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# Remote Sensing as an Advanced Technique to Study Environmental Resources: A Review

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**Abstract—***The pressure posed by the increasing population on our natural resources has led to its depletion and degradation .For this, researchers now employ the use of remote sensing to monitor various environmental resources like hydrology, forestry, vegetation, soil, land and many more, thereby helping in preservation and conservation of these valuable resources. Remote sensing is a technology to obtain information regarding an event, object or phenomena without coming into contact with the event, object or phenomenon. Its applications have multiplied in the recent years, realizing its significance in the development and management of environmental resources. This paper reviews the benefit of remote sensing in studying various environmental resources.*

**Keywords:** *degradation, remote sensing, environmental resources*

## 1. INTRODUCTION

Remote sensing is a skill of gaining knowledge about earth's features from a distance. It makes use of the electromagnetic energy being emitted from the object of interest (Campbell, 1987). It is a science of attaining the data about an object from a distance. It is a technology of acquiring information about an object or phenomenon without coming in physical contact with the object. It generally refers to the use of sensors to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals *e.g* electromagnetic radiation emitted from aircraft or satellites (Schowengerdt, 2007, Schott, 2007)**.** According to Smith (2012), the art of gathering data about an object without touching it, with the help of sensors is termed as remote sensing.

The earliest version of remote sensing was the use of aerial photography in the visible region of the electromagnetic spectrum but recent advancement have made it possible to gather information at other wavelengths too like near infrared, thermal infrared and microwave. Data collected over wide range of wavelengths is termed as multi-spectral or hyper-spectral data. The ability of this technology in recognizing and mapping land and other environmental phenomena has grown over the years, and will prove to be vital component in the management of natural resources (Sanderson, 2013). Each application of remote sensing in fields like agriculture, forestry, hydrology, land use land cover (LULC) *etc* depends on particular spectral, spatial and temporal resolution (Levin, 1999).This paper evaluates the different areas in which remote sensing can be applied to study different environmental variables.

## 2. WATER

The study of water which is flowing or static, frozen in the form of ice or glaciers and underground water is referred to as hydrology. According to Levin (1999), remote sensing can be applied to study various hydrological applications like mapping and monitoring of wetlands, glaciers, floods, watershed monitoring, river & lake ice monitoring *etc.*

Bhavsar (1984) recognized the importance of using remote sensing technology in India to gather information quickly in many fields of resource management. It is particularly useful in surface water resources, flood plain mapping, monitoring of sediment, water pollution, water management and ground water targeting. Su *et al*; 1992, Baumgartner and Apfl, 1996, highlighted the application of remote sensing and Geographical Information System (GIS) in hydrology. The aim of the study conducted by Gupta *et al;*( 1997) was to develop a water harvesting strategy in the semiarid area of Rajasthan, India using the GIS. The results demonstrated the capability of GIS and its application for water harvesting planning over large semiarid areas.

The research work conducted by Jain (1998) concentrated on locating favourable zones for ground water targeting using IRS-LISS-II data. Baban, 1999 did a comprehensive work in lake management. Remote sensing and GIS technologies along with in-lake and catchment area parameters were explored. Gao & Liu, 2001 have emphasised on the utilization of remote sensing technique as an effective mean to acquire data about glaciers. For the efficient monitoring & mapping of temporal changes in glaciers, GIS & GPS were put to use. They have also stressed on the integration of remote sensing in the study of glaciers making it more analytical, global and far-sighted.

Tahir *et al*; 2006.,Twumasi &Merem,2006 in their paper reviewed the new and innovative trends in the field of remote sensing technique in acquiring spatial & temporal information on the coastal environment. According to them, there is a high need in ensuring sustainable development of the coastal zones.

Asadi *et al;* 2007 monitored the ground water quality, related it to the land use land cover (LULC) and mapped such quality using remote sensing and GIS techniques for a part of the Hyderabad city. Ramakrishanan *et al;*(2007) did a valuable work on the efficacy of remote sensing and GIS tools for identifying suitable sites for check dams, percolation ponds and subsurface dykes for watershed management. The sites derived for check dam, percolation pond and subsurface dyke were found to be accurate in 75% of the cases. This kind of work was further carried on by Kumar *et al;*(2008) who did a comprehensive study in Bakhar watershed of Mirzapur district, Uttar Pradesh to find the potential sites for construction of rain water harvesting structures due to increasing scarcity of the water. Various thematic maps such as land use/land cover, geomorphology and lineaments etc were prepared using remote sensing and these layers were integrated using GIS to derive suitable water harvesting site.

