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Tania Patra
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REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

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Introduction

Remote sensing technology in recent years has proven to be of great importance in acquiring data for effective resources management and hence could also be applied to costal environment monitoring Remote Sensing and Geographical Information System (GIS) and its application in various fields and management. Further, the application of Geographical Information System (GIS) in analyzing the trends and estimated the changes that have occured in different themes helps in management decision making process. In particular, GIS and remote sensing technologies together offer the abilities of rapidly collecting data, processing and integrating data and information, and displaying results in geographic referenced maps and reports. Now-a-days the field of Remote Sensing and GIS has become exciting and glamorious with rapidly expanding opportunities. A GIS based integrated approach can be used for the risk management of natural hazards. Several researchers have documented the theory behind the use of these techniques for monitoring aquatic weeds. And other authors have explained eloquently how remote sensing can be used as a tool for natural resource management. Nowadays, the remote sensing technology can be used to investigate urban terrain, physiognomy, lakes, plants, sights, traffic, land utilization, building and population distribution quickly.

Aims and Objectives

Remote sensing and geographic information system is designed to fulfill the following objectives and aims

1. To provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management using Remote Sensing.
2. To acquire skills in storing, managing digital data for planning and development.
3. To acquire skills in advance techniques such as hyper spectral, thermal and lidar scanning for mapping, modeling and monitoring.
4. To introduce the student to the physical principles of remote sensing and photogrammetry as a tool for mapping.
5. To inform him of the data products, their properties and methods of preparing thematic information.
6. To understand the working of Total Station and GPS equipment and solve the surveying problems.
7. It also adds skill in mapping techniques and map outputs.
8. To describe about the procedure of satellite data acquisition and analysis.
9. To impart the knowledge of Microwave Remote Sensing and its application.
10. The objective of it is to understand the various remote sensing and GIS technological applications in Environmental Impact

Assessment and Risk Assessment.

11. The objective of this subject is to impart knowledge about the various geological structures and Geomorphic Landforms.

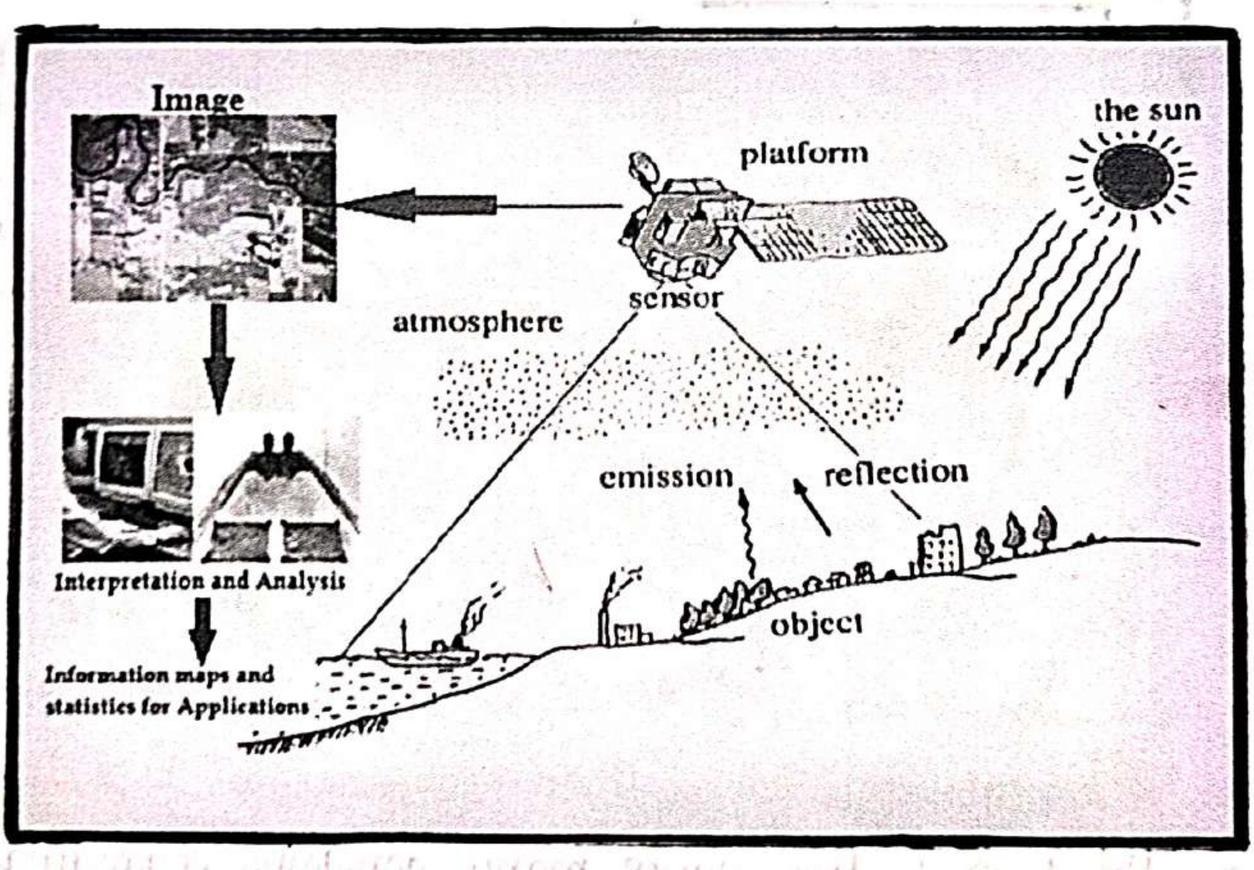
12. To impart knowledge in concepts in Meteorology, Radio and Satellite Meteorology and its Applications.

