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A Remote Sensing and GIS Approach to Watershed Management for Phalguni River Basin

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Abstract:
The need of water for India's rapid development is growing day by day. Dry land farming in India accounts for 63% of the cultivated land of 144 million hectares. Different types of problems which are related to watershed like depletion in water table, depletion of sources, scarcity of water, floods, reduction in water carrying capacity of streams are the biggest challenge to an engineer. The main intension is to utilize the water resources of that particular area. Mapping is done using satellite images by remote sensing technique. The data which is used for the project work is of LISS-4 type. The topographical sheets and geological maps Gurupura river (D43U13) are used and processed using ArcGIS and ERDAS softwares. Special attention was paid to rich vegetation area and average vegetation area to know the ground water. The drainage maps, base maps, geology maps and geomorphology maps were prepared in ArcGIS. And the satellite images were processed to produce the different color combinations using ERDAS softwares. The land use and land cover map is prepared using satellite data which offers new opportunity for planning, design and management of water resources of the study area. The watershed management project will utilize the complete water resources of the study area.

Keywords: Remote Sensing (RS); Geographic Information System (GIS); Linear Imaging Self Scanning (LISS); Watershed.

I.INTRODUCTION

Water is an essential requirement for the living Organisms. It is very important for the agricultural, industrial and residential activities. Water covers for about 71% of the Earth's surface. It is vital for all known forms of life. On Earth, 96.5% of the planets crust water is found in seas and ocean. And about 1.7% as groundwater. Only 2.5% of water is freshwater. In that less than 0.3% of all fresh water is in river, lakes.

The human activities leads to the variation in the rainfall such as depletion in water table, scarcity of water, floods, reduction in water carrying capacity of streams. So we need to manage the resources for a particular watershed so that the nearby area of the watershed can be benefitted.

A watershed means an area of land that contains a common set of streams and rivers that all drain into a single larger body of water such as river, lake or an ocean. For the particular watershed we need to manage the sources. Watershed is not simply the hydrological unit but also socio-political-ecological entity which plays crucial role in determining food, social, and economical security and provides life support services to rural people. Management of natural resources at watershed scale produces multiple benefits in terms of increasing food production, improving livelihoods, protecting environment, addressing gender and equity issues along with biodiversity concerns.

Watershed management consists of those coordinated human activities aimed at controlling, enhancing, or restoring watershed functions. Management of a watershed thus results in rational utilization of land and water resources at a time.

II.OBJECTIVES

- Study land and Environmental changes in and around Moodbidri using RS and GIS Techniques.
- Find out Land Use, Vegetation and Built Up area using ERDAS Imagine & Arc GIS softwares.
- Generate the Land Use-Land Cover maps based on multi dated satellite images.

III.DISCRIPTION OF STUDY AREA

A. General Discription:

Gurupura is a small town situated on the bank of Phalguni, or Gurupura River. It is located about 345 kilometers (214 miles) west of Bangalore, the state capital, and 13 kilometers (8 miles) east of Mangalore, Karnataka's chief port city. According to the records of the local temples, the town of Gurupura was once known as Gulipur. Being situated on the banks of the Phalguni River, Gulipur was a commercial town and was connected to other parts of the river. Banda Saale is a place on this river where goods are collected from many sources and distributed to other places.

Fig 1: Sand Mining in study area.

Gurupura is famous for its religious activities, and the Phalguni River is also named Gurupura, after this town. It also

lies close to Vamanjoor and Kaikamba. The village has become a small town with the rapid urbanization of the Dakshina Kannada district. The entire study area is about 80km^2.The latitude of Gurupura is 12^{0}93$^{'}$and the longitude is 74^{0}93$^{'}$.

Fig 2: Flow of Phalguni River.

B. Climate:

The climate of the Dakshina Kannada district is similar to other parts of west coast of India.

1)Four wet months of June, July, August and September, with strong winds, high humidity, heavy showers and a slight fall in temperature,

2) Two warm and damp months (October and November) of south west monsoon having little or no rains,

3) Three relatively cool months (December, January and February) having dry conditions,

4) Three hot months (March, April and May) which is the period of rising temperature. However, the climate is quite uniform throughout the coastal stretch while the inland is relatively cooler.