The research carried out by Papastergiadou *et al*; 2008 highlighted the importance of wetlands as sensitive and fragile ecosystems subjected to degradation by human activities. The study stressed upon using remote sensing and GIS tools as a means in acquiring information on the spatial & temporal changes in LULC & also the factors responsible for such changes. Chaves and Lakshumanan, 2008 documented the importance of mangroves and wetlands and their urgency to map and monitor in the east coast of India.

Yan *et al;*(2010) developed an integrated, remote sensing based approach to improve estimation of renewable water resources. It resulted in providing estimates for potential water resources which could be used as a tool for future management optimization. The study conducted by Pareta, 2011 on the Rajghat dam situated in Sagar district of Madhya Pradesh, India have proven to be effective in the identification of geo-hydrological and geo-environment of the study area. For the study, IRS-P6 LISS-IV data was used and various thematic maps were generated on 1:15,000 scale. The study recommended the integration of all attributes leading to more accurate identification of geo-environmental and geo-hydrological characteristics.

Abdalla, 2012.,Hammouri*et al;*2012 and Arkoprovo *et al*;2012 carried out the study to assess the potential sites for groundwater exploration using remote sensing and GIS tools in their respective study areas.

## 3. SOIL

Soil is a vital component for sustenance of life on the earth. Remote sensing technique can be applied to study soil & its various characteristics. The highest use of remote sensing and GIS technique was made in assessing land use and soil classification by Ming *et al*;1993 in the rolling hilly area around Nanjing, eastern part of China. Jackson (1993), Njoku and Entekhabi,1994 in their study came up with the idea of using passive microwave remote sensing for measuring soil moisture. Mattikalli and Engman (1997) employed the use of passive microwave remote sensing and GIS for monitoring and quantifying spatial and temporal variability of surface soil moisture over little Washita Drainage Basin, Oklahoma, USA. Analysis of soil moisture change with digital soils data revealed a direct relationship between changes in soil moisture and soil texture. Manchanda *et al;*(2002) described in their research paper the role of remote sensing and GIS for mapping and characterizing soils at various scales. They have also discussed the spectral behaviour of soil and its components for deriving information on soil surveys. Barnes *et al*; in 2003 further added that the increasing awareness of the spatial variability in crop production with the growing availability of yield monitors can be related to different soil properties *eg*-texture, organic matter, salinity levels and nutrient status. In the study conducted by Gomez *et al;*2008 in the Narrabri region of North Western South Wales, Australia, soil organic carbon was analysed using visible and near infra red reflectance (vis-NIR) hyperspectral proximal and remote sensing data. Recent technological advancement in satellite remote sensing showed that soil moisture could be measured by variety of remote sensing techniques ranging from optical, thermal, passive microwave and active microwave measurements (Wang and Qu, 2009).

The use of remote sensing to survey the saline soil distribution for the proper management and wise use of the saline soil in Yinchuan plain of China was performed with the use of China's HJ-1B satellite by combining the texture features using support vector classification. The result demonstrated three types of saline area – severely affected, moderately affected and mildly affected. The underlying causes were analyzed and control measures were discussed (Meimei *et al*; 2011). Mulder *et al;* 2011, in their paper reviewed the use of optical and microwave remote sensing data for soil and terrain mapping with emphasis on applications at regional and broader scale. In 2011, Saha discussed the potential of microwave remote sensing for spatial estimation of various soil properties (except soil moisture) such as soil salinity, soil erosion, soil physical properties (soil texture and hydraulic properties, drainage condition) and soil surface roughness.