13. This subject deals with the basics of hydrology and also various remote sensing and GIS applications in the field of hydrology and water resourses.

Study Area

The use of remotely sensend data in the study of environmental changes is substantial. Remotely sensed data can be used to develop comprehensive digital databases for any target area to study different environmental issues and parameterize environmental models. One of the most destructive processes, steadily increasing as a result of human activity in these areas, is soil erosion (Lal, 1988). This raises many concerns regarding the potentially damaging impacts of contemporary land use in relation to the often weak or non-existent land management initiatives. Malaysia is one country suffering heavily from land degradation due to increasing anthropogenic pressure on its natural resources. The economic activity and population increased, in many parts of Malaysia agriculture, built-up areas and infrastructure development spread rapidly to the uplands. Consequently, the problem of

DATA COLLECTION BY REMOTE SENSING

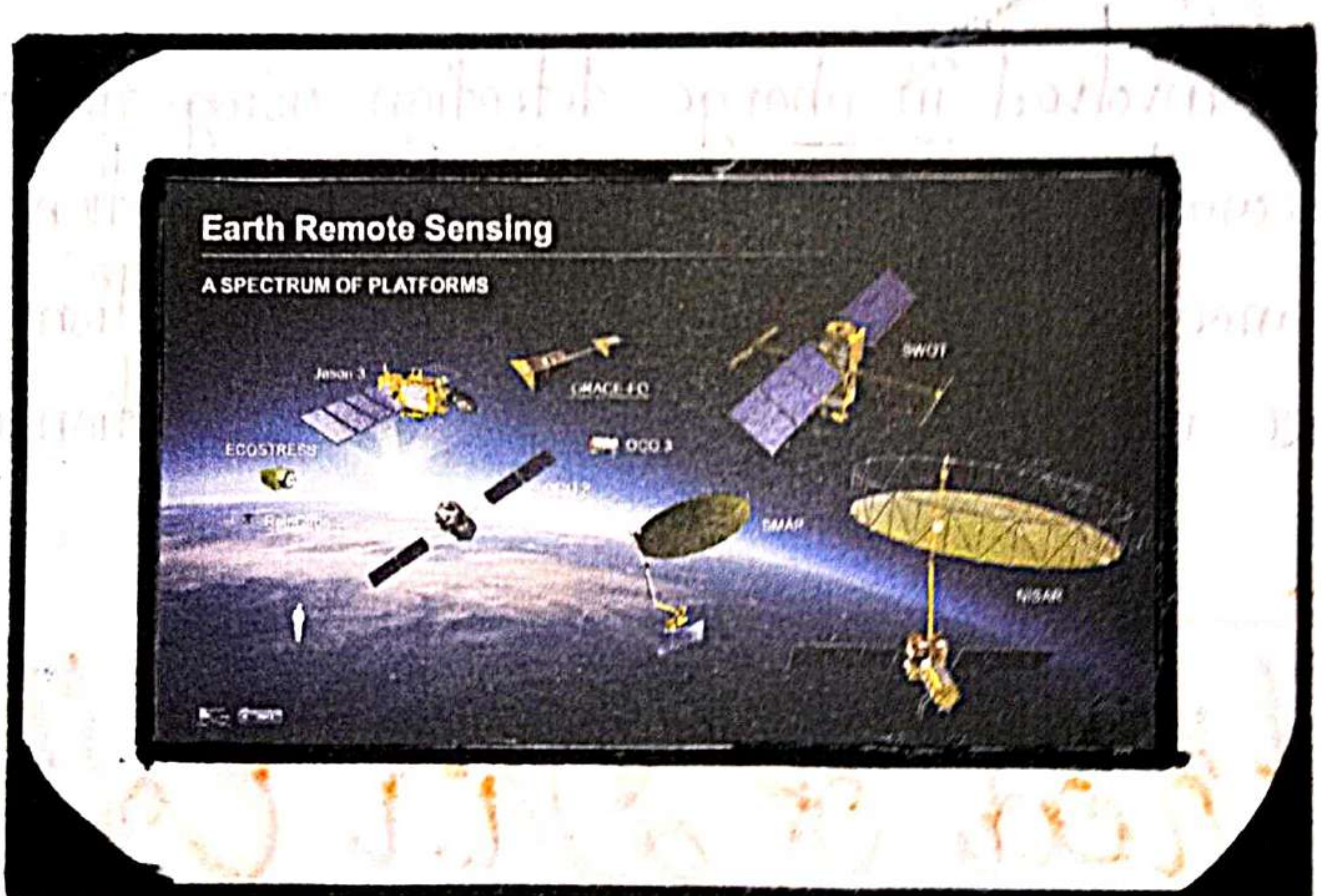


soil erosion and degradation, sedimentation and river pollution increased (Hashim et al., 1995; Bawahidi et al., 2004).
The research also covers most important aspects of remote sensing and GIS techniques. Given multi-source remotely sensed data, there is an increasing need for improved techniques to extract variety of information from the data. Moreover, new satellite sensors are now providing a huge amount of time series data for environmental monitoring.
Major issues involved in change detection using remote sensing data including geometric correction, radiometric correction or normalization, change enhancement and detection, and classification for land-cover and land-use monitoring, catchment characterization and soil erosion estimation.