C. Population:

The population of entire study area is growing day by day. It is about 16000 according to present census data. The water requirement to the present population is very high. The present population is getting the water from the Phalguni River Basin to serve the different purposes.

D. Geology:

The soil in the region is mostly laterite type and the migmatitic type. Laterite soil is commonly considered to have formed in hot and wet tropical areas. The laterite soil is very rich in iron and aluminium. Laterite has commonly been referred to as a soil type as well as being a rock type. Migmatitic soil is a form of migmatite rock which is a mixture of metamorphic rock and igneous rock.

II. MATERIALS USED

- Drainage map, Geology map, Geomorphology map.
- Geology maps of scale 1:250000 from Geological survey of India, Bangalore
- Multi-spectral satellite data of 2015 from NRSC, Hyderabad.
- Topo-sheet D43U13 of scale 1:50000 which covers the entire study area.

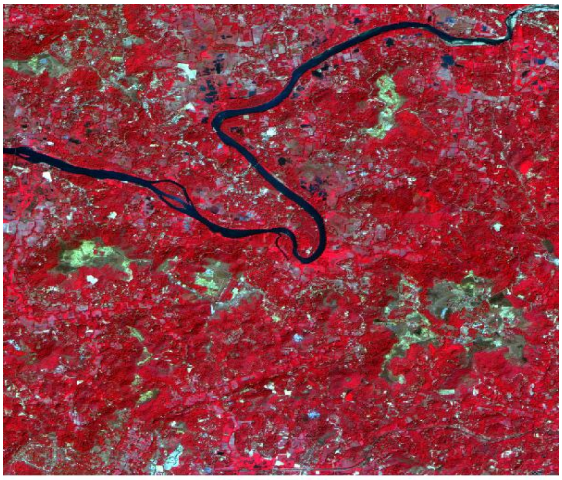

Fig 3: Study Area satellite Image After color composition in ERDAS Software.

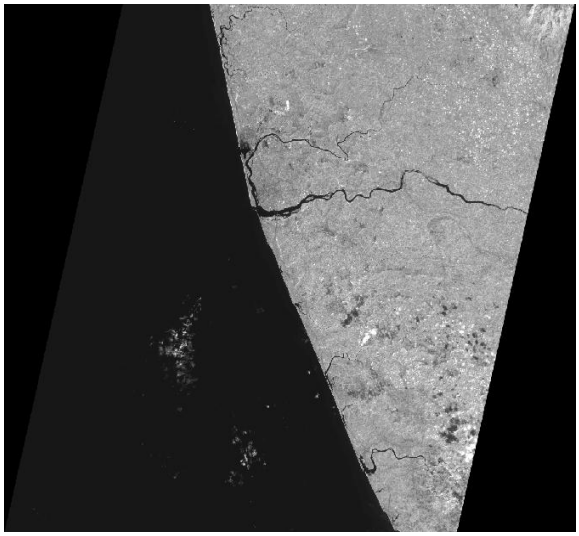

Fig 4: Study Area Satellite Image(LISS 4).

V. METHODOLOGY

***A.* Collection of data from Remote sensing Technique:**

- 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.

B. Watershed Management using Data Processing:

The maps which are collected are in the form of hard copy, these maps are to be scanned and converted into TIFF or JPEG format which are basically soft copies of images. The output of Satellite which is in the form of images is collected. The satellite images, Geological map and the toposheets are processed using ArcGIS and ERDAS Imagine software's. Initially the toposheets and the geological maps are digitized using ArcGIS software. And color compositing will be done for satellite images using ERDAS Imagine Software. The different bands are created while color compositing of satellite data since every band has its own advantage. Later the satellite images are digitized using ArcGIS software to get the required layout of result for different parameters like land use land cover and drainage network.

VI. RESULTS

Different maps are created using arcGIS software such as drainage network, base map, land use Land cover map for the study area. The required results are obtained based on the prepared layout of maps.

