 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.
- [14] 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.
- [15] 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.
- [16] 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.
- [17] Paul, P. K. & Aithal, P.S. (2020). Environmental Informatics and its Features, Functions and Stakeholders: *A Comprehensive Overview*. *Educational Quest - An International Journal of Education and Applied Social Science*, 11(1), 1-5.
- [18] Paul, P. K., Bhumali, 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.
- [19] Paul, P. K., Aithal, P. S., Bhumali, 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.
