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GEOSPATIAL APPLICATION-BASED LAND RESOURCE MAPPING AND MANAGEMENT: A REVIEW

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ABSTRACT

Any country's basic development is governed by its available natural resources. Among many, land and water resources are the most important for human survival on the planet. Because of the rapid increase in population, these resources are frequently overstressed, resulting in constant depletion. Geospatial techniques have recently been used effectively for more precise mapping and wise management of land resources.Geospatial technology is concerned with real-time spatial information about features at a location or in space. Geospatial techniques are a combination of Remote Sensing (RS), Geographic Information systems (GIS), Global Positioning Systems (GPS), cartography, and spatial statistics that capture, store, manipulate, and analyze data in order to understand complex environmental situations and solve problems for sustainable development.The study attempted to review the use of geospatial techniques in land resource inventory, analysis, mapping, and management. According to the review, these techniques have enormous potential and are being used in various aspects of land resource inventory such as digital terrain analysis, soil resource inventory, land use/land cover mapping, wastelands mapping, water resources, and environmental management.

Keywords: *Geospatial Approach, RS, GIS, Resources, GPS*

1. INTRODUCTION

The term “Land resources” refers to a specified region of the earth’s terrestrial surface that encompasses all biotic characteristics immediately above or below this surface, including those of the atmosphere. The near-surface climate, soil, landforms, and surface hydrology (which includes shallow lakes, marshes, rivers, and wetlands) as well as the near-surface sedimentary strata and associated wetlands. The plant’s groundwater and geo-hydrological reserve, as well as the plant’s groundwater and geo-hydrological reserve animal population, human settlements pattern, physical conditions, the presence of humans (terracing, water), historical and current for storage or drainage, highways, and other structures (FAO/UNEP, 1997; Ramteke et al, 2018). Due to the rapid growth of population, urbanization, and industrialization, pressure is increasing on land resources.In the fast-growing century, environmental change can be seen by changing the pattern of land use and land cover atthe global level.Land-use and land-cover (LULC) change have become a vital factor in present procedures in managing natural resources and monitoring environmental changes.For better management, conservation, optimum uses, and planning, there is a need to obtain reliable data about land resources for sustainable development (Arvind et. Al, 2022; Akike and Samanta 2016; Shaw et al. 2015). The increasing population puts pressure on land resources and results in the need for increasing the productivity of agricultural products like fodder, fuel, fiber, and food. So, there is a great need for an improved plan and management of land resources, particularly soils and water. Soil is considered an integral part of the landscape and itscharacteristics are largely governed by the landforms on which they developed. The systematic study of soil morphology and taxonomy provides information on the form and nature of soils as well as their nutrients, suitability, capabilities, and potentiality for different types of fields (Sehgal). At present, agricultural revolution, overuse, damming, pollution and diversion threaten these irreplaceable resources in many parts of the globe.

GEOSPATIAL TECHNOLOGY AND LAND RESOURCE MAPPING

Geospatial technology includes remote sensing, geographical information system, and global positioning systems. GIS, remote sensing and global positioning systems are the most widely useful tools for land use planning and decision support systems. Remotely sensed imagery is beneficial for land resource mapping. Terrain, soil, water, and land use as important components of land resources must be studied for optimal utilization and the long-term quality of human life on the earth’s surface. To ensure food, water, and environmental security for current and future generations, scientists, planners, policymakers, administrators, and farmers must manage these resources efficiently and effectively. Satellite remote sensing, GPS, and GIS have added new dimensions to monitoring and managing land resources for effective utilization (Kasthuri and Sivasamy, 2013). Remote sensing data provides very high-resolution data for resource mapping and management.

2. METHODOLOGY

Satellite data having a very fine, fine, medium, and coarse resolution is processed in image processing software by applying various methods like image classification, NDVI, SAVI, NDWI, MNDWI, NDSI, SI, and NDBI, etc. All the methods are discussed below: -

3.1 NDVI (Normalized Difference Vegetation Index)

Normalized Difference Vegetation Index categorized vegetation by calculating the difference between the near-infra-red band and red band. NDVI always ranges from -1 to +1. Negative values reflect waterbody while close to +1 reflects a high possibility of dense green leaves. NDVI is the most common indices for source mapping in remote sensing. The following formula is used for NDVI calculation: -

NDVI= (NIR-RED)/(NIR+RED) …………... (Xu. H (2007)

Here,

NIR= Near Infra-red Band

Red= Red Band

3.2 SAVI (Soil Adjusted Vegetation Index)

It is a modified index of NDVI. It is a vegetation index that uses a soil brightness correction to try to reduce soil brightness impacts. This method is mainly used where vegetation cover is low. The following formula is used for SAVI calculation: -

SAVI= (NIR-Red) / (NIR + Red + L) *(1+L) ………………. (Huete, 1988)

Here,

NIR= Near Infra-red Band

Red= Red Band

L= Soil Adjusted Factor

3.3 NDSI (Normalised Difference Salinity Index)

Commonly used index for soil salinity assessment. In salty soil, vegetation growth becomes poor. So, indirectly stressed vegetation presents salt in the soil. The following formula is used for NDSI calculation: -

NDSI=(R-NIR)/ (R+NIR) …………………. (Major et al., 1990)

Here, R= Red Band

NIR= Near Infra-red Band

Kumar S. and Kumar G (2019) studied the water logging and salinity status using NDWI and NDSI in Central Haryana.