A. LAYOUT OF MAP SHOWING DRAINAGE NETWORK OF STUDY AREA:

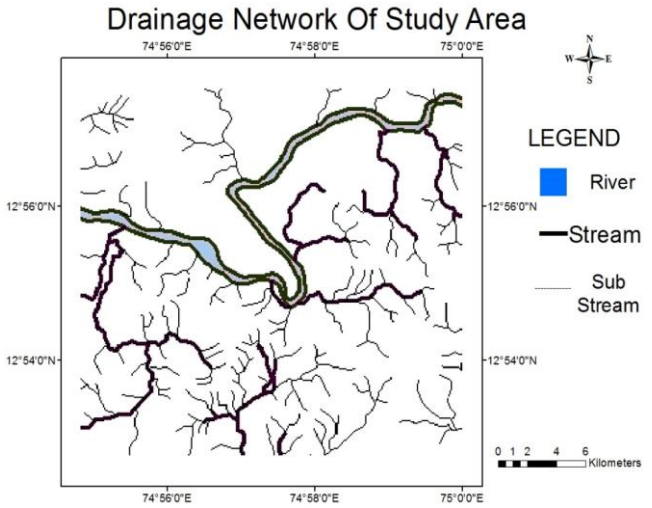

Fig 5: Drainage map layout Prepared in ArcGIS Software.

B. LAYOUT OF LAND USE LAND COVER MAP:

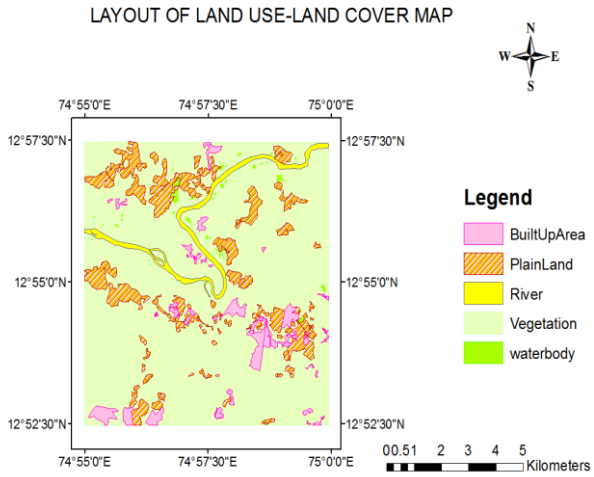

Fig 6: Land use and land cover map layout.

C. TOTAL PROBABLE AREA OF DIFFERENT FEATURES:

Feature	Area (km^2)
River	2.51
Pond	0.76
Total Vegetation including Agriculture	55.85
Rich Vegetation	3.8
Average Vegetation	52.05
Plain Land	16.72
Built Up Area	4.15

D. TOTAL PERCENTAGE OF PROBABLE AREA OF DIFFERENT FEATURES:

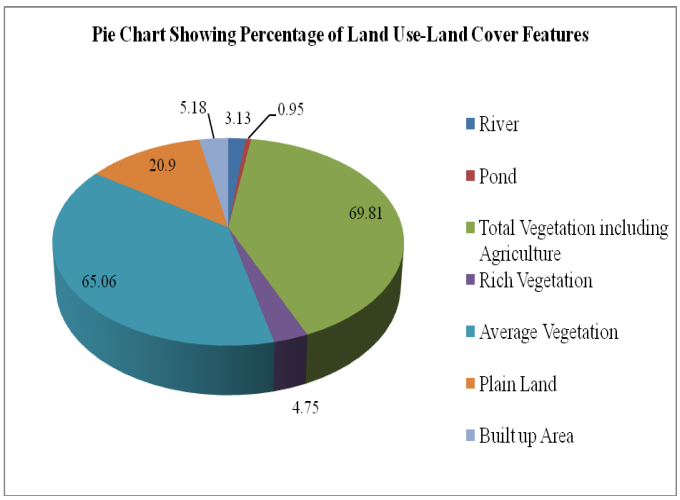

Fig 7: Land Use-Land Cover Percentage.

