A Study of GIS and Remote Sensing for Developing Information Systems in India

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Abstract

Now-a-days the field of Remote Sensing and Geographical Information system (GIS) has become exciting and desirable with rapidly expanding opportunities and provides vital tools which can be applied in the various levels leading to decision making toward sustainable socio-economic development and conservation of natural resources. Remote sensing and GIS technology, and its applications in various fields, have experienced a successful development in recent decades. In this paper the most commonly used processing procedures for remotely sensed data in particular image processing techniques and the application capabilities of GIS technologies are presented. GIS and remote sensing can play an important part in the rapid planning of various control management programmes. Further, remote sensing and GIS have been used conjunctively in several studies for addressing issues related to developmental planning. Remote sensing also provides a sound data base for generating baseline information on natural resources, a pre-requisite for planning and implementation, and monitoring of any developmental programme.

Keywords: *Geographic Information System (GIS), Remote Sensing, Sustainable Development, Natural Resources*.

1. INTRODUCTION

Remote sensing covers camera remote sensing (CRS) which generally means the acquisition of images in the visible and near infrared spectra using photographic camera and digital camera. The camera can be borne by either aircraft or spacecraft and they are both usually manned. Camera Remote Sensing is commonly referred to as Photogrammetry; satellite remote sensing (SRS) in which the sensor is mounted on satellite (a space platform that is un-manned). The sensor system is limited to the visible and infrared regions of the electromagnetic spectrum (EMS); radar remote sensing (RRS) also has its sensor mounted on satellite but the sensor system operates only within the microwave portion of the EMS; and natural remote sensing (NRS). This concerns the human vision system in which the eye is used to view and image object on temporary basis using the eyeoptic-nerve-brain combination. Other forms of natural sensing are those of sound with the aid of the ear; smell with the aid of the nose; feel with the aid of body or skin; and taste with the aid of the tongue. Based on the above, it becomes a lot easy for reader of this book to appreciate or at least feel the with closeness the rather universal way in which remote sensing technology can be a tool of investigation in their chosen field of endeavour. The scientific world witnessed the birth of remote sensing before the birth of Geographical Information System or Science (GIS). Arguably remote sensing laid the foundation for the advent of GIS, because of the thematic processing of imagery. In recent years, however, remote sensing and GIS have gone hand in hand, to the extent that remote sensing provides data or input data to GIS. According to the American Society of Photogrammetry –ASP (1983) remote sensing can be as the acquisition of information about an object without physical contact. Remote sensing was further described as the measurement or acquisition of information of some property of an object or phenomenon, by a recording device that is not in contact with the object or phenomenon under study.

GIS on the other hand, is a system of capturing, storing, querying, analyzing and displaying geospatial data (Cheng, 2012). Geo-spatial data illustrate both the locations and attributes of spatial features. The capability of GIS to

process and integrate geo-spatial data differentiates it from other information systems. GIS capabilities validates it as a significant geographic tool applied by geoscientists, cartographers, photogrammetry's, environmental engineers, urban and regional planners, among others (Cheng, 2012). The capability of data integration perhaps explains why some software's such as ArcGIS, QGIS, etc. incorporate GIS and remote sensing together in a single system. Thus, remote sensing and GIS are powerful tools that are very important in every area of human endeavour over which geographers are very proud, hence the need to showcase some of the very numerous ways in which the technology has been of immense benefit to mankind. This study therefore highlights the importance of remote sensing and GIS in their various areas of applications vis-a-vis development.