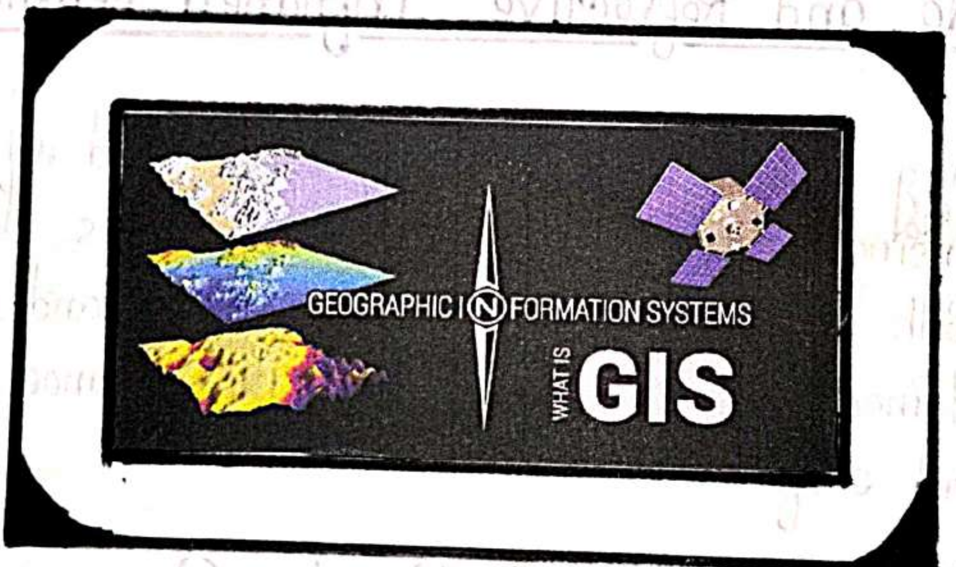
Method of Data Collection

Remote sensing method accuracy depends on whether satellite sensors observe a flood at its peak and this in turn depends on flood at its peak and this in turn depends on satellite overpass timing. The types of satellites used for microwave remote sensing have irregular overpass intervals. For example, with combined AMSR2 and GMI sensor data, an area in the mid-latitudes is observed about 3-times per day on average, with 5% of days having just one observations and about 1% of days have no observations. Furthermore, observa-tions cannot be made through rain and ideally multi-observation

REMOTE SENSING



GEOGRAPHIC INFORMATION SYSTEM



GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Geographic Information System (GIS) refers to a system used for storing, manipulating, and retrieving spacially referenced data. This definition also includes systems designed to capture spacial 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 (Young and RSS, 1986). 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 spacially referenced statistics and remotely sensed imagery into one

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integrated system. GIS can also be useful in improving information extraction capabilities from remotely sensed data as outlined by Venkatachary, 2001. The integration of remote-sensing 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 special 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 1:5000, with a measure-ment precision of 1 meter. Today, numerical ortho-photographies or aerial remote sensing (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 comphehensive 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 constitude 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 design. All these characteristics not only increase map production, but also improve their quality by a better adequacy with the objectives to be reached.

To secure such information, there are six prerequisite stages in a GIS to be followed as detailed by Tomlinson et al., 1976 and Jackson, 1985: Data acquisition, input and storage, processing, output and use.

APPLICATIONS OF REMOTE SENSING AND GIS

Remote sensing and GIS are playing a rapidly increasing role in the field of hydrogeology and water resources development. Extensive hydrogeological studies have been carried out by several workers in delineating groundwater potential zones in hard rock terrain (Rao et. al., 2001). A comprehensive review of RS and GIS applications in biodiversity conservation was compiled by Gross et al., 2009; Joshi et al., 2009; Roy, 2003. Remote sensing and geographic information systems is the only technique that can provide holistic approach to the study of total environment while still make visible the different process ont interrelationships that exist within the different biophysical components. When all of these are done, we will have eco development (Falkenmark, 1983) and balance environment (Tolba, 1988).

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There can be many applications for Remote Sensing and GIS different fields, as described below.

Application in the Field of Agriculture

Agriculture plays a dominant role in economics of both developed and underdeveloped countries. Satellite and airborne images are used as mapping tools to classify crops, examine the health and viability, and monitor farming practices. Agriculture applications of remote sensing include the following:

- crop type classification
- classification of agriculture areas (Collingwood et al., 2009)
- crop condition assessment
- crop yield estimation
- use in agriculture statistics
- mapping of soil characteristics
- crop area estimation (Alonso, 1991)
- mapping of soil management practices
- compliance monitoring (farming practises)
- crop monitoring

Recent research has documented radar as a tool for crop monitoring. Chen and Mcnairn (2006) used radar, for example, in rice monitoring within Asia.

