



A study of significant applications of Geographical Information System (GIS) in sustainable development in India

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ARTICLE INFO

Article history:

Received: 28 June 2026

Received in revised form:
18 July 2026

Accepted: 4 August 2026

Keywords:

GIS, sustainable development, applications

ABSTRACT

This paper studies the application of the Geographical Information System (GIS) in sustainable development in India. The GIS is the tool which provides digital data of geographical information for the user to analyse and make decisions. The GIS is widely useful in various fields such as precision agriculture, industry management, health sector, public transports, smart city management, infrastructure and development management, research, strategic planning and governance. GIS is very useful in digitization for observation, analysis and decision making for sustainable development of India.

Introduction:

In the current scenario every sector is accommodated with new technologies. The technologies are for observation, analysis, decision making, planning and development. The sectors like precision agriculture, health, transport, domestic services, disaster management, rural development, urban planning and smart cities, environment and climate change, water resource

management, natural resource management, defence and national security, telecommunication, business and market analysis, mining and geology, marine and coastal management and many more taken advantage of recent technologies in their growth. The Geographical Information System (GIS) is one of the tools that can facilitate the ease in handling the activities like capturing, storing, processing, analysing and displaying the

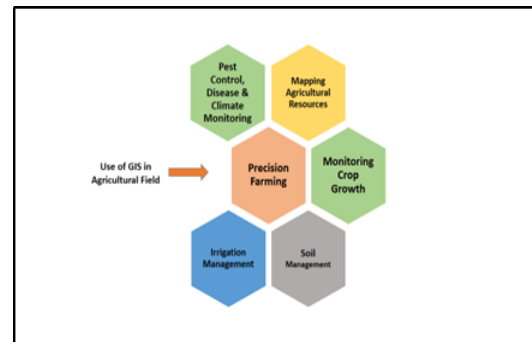
geographical data. The GIS uses geographical referenced data integrate it digitally and provides a decision making platform for real world activities. GIS has four major components: Hardware, Software, Data and Users. The Hardware embedded with- Computers, Servers and Global Positioning System (GPS). Software like QGIS or ArcGIS is used to process geographical data, that data is the representation of geometry and its description. Spatial and attributes are used by the user for analysis and interpretation. In GIS the user handles the spatial information for analysis and interpretations.

Review on Applications of GIS

Geographic Information System (GIS) can effectively be used in various fields including Natural resources and Environment survey, mobility and urban planning, strategic and Scientific, Economic and Industrial and governance and public services sectors.

A) Agricultural Applications:

Agriculture not only provides food to the human being but also it provides raw material, employment and also it impacts the global economy. However, growing population, environmental crisis, water scarcity, pollution and soil degradation are the challenges to sustain agricultural fields. To overcome these challenges, promising technologies must be adopted in the agricultural field. To meet the need of all this, GIS is a promising tool for the agriculture field. It can significantly be used for collecting agricultural data for further storage, analysis and decision making approach. The crop management, soil assessment, planning of irrigation, wild and pest control can be made easy with the GIS technology. Embedding GIS technology with Artificial Intelligence (AI), Remote Sensing (RS), and Global Positioning System (GPS) made agricultural activities more precise, handy, reduced cost, increases in productivity and sustainable. Precision agriculture is incorporated with Soil management, monitoring of crop growth, irrigation management, diseases monitoring, pest control, monitoring of climate and mapping of agricultural resources [1-3].



B) Infrastructure and Development Applications:

The Geographic Information System (GIS) tool opens significant opportunities in infrastructure development and planning of urban areas. The activities like transportation management, communication network development and smart city implementation benefits by GIS technology. GIS provides spatial and non spatial information to the planners to make precise decisions in systematic development and management of urban areas.

a) Urban Planning:

Nowadays most of the people migrate towards urban cities in search of their livelihoods. This results in an increase of population density in urban areas. The demand for infrastructure and utilities is also increasing in proportion. The growing urbanization faces significant issues in management of land use, planning of infrastructure, public services, transportation, etc. The traditional methods of urban planning are insufficient to handle complex and dynamic needs of modern cities. So emerging techniques such as GIS are very helpful in urban planning.

The major components of urban planning are Land use, Land cover, Site selection, Disaster and risk management. The GIS tool significantly helps planners to prepare the maps of used land. It prepares zones of the land such as residential, agricultural, industrial and institutional. This will be further useful for monitoring the expansion of urban areas, prevention of unauthorised infrastructure development and analysis of land suitability for use. GIS also helps in population mapping, demographic analysis, and study of migration. Disaster management is one of the vital applications of GIS. The mapping of flood prone areas, earthquake sensitive regions and

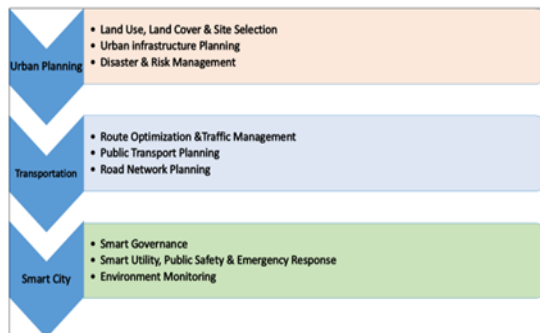
accident-prone spots effectively carried out GIS [4-6].

b) Transportation:

The GIS is useful in transportation management by integrating spatial and attribute data. Planning of route network, identification of traffic pronezone, identification of accidental hotspots, passenger demand forecasting, selection for suitable location for development of transportation infrastructure can significantly improve decision making ability of planners. It also provides information to the user such as shortest route for travel, real time traffic, cost effectiveness and travel time etc.[7-8].

c) Smart city:

Digital technology is the measure component of a smart city. Sensor based automated decision making systems are used to enhance services, resource availability and sustainability. The infrastructure in smart cities such as the water supply network, Sewage system, electricity, gas pipelines, pollution monitoring and telecommunication networks can be managed by GIS technology [9-10].