## 4. VEGETATION

Vegetation collectively refers to all plants and trees found in a particular area or habitat. Iverson *et al;*(1994) in their study applied a combination of Landsat thematic Mapper (TM), AVHRR imagery and other biogeographic data to estimate forest cover over large areas. The method was tested over two large regions in eastern United States. White *et al*; (1996) observed that burned forested areas with patterns of varying burn severity were detected and mapped by using satellite

data. This satellite based technology was useful for mapping severely burned areas and the ecological consequences before and after fire**.**

The extent of mangroves within and adjacent to Kiunga Marine Protected Area (MPA) was measured with the help of aerial photography and ground truth by Kairo *et al*;2002. Vegetation maps were prepared on GIS to store, retrieve and analyze the data which provided the information for its management. The statistics revealed that a large area was under eight species of mangroves and sustainable exploration was possible due to high productivity and regenerative capacity of mangroves. The study by Kia-Li *et al*; 2005 focused on using Landsat Thematic Mapper(TM) in quantifying vegetation index.

Karthikeyan *et al*; in 2010 examined that vegetation was characterized by strong absorption in the visible red wave length region and high reflectance in the near infrared region wavelengths of electromagnetic spectrum (EMR). The multi-spectral imagery generated from various vegetation indices like Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI) *etc* provides valuable information about a particular area. In this study, soil adjusted vegetation index (SAVI) was selected and applied for study and the analysis for the change in vegetation vigour was done for different time series.

## 5. LAND USE LAND COVER (LULC)

Land covers refer to the natural cover on the ground whereas land use refers to the purpose the land serves. Remotely sensed data helps in measuring the land cover properties from which land use can be make out (Rogan and Meichen (2004)., Prenzel (2004)., Zhang and Zhang, 2007).

Nigam, 2000 viewed the importance of remote sensing and GIS technology for the analysis of LULC due to their associated advantages. In his study, he made the use of high resolution data to monitor LU changes in Enschede city from 1993 to 1998.

The objective of the study carried out by Reid *et al*; 2000., Weng(2002),Tiwari & Khanduri,2011;El-Gunaid&El-Hag,2013; Al-Doski *et al*;2013;Katana *et al*;2013 and Singh *et al*;2014 were to determine the factors leading to LULC changes over time and how these changes influenced ecological properties of the land. In the study conducted by Shalaby & Tateishi (2007), maximum likelihood supervised classification and post classification change detection techniques were used to study Landsat images of 1987 & 2001 to map LC changes in the north-western coast of Egypt. The main objective of the work done by Dirim *et al*;2009 and Cymerman *et al*;2009 was to study the multi-temporal changes in the natural resources of the selected study area. They also recommended that use of such data were helpful in quantifying LC & its associated changes. Such data provided inputs for planners & policymakers to plan for future LC changes.

The experiment set up by Tsuchiya *et al*; 2010 was to analyse the LC change in the area located to the south of Aksu in the northern Taklimakan Desert using satellite data. The data was examined for the late summer & early autumn of the year's 1973, 1977, 1993 &1995. The paper by Metternicht *et al*; 2010 addresses the land degradation issue of Latin America and the Caribbean (LAC) region through remote sensing technology. Moreover, the accuracy of the data generated by satellites was also assessed.

To study coastal LU changes for Chennai coast cover stretch of approximately 125 kms from Pulicat lake to Kovalam creek, monitoring was done using remote sensing and GIS technique in a study by Santhiya *et al*;2010. Realizing the importance of forest, Shooshtari *et al*;2012 conducted a broad study to investigate LC changes and reduction of Hycranian forests in northern Iran for the study period 1977-1987, 1987-2001 & 2001-2010. Paper by Kishor and Singh, 2014 studied the LULC impact on the Pichavaram Mangrove Area at Cuddalore District, India between 1991-2000 & 2009.

## 6. CONCLUSIONS

Remotely sensed data plays a vital role in studying major environmental resources like hydrology, forestry, land surface etc. The data obtained by remote sensing serves as input for GIS for its interpretation and analysis which is helpful for planners in framing policies. Remote Sensing is a non-destructive physical technique used for the identification and characterization of material objects or phenomena at a distance. It may be used for constructive purposes in natural resources exploration and management, or for destructive purposes in military applications. Of course, the final choice of its applications should be dictated by the human need, the user's conscience and the policy of a nation.

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