Application in the Field of Forestry

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Forests are a valuable resource providing food, shelter, wildlife habitat, fuel, and daily supplies such as medicinal ingredients and paper. Forests play an important role in balancing the Earth's CO_2 supply and exchange, acting as a key link between the atmosphere, geosphere and hydrosphere.

Forestry applications of remote sensing include the following:

• Reconnaissance Mapping:

Objectives to be met by national forest/environment agencies include forest cover updating, depletion monitoring, and measuring biophysical properties of forest stands.

• Commercial Forestry:

Of importance to commercial forestry companies and to resource management agencies are inventory and mapping applications: collecting harvest information, updating of inventory information for timber supply, broad forest type, vegetation density and biomass measurements.

• Environmental Monitoring:

Conservation authorities are concerned with monitoring the quantity, health, and diversity of the Earth's forests.

Application in the Field of Geology

Geology involves the study of landforms, structure and the subsurface, to understand physical processes creating and modifying the earth's crust. It is most commonly understood as the exploration and exploitation of mineral and hydrocarbon resources, generally to improve the conditions and standard of living in society.

- surficial deposit / bedrock mapping
- lithological mapping
- structural mapping
- sand and gravel (aggregate) exploration / exploitation
- mineral exploration
- hydrocarbon exploration
- land resource assessment (Burrough, 1986)
- environmental geology
- geobotany
- baseline infrastructure
- sedimentation mapping and monitoring
- identification of rock types
- location of geological faults and anomalies
- event mapping and monitoring
- geo-hazard mapping
- planetary mapping

Application in the Field of Hydrology

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Hydrology is the study of water on the Earth's surface, whether flowing above ground, frozen in ice or snow, or retained by soil.

Examples of hydrological applications include:

- wetlands mapping and monitoring,
- soil moisture estimation,
- snow pack monitoring / delineation of extent,
- measuring snow thickness,
- determining snow-water equivalent,
- river and lake ice monitoring,
- flood mapping and monitoring,
- glacier dynamics monitoring (surges, ablation)
- river / delta change detection
- drainage basin mapping and watershed modelling
- irrigation canal leakage detection
- irrigation scheduling
- mapping of groundwater recharge zone (Sharma and Kujur, 2012).

Application in the Field of Sea Ice

Ice covers a substantial part of the Earth's surface and is a major factor in commercial shipping and fishing industries, Coast Guard and construction operations, and global climate change studies. Examples of sea ice information and applications include:

- ice concentration
- ice type / age / motion

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- glacier mass balance determination
- iceberg detection and tracking
- surface topography
- tactical identification of leads : navigation : safe shipping routes
- ice condition (state of decay)
- historical ice and iceberg conditions and dynamics for planning
- meteological / global change research

Application in the Field of Land Cover and Land Use

Although terms land cover and land uses are often used interchangeably, their actual meanings are quite distinct. Land cover refers to the surface cover on the ground, while land use refers to the purpose the land serves. The properties measured with remote sensing techniques relate to land cover, from which land use can be inferred particularly with ancillary data or a priopi knowledge;

Land use applications of remote sensing include the following:

- natural resource management
- wildlife habitat protection
- baseline mapping for GIS input
- urban expansion / encroachment
- land cover area estimation
- routine and logistics planning for seismic / exploration
- damage delineation
- legal boundaries for tax and property evaluation
- target detection - identification of landing strips, roads, clearings,

bridges, land / water interface

Application in the Field of Mapping

Mapping constitues and integral component of the process of manag-ing land resources, and mapped information is the common product of analysis of remotely sensed data. Mapping applications of remote sensing include the following:

- **Planimetry:** Land surveying techniques accompanied by the use of a GPS can be used to meet high accuracy requirements, but limitations include cost effectiveness, and difficulties in attempting to map large or remote areas. Remote sensing provides a means of identifying and presenting planimetric data in convenient media and efficient manner. Imagery is available in varying scales to meet the requirements of many different users. Defence applications typify the scope of planimetry applications - extracting transportation route info, building and facilities locations, urban infastructure and general land cover.