2. GEOGRAPHICAL APPLICATIONS

These are too numerous, but it will suffice to mention a few spatio-temporal studies of geographical significance here. Rawat & Kumar (2015) evaluated the spatio-temporal dynamics of land use/cover of Hawalbagh block of district Almora, Uttarakhand, India. Landsat satellite imageries of two different time periods of 1990 and 2010 were categorized into five different land use/ cover classes namely vegetation, agriculture, barren, built-up and water body. The results indicated that during the last two decades of the study, vegetation and built-up land increased by 3.51 per cent (9.39 km2) and 3.55 per cent (9.48 km2), respectively. The agriculture, barren land and water body decreased by 1.52 per cent (4.06 km2), 5.46 per cent (14.59 km2) and 0.08 per cent (0.22 km2), respectively. They concluded that remote sensing and GIS are vital tools for temporal analysis and quantification of spatial phenomena which is otherwise may not be possible to attempt through conventional mapping techniques. Ashaolu & Omotosho (2015) assessed the static water level and overburden pattern for sustainable groundwater development and management in Ilorin, Nigeria using GIS. They computed the static water level and contour map with the data on depth to water to show the pattern of water level in Ilorin. They also plotted the overburden map from the overburden data using IDW interpolating method in GIS. From the result, they classified Ilorin into poor (overburden <10m), marginal (10m-19m overburden) and good or high zone (overburden ≥ 20m) of groundwater potentials. Their analysis of the spatial pattern of overburden depth revealed that the majority of Ilorin city was underlain by marginally thick overburden. They concluded that sustainable groundwater development and management in Ilorin could only be attained by controlling the indiscriminate drilling of boreholes (wells), continuous mapping and regular updating of the available records on groundwater resources.

3. REMOTE SENSING

The technical term remote sensing was first coined by Evelyn Pruitt at the United States office of novel research in the 1958 (Estes and Jensen, 1998). Since, Landsat – 1 is the first earth observation satellite was launched in 1972; remote sensing has become widely used. Remote sensing is defined as the science and technology by which the characteristics of objects of interest can be identified, measured or analyzed the characteristics without direct contact. According to Colwell (1997), remote sensing is "the art, science, and technology of obtaining reliable information about physical objects and the environment, through the process of recording, measuring and interpreting imagery and digital representations of energy patterns derived from noncontact sensor systems".

1. Stages in Remote Sensing

- Emission of electromagnetic radiation or EMR (sun/self- emission)
- Transmission of energy from the source to the surface of the earth, as well as absorption and scattering
- Interaction of EMR with the earth's surface: reflection and emission
- Transmission of energy from the surface to the remote sensor
- Sensor data output
- Data transmission, processing and analysis

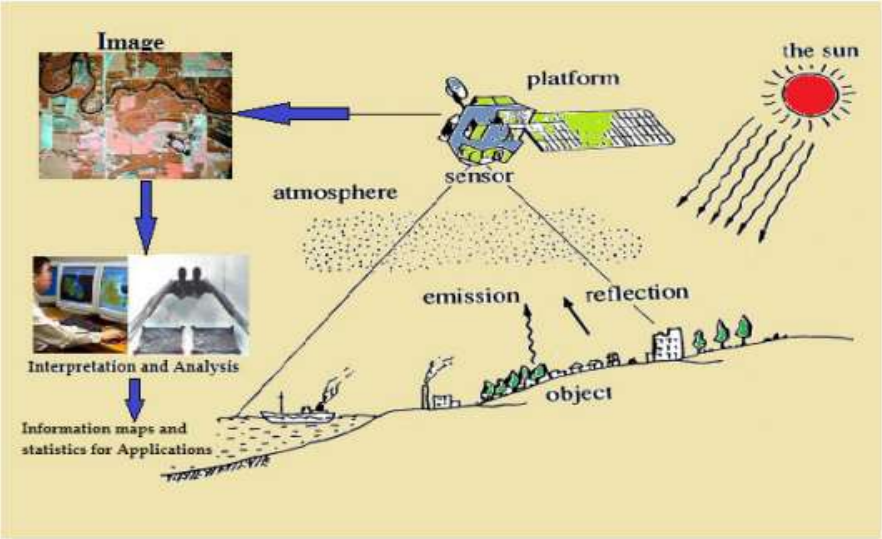

Figure 1: Data Collection by Remote Sensing

4. COMPONENT AND PRINCIPLE OF REMOTE SENSING

The components of remote sensing are object, source of electromagnetic radiation, sensor, platform, image research, data interpretation etc.

1. Electromagnetic Radiation

Electromagnetic radiation which is reflected or emitted from an object is the usual source of remote sensing data. However any media such as gravity or magnetic fields can be utilized in remote sensing. Electromagnetic radiation is a carrier of electromagnetic energy by transmitting the oscillation of the electromagnetic field through space or matter. The transmitting the electromagnetic radiation is derived from the Maxwell equations. Electromagnetic radiation has the characteristics of both wave motion and particle motion.