3.4 SI (Salinity Index)

The salinity index is very helpful in spatial distribution mapping of soil salinity which is purely based on stages of vegetation health. The following formula is used for SI calculation: -

SI= (NIR*R)/G ………………. (Elhag, 2016)

Here,

NIR= Near Infra-red Band

R= Red Band

G= Green Band

3.5 NDBI (Normalized Difference Built-Up Index)

The Normalized Difference Built-up Index (NDBI) uses the NIR and SWIR bands to emphasize manufactured built-up areas.The Normalize Difference Build-up Index value lies between -1 to +1. A negative value of NDBI represents water bodies whereasa higher value represents build-up areas. NDBI value for vegetation is low. The following formula is used for NDVI calculation: -

NDBI= SWIR-NIR/ SWIR+NIR

S. Kumar (2018) studied the Gangotri Glacier status have been analyzed using based on NDVI.

3.6 Supervised image classification

The term "supervised" refers to a classification system that is primarily guided by humans. Unsupervised classification, on the other hand, is determined by software.

3.7 Unsupervised image classification

The automatic detection and assignment of picture pixels to spectral groupings is the sole basis for unsupervised image categorization. It just takes into account spectral distance measurements and requires very little user intervention. After classification, this method necessitates interpretation. (Kumar and Singh, 2021) studied the land use and land cover mapping of Central Haryana using unsupervised classification.

3.8 Snow Indices (Normalized Difference Snow Index)

NDSI= (Green-SWIR) / (Green + SWIR)

3.9 Water Ration Index

WRI= (Green + Red)/(NIR+SWIR)

3.10 NDSII (Normalized Difference Snow and Ice Index)

NDSII= (Red-SWIR)/ (Red + SWIR)

3.11 SWI (Snow Water Index)

SWI= Green (NIR-SWIR)/ (Green+ NIR) (NIR+SWIR)

3.12 Groundwater prospects and quality mapping

In the modern period of urbanization, industrialization, agriculture, and increasing population have a great effect on the quantity and quality of groundwater. (Kumar S., 2018) studied the grounder water prospects and quality in the Fatehabad District of Haryana. In the district, Older Alluvial Plain, Aeolian plain, Sand Dune, Sand Dune Complex, 2 Palaeochannel, and Older Flood Plain have been demarcated. Older Alluvial covers the largest area of 1498.94 sq. km (59.09%) having good to very good groundwater prospects, which is 59.09% of the total area. After that Aeolian plain covers 2 411.8 km (16.22%) having moderate to good, sand dune and dune complex covers 30.86 km (1.21) and 70.04 km^2 (2.77%), respectively havingpoorgroundwaterprospects.Olderfloodplaincovers 368.84 km (14.53%) havinggoodtovery good groundwater prospects. Palaeochannel covers 86.68 km (3.41%) having very good to excellent groundwater prospects. For ground water quality, data has been collected from Groundwater Cell, Hisar.The major constituents,such as TDS, Cl, Ca+Mg, EC (µmho/cm), pH, and TH are used to assess the groundwater quality from pre monsoon and post-monsoon data. Based on Indian Drinking Water Standards (BIS Guideline–IS: 10500:1991), ground water quality has been categorized into desirable and permissible limits and non-potable limit. In the integrated groundwater quality map, only two categories have same permissible and nonpotable limit. Permissible limit covers an area of 1703.67 sq.km (67.13%) and the non-potable area covers an area of 834.33 sq.km (32.87%). They conclude that present study is highly useful for giving a glance view of prospectsandquality in thedistrictwhichwillbehelpful in furtherdevelopmentandmanagement.

3.13 Geomorphologic Mapping

Geomorphologic mapping is a fundamental technique of producing valuable base data for land management and geomorphologic risk management, also providing data for other sectors of landscape ecology, forestry, or soil science. Traditionally, geomorphologic mapping was based upon using information from the field survey and the interpretation of satellite data, photographs, and Toposheets. Recent advances in geospatial techniques such as remote sensing, geographical information system and global positioning system have led to a revolution in the field of geomorphologic mapping. (S. Kumar, 2017) studied the geomorphological classification of Fatehabad district, Haryana. They identified in the district, Older Alluvial Plain, Aeolian plain, Sand Dune, Sand Dune Complex, Palaeochannel and Older Flood Plain have been demarcated. Older Alluvial covers the largest area of 1498.94 sq. km which is 59.09% of the total area. After that Aeolian plain, Older Flood Plain, Palaeochannel, Dune Complex, Ghaggar River, Sand Dune cover 411.80 sq. km, 368.84 sq.km., 86.68 sq km, 70.48 sq km, 70.4 sq kmand 30.86 sq km which is 16.22%, 14.53%, 3.41%, 2.77%, 2.77% and 1.21% They conclude that the study gives a glance view of the geomorphic unit in Fatehabad district for further development and management of land use and land cover.

3. CONCLUSION

The review of geospatial techniques in resource mapping demonstrates that these techniques allow for the capture, storage, management, presentation, and display of resource features via various analyses and the integration of large amounts of spatial and non-spatial data. Geospatial techniques are also more convenient, less time-consuming, and more precise in the generation of land resource databases when compared to traditional methods. With increasing human activity and over-exploitation of land resources, there is an urgent need to precisely map and manage available land resources using cutting-edge geospatial techniques, which have enormous potential in the generation of location-specific spatial databases for assessing their potential and limitations.

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