- **Digital Elevation Models (DEM's):** Generating DEM's from remotely sensed data can be cost effective and efficient. A variety of methodologies to generate such models are aproven for mapping apps. Two primary of generating elevation data are 1. Stereogrammetry techniques using air photoes, VIR imagery or radar dada (radargram-metry) and 2. Radar Interferometry.

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• **Baseline Thematic Mapping / Tropographic Mapping:** As a base map, imagery provides ancillary information to the thematic detail. Multispectral imagery is exellent for providing ancillary land cover information, such as forest cover. Supplementing the optical data with the tropographic relief and textual nuance inherent in radar imagery can create an extremely useful image composite product for interipretation.

Application in the Field of Oceans & Costal Monitoring

The oceans not only provide valuable food and biophysical resources, they also serve as transportation routes are crucially important in weather system formation and CO_2 storage and are an important link in the earth's hydrological balance. Coastlines are environmentally sensitive interfaces between the ocean and land respond to changes brought about by economic development and changing land-use patterns.

Oceans applications of remote sensing include the following:

• **Ocean Pattern Identification:** ✓ currents, regional circulation patterns shares ✓ frontal zones, internal waves, gravity waves, eddies, upwelling zones.

• **Storm Forecasting:** ✓ wind and wave retrieval.

• **Fish Stock and Marine Mammal Assessment:** ✓ water temperature monitoring ✓ ocean productivity, phytoplankton concentration and drift ✓ adequaculture inventory and monitoring.

• **Oil Spill:** ✓ mapping and predicting oil spill extent and drift ✓ strategic support for oil seepage areas for exploration.

• **Shipping:** ✓ navigation routing ✓ traffic density studies ✓ operati-onal fisheries surveillance ✓ near-shore bathmetry mapping.

• **Intertidal Zone:** ✓ tidal and storm effects ✓ delineation of the land / water interface ✓ mapping shoreline features / beach dynamics ✓ coastal vegetation mapping ✓ human activity / impact.
• **Coastal Ecosystem Management:** ✓ Monitoring Mangrove Forests ✓ Mangrove Wetland Studies ✓ Mangrove and Coral Reef Mapping.

Application in the Field of Landscape Ecology, Biodiversity

• Biodivesity Assessment
• Landscape Analysis
• Analysis of forest degradation and fragmentation at landscape level.
• Habitat mapping

Application in the Field of Environmental Monitoring

• environmental impact assessment
• water quality monitoring
• wildlife habitat analysis
• pollution monitoring
• disaster control
• analysis of earthquakes
• flood management
• warning of sand and dust storms

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Conclusion

Remote Sensing and GIS are integral to each other. The development of Remote Sensing is of no use without the development of GIS and vise versa. Remote Sensing has the capability of providing large amount of data of the whole earth and also very frequently. GIS has the capabilities of analyzing a large amount of data within no time. These voluminous data would have become useless without the development of GIS. Many environmental issues have motivated significant investments in the use and development of Remote Sensing and GIS technology. Remote Sensing technology has developed from balloon photography to aerial photography to multi-spectral satellite imaging. Radiation interaction characteristics of earth and atmosphere in different regions of electromagnetic specturm are very useful for identifying and characterizing earth and atmospheric features. Now-a-days the field of Remote Sensing and GIS has become exciting and glamorous with rapidly expanding opportunities. So the Remote Sensing and GIS based integrated approach can be used for solving the problems in various fields.

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Bibliography

Help from Internet, following websites links have been used in the completion of this project file:

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* w.ww. wikipedia. org
* www. researchgate. net
* www. youtube. com
* www. sciencedirect. com

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