E.LAYOUT OF GEOMORPHOLOGY MAP:

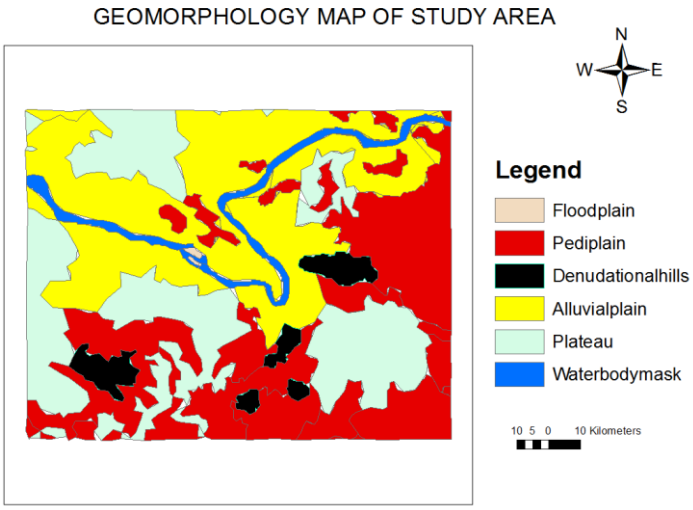

Fig 8: Geomorphology Map Prepared in ArcGIS Software.

V. DISCUSSION

The total capacity of water storage of the study area is $5.245x10^6$ m^3. And stretch of the river of the study area is 15.91km.Rich vegetation in the study area is about 4.75% which shows the healthy ground water table. And about 65.06% of average vegetation shows the average health of the ground water table.

The built up area of about 5.18% which shows the less ground water table level. This is because of the construction of residential, commercial, industrial area and the construction of roads which directly reduced the rate of permeability of the soil. Because of the new construction works the plain land is gradually converted into built up land which is affecting the ground water table.

The percentage of area of pond is about 0.95% which is the second largest water source of the study area. The use of pond water by the area which are far away from the river is very beneficial to the residential areas. And also care should be taken to reduce the sedimentation of river.

Measures to Manage the Water:

Check Dams:

A small dam can be constructed across the river and the main streams. The check dam will store the water as well

as it induces infiltration. The check dams are more suitable for main streams than river since streams will have less flow velocity than the river. Check dams will be very use full in summer seasons since they provide water for the requirement.

Micro Catchments:

Micro catchment technique can be adopted where the plain land is available. It will collect the surface runoff water, increases the water infiltration and it will prevent the erosion of soil. These are constructed in an enclosed shape to form a basin which helps to prevent the run off. Micro catchments is the effective method to increase the level of ground water table in the rainy seasons.

Farm Pond:

The technique of construction of farm pond can be adopted in plain land. Pond is usually smaller than lake. The water can be stored in rainy seasons. It will provide the water for the requirement and also induces infiltration of the water at that particular place.

Percolation pond:

The technique of making the percolation pond can be adopted. Percolation pond cuts the velocity and reduces erosion activity. The stored water improves soil moisture of the adjoining area and allows percolation to recharge the aquifers. Height of the percolation pond varies from 1m to 3m and length varies from 3m to 10m.

Vegetative barriers:

This technique can be adopted in an effective way. Vegetative barriers parallel strips off stiff, erect, dense grass plantation. It improves the efficiency of other water conservation practices. It can be used to divert runoff to a stable outlet. Vegetative barrier is an effective technique if the water conservation system is properly planned.

Broad beds and Furrows:

This technique is used to conserve In-situ moisture and to reduce soil moisture. The broad bed and furrow system is laid within the field boundaries. And it acts as a drainage channel during heavy reasons. It even helps to conserve soil moisture in dry land.

VI.CONCLUSION

By approaching Remote Sensing and GIS techniques, we can reduce field work and implement the plans to the Phalguni watershed basin more effectively as follows:

1) The micro catchments which can be constructed in plain land which will help to increase the ground water table.
2) Check dams, Farm ponds can be constructed to store the water.
3) The effective utilization of pond water and other surface water features like sub streams will help to utilize the available water in an effective way.
4) The built up areas such as Residential and commercial areas should prefer roof top water harvesting techniques to utilize the rain water in rainy seasons.
5) Recharge pits should be installed to recharge the ground water table.
6) The pervious concrete should replace the normal concrete in construction of roads to increase the permeability of the soil to recharge the ground water.
7) The idea of integrated watershed management can be adopted in the study area for Phalguni River for the water management.
8) With the public support and participation there will be proper use of water resources. This will lead to the effective agriculture in the study area. And with the proper implementation of the action plans, we can achieve very effective water management in the study area.

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