C) Strategic and Scientific applications:

GIS has wide applications in strategic and scientific management. GIS collects, analyses and manages the spatial data and provides assistance to various fields such as research, defence, marine, archaeology, environment monitoring, and disaster management.

The GIS is a very useful tool in environmental research such as climate change assessment, forest cover monitoring, biodiversity conservation, pollution mapping and watershed management.



It is also beneficial in public health research in disease outbreak mapping, healthcare accessibility analysis, and epidemiological modelling etc.

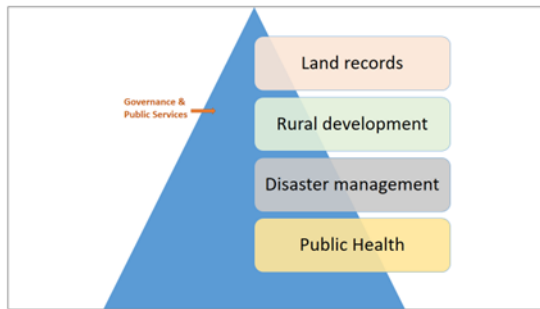
In defence it can be used for battlefield management, border surveillance, intelligence gathering .

The GIS supports ocean and coastal resource management. The coastal zone management, marine biodiversity, fisheries management, oceanographic studies and marine pollution monitoring can be facilitated with GIS [11-12].

D) Governance and Public Services applications:

In the government sector there are many location based activities such as land administration, infrastructure planning, disaster management, taxation, environmental conservation, healthcare accessibility and public utilities. Traditional methods used to handle such activities are critical and time consuming. The GIS tools provide significant applications in governance and public services. The land record can be easily digitised in GIS, it avoids traditional paper maps. The accurate boundary mapping, faster mutation, online verification is possible and it can reduce land disputes issues. It is also helpful in online verifying land ownership, land use, tax information and encumbrance records. The watershed development, agricultural planning, village resource mapping, and road planning can also easily be managed by GIS.

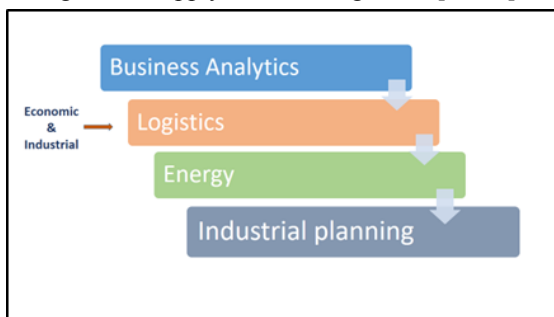
The disaster such as flood, earthquake, cyclone, forest fire, and landsliding can be emergency responded and managed by the use of GIS [13-14].



E) Economic and Industrial applications:

In the digital transformation era industries are using GIS tools widely to optimise operations, improve decision makings, reduction of cost and increasing sustainability. GIS also supports business intelligence, supply chain management, logistics, site identification and selection, management of energy infrastructure, market analysis and economical plannings. Economic development relies on geography of resources, population density, availability of infrastructure, markets and industries. The GIS helps policymakers in regional economic planning, identification of investment zones, industrial corridor management, planning of infrastructure, employment analysis, mapping of tourism economy and export import management etc.

In business analytics GIS supports market analysis, customer segmentation, sales territory management, supply chain management [15-16].



Discussion & Conclusion:

The Geographic Information System (GIS) is the emerging technology that supports achieving sustainable development across every sector of India right from agricultural and water resource management to urban planning, industries, health, transportation, energy, environmental conservation, business analytics, strategic management and governance. By adding satellite imagery, remote sensing data, Geographical Positioning System

(GPS), and real time geospatial data, GIS provides help to policymakers, researchers, industries, and public administrators in resource utilization, reduction of cost and enhanced operational efficiency.

Considering the current scenario of India as national initiatives such as Digital India, Smart Cities Projects, PM Gati Shakti abhiyan, National Geospatial Policy and various research institutions like ISRO supported geospatial programs have significantly increased the adoption of GIS. These initiatives in India signifies the role of geospatial technologies in overall growth, infrastructure development, climate resilience, environmental protection, and transparent governance.

Furthermore, GIS proves its role in achieving the United Nations Sustainable Development Goals (SDGs) by supporting informed planning, monitoring development indicators, conserving natural resources, and promoting equitable access to essential services. The emerging technologies such as Artificial Intelligence, Internet of Things (IoT), Drone Technology, Big data and Cloud computing continue to integrate with GIS, and will expand the role of GIS as a predictive analytics and intelligent decision support system.

In conclusion the GIS is not only the mapping tool but a strategic decision support platform in sustainable economic, social, and environmental development. The continuous investment in geospatial infrastructure, skilled human resources, and research and innovation will ensure that GIS remains a cornerstone of India's journey towards sustainable and inclusive development.

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