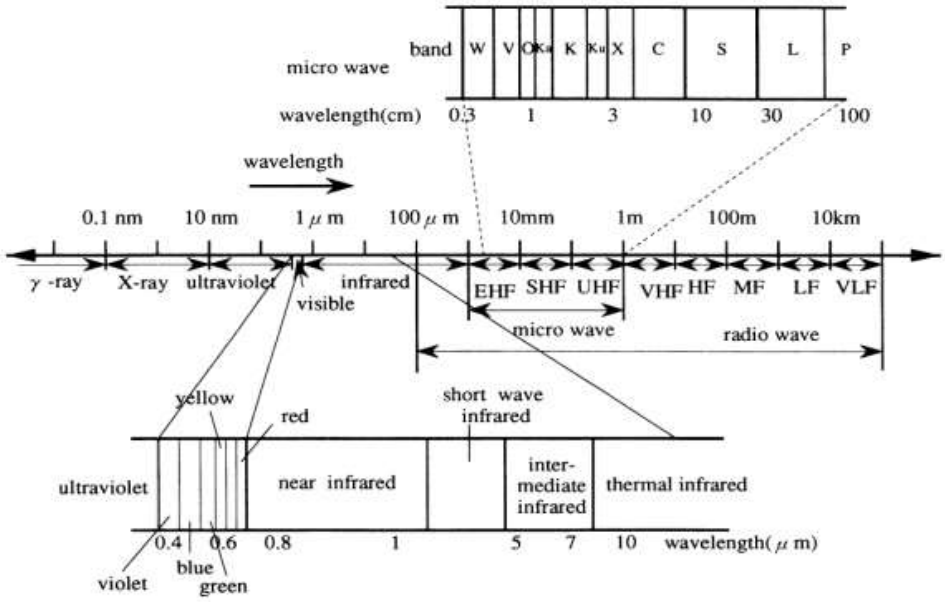

Figure 2: Bands Used in Remote Sensing

The characteristics of an object can be determined, using reflected or emitted electromagnetic radiation, from the object. That is "each object has a unique and different characteristics of reflection or emission if the type of object or the environmental condition is different." Remote sensing is a technology to identify and understand the object or the environmental condition through the uniqueness of the reflection.

2. Sensor and Platform

A device to detect the electromagnetic radiation reflected or emitted from an object is called remote sensor or Sensor. Cameras or scanner are examples of remote sensors. A vehicle to carry the sensor is called a Platform. Aircraft or satellites are used as platforms.

3. Types of Platforms used for Remote Sensing

• Ground-based platforms: ground, vehicles and/or towers → up to 50 m

• Airborne platforms: airplanes, helicopters, high-altitude aircrafts, balloons → up to 50 km

• Space borne: rockets, satellites, shuttle → from about 100 km to 36000 km

- Space shuttle: 250-300 km
- Space station: 300-400 km
- Low-level satellites: 700-1500 km
- High-level satellites: about 36000 km

5. GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Geographic Information System (GIS) refers to a system used for storing, manipulating, and retrieving spatially referenced data. This definition also includes systems designed to capture spatial information and to process it. Data in a GIS are its database, usually composed of data planes derived from different data sources. The combination of data sets allows data interpretation. A data plane is composed of one data type, for example, digitized elevation data. Digital data may either be in form of written text, maps, tables or photographs. In order to manage tropical waters effectively it is inevitable that a large amount of data is handled. Those involved in the general management of these resources require rapid access to statistical data and thematic maps. Manual interpretation only allows integrating of relatively small amounts of field data, maps and aerial imagery. A GIS brings together spatially referenced statistics and remotely sensed imagery into one integrated system. GIS can also be useful in improving information extraction capabilities from remotely sensed data as outlined by Venkatachary, 2001. The integration of remotesensing into GIS has provided environmental studies with a genuine investigation power. Nevertheless, it is only a potential source of data among others whose use finds its justification in the aim to be reached. At the spatial scales at which satellites observe the Earth, one cannot seriously envision to use satellite imagery to monitor the dynamics of small environments on short time-scale, e.g. every 5 years. To detect space changes in these areas, data-acquisition and-analysis scales must be greater than 1:5 000, with a measurement precision of 1 meter. Today, numerical ortho-photographies or aerial remotesensing (CASI) can punctually overcome the too low resolution of satellite sensors; so, one can use them to monitor tropical shallow lakes.

A GIS must be able to present information to users in a language and format that is not only accurate, but also graphic and comprehensible to all users. To facilitate urgent response from decision-makers in matters related to tropical water management, it is prudent to have a high ratio of maps and diagrams in written text. Such documents constitute a visual help essential for field staff, an aid for drawing up inventory as well as a mean of information and communication. In a short access time GIS allows one to store data from various origins, facilitates the design of maps meeting specific needs, e.g. scale, typology, and enables one to spare time in the production information through a possible automation of Remote Sensing and Geographical Information System (GIS) and Its Application in Various Fields design. All these characteristics not only increase map production, but also improve their quality by a better adequacy with the objectives to be reached.

6. URBAN PLANNING, DEVELOPMENT AND MANAGEMENT

The input of remote sensing and GIS to urban planning, development and management are enormous. Urban planning involves many functions, scales, sectors and stages that can be classified into administration, development control, plan making, and strategic planning. Several other authors have applied the technology to urban growth; urban change detection; land use/ land cover study; urban sprawl mapping and measurement; urban facilities distribution and the generation and development of accurate urban land use map. Remote sensing and GIS have been applied in modeling, quantifying, and predicting the future urban phenomena. The combinations of these technologies are capable of calculating the fragmentation, patchiness, porosity, patch density, interspersion and juxtaposing, relative richness, diversity and dominance in term of structure, function and change. Remotely sensed data provides a robust source of spatial attributes of the urban landscape. Ogunbodede and Balogun (2013) determined the spatial growth, rate and direction of growth of Benin City between 1986 and 2017. Future growth projection and the possible effects of the growth on Benin urban environment were determined from their analysis. They discovered that the absolute growth for the 21 years was 115.5785 sq km with an annual rate of growth is 5.5sq km. On the basis of their findings, they recommended regular monitoring of urban expansion and its direction using integrated remote sensing and GIS approaches. This will assist in determining the pattern of land use/cover and will also guide the provision of urban services and infrastructures.

7. CONCLUSION

The effective means of using space technology and its integration with GIS have assisted in solving problems that are of regional and global significance. As highlighted in this study, the application of remote sensing and GIS to different fields has contributed in no small measure to development. Information from satellite remote sensing and GIS has contributed significantly to the acquisition of knowledge and thus, resulted in better management of environmental resources. There is now a recognized need to manage the earth's resources in a sustainable and environmental friendly manner and remote sensing and GIS have provided a variety of information essential in facilitating such management.

8. REFERENCES

1. Abbas, I.I. and Ukoje, J.A. (2009). Application of remote sensing (RS) and geographic information systems (GIS) to environmental impact assessment for sustainable development. Research Journal of Environmental and Earth Sciences, 1 (1), 11-15.
2. Alonso, F.G., Soria, S.L. and Gozalo, J.C. (1991). Comparing two methodologies for crop area estimation in Spain using Landsat TM images and ground gathered data. Remote Sensing of Environment, 35 (1), 29-35.
3. Altan, O., Toz, G., Kulur, S., Seker, D., Volz, S., Fritsch, D. and Sester, M. (2001). Photogrammetry and geographic information systems for quick assessment, documentation and analysis of earthquakes. ISPRS Journal of Photogrammetry and Remote Sensing, 55 (5-6), 359–372.
4. Bainbridge, S.J. (1998). Remote sensing in the ASEAN region- an Australian perspective. Proceedings of the Symposium on Remote Sensing of the Coastal Zone. Gold Coast, Queensland, Australia.
5. Bamber, J.L. and Rivera, A. (2007). A review of remote sensing methods for glacier mass balance determination. Global and Planetary Change, 59, 138–148.
6. Berry, J.K. (1996). Learning computer-assisted map analysis. Journal of Forestry, 84 (10), 39-
8. 43.
7. Brown, W.W. (1998). Wetland mapping in New Jersey and New York. Photogrammetric Engineering and Remote Sensing, 44 (3), 303-314.
8. Burrough, P.A. (1996). Principles of geographical information systems for land resources assessment. Clarendon Press, Oxford.
9. Campell, J.B. (1997). Introduction to remote sensing. Guilford Press, New York.
10. Carfagna, E. and Gallego, F.J. (2005). The use of remote sensing in agricultural statistics. International Statistical Review, 73 (3), 389.404.
11. Chen, C. and Mcnairn, H. (2006). A neural network integrated approach for rice crop monitoring. International Journal of Remote Sensing, 27 (7), 1367.1393.