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Identification Of Manimuthar River Course Changes And Estimation Of Command Area In Ambasamudram Taluk Using Remote Sensing And Gis

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ABSTRACT: *Water management practices in India have major concern in recent years to aid sustainable irrigation system in the Country. The application of Remote Sensing and Geographic Information System has been increased to study and address the various issues relevant to the management of irrigation systems and the agricultural information derived from the satellite data forms the basic input for the study. There has been a significant increase in river bank encroachment in India in the la st few decades. This is largely because of rapid population growth and economic development in the country, leading to increased anthropogenic activities along the river lines. Sand excavation along the river banks has become a major environmental issue in our country. River Course Monitoring is an important part of river management system, which requires much attention to protect the natural resources in our environment. This project aims at proper management of water and agriculture attempts to identify the sites where the changes in the river course and command area have been largely affected .Based on the above observations statistics is generated to provide an overview of the modifications in the river channel and irrigated agriculture land. The present study focuses on finding course changes in the Manimuthar River and crop command area estimation in Ambasamudram Taluk, Tamilnadu using GIS techniques. Raster Overlay tool of ArcView GIS software was used for identification of changed areas. Manual method of demarcation of channel changes is very tedious. Integration and correlation of the information related to the factors considered for water monitoring, which is very complex, can be handled easily with GIS. The ability of GIS based overlay analysis helps us to make decision about the identification of areas that have been susceptible to course and command area change over a period of twelve years.*
Keywords *-command area, changes detection, GIS, overlay, river course.*

I. INTRODUCTION

This chapter gives a brief discussion about river, river course change, crop command area and the role of remote sensing and GIS in monitoring the stream course and command area. It also describes the Scope and Objectives of the present study.

A river is a natural water course, usually freshwater, flowing towards an ocean, a lake, a sea or another river. In a few cases, a river simply flows into the ground or dries up completely at the end of its course, and does not reach another body of water.[2] Small rivers may be called by several other names, including stream,, creek, brook, rivulet, and rill.. Rivers are part of the hydrologic cycle. Water generally collects in a river from precipitation through a drainage basin from surface runoff and other sources such as groundwater recharge, spring and the release of stored water in natural ice and snow packs (e.g. from glaciers. Rivers have formed over a long time and continue to evolve because of their dynamic nature. Human activities accelerate and redirect these processes of change in many different ways, indirectly through anthropogenic stressors such as global warming or directly by interfering in the physical, geo-morphological characteristics of a river. Reducing the length of the channel by substituting straight cuts for a winding course is the only way in which the (effective) fall can be increased. This involves some loss of capacity in the channel as a whole, and in the case of a large river with a considerable flow it is very difficult to maintain a straight cut owing to the tendency of the current to erode the banks and form again a sinuous channel. Even if the cut is preserved by protecting the banks, it is liable to produce changes shoals and raise the flood-level in the channel just below its termination [5]. Nevertheless, where the available fall is exceptionally small, as in land originally reclaimed from the sea, such as the English Fenlands, and where, in consequence, the drainage is in a great measure artificial, straight channels have been formed for the rivers. Because of the perceived value in protecting these fertile, low-lying lands from inundation, additional straight channels have also been provided for the discharge of rainfall, known as drains in the fens. Even extensive modification of the course of a river combined with an enlargement of its channel often produces only a limited reduction in flood damage. Consequently, such flood works are only commensurate with the expenditure involved where significant assets (such as a town) are under threat.

Command area is the agriculture or cultivable area which receives assured irrigation through canals, waters, courses and field channels up to farmer□s field [6]. The Command Area Development works for execution of on Farm Development, works and regulation of water resulting in considerable saving of water for successfully raising the crops. The improvement in application efficiency of water not affects economy in water use but else serves improving the crop production. The water saved there from, can be fed to additional area for irrigated cropping. Dependability of water supply has played an equitable distribution of water amounting the farmers to play a prominent part in the system of operation in eliminating and reducing the time log [9].

Availability of water has therefore to be improved in the command area for the betterment of millions of land less, small and marginal farmers and those who are living in Sub-human condition. Availability of water generates employment opportunities. It is estimated that to manage a farm with irrigation facilities, four times of the labor is required than to manage a farm under rain fed agriculture.

Remote Sensing is one of the excellent tools for inventory and analysis of environment and its resources, owing to its unique ability of providing the synoptic view of a large area of the earth□s surface s and its capacity of repetitive coverage. [6] The potential for social and economic benefits offered by remote sensing (Earth Observation (EO)) arise from its unique capabilities. These include the ability to provide near real time monitoring of extensive areas of the earth□s surface at relatively low cost, as well as the capability to focus on particular land and sea surface features of interest to provide detailed, localized information. Remote Sensing can offer an alternative source for data in some applications which could be acquired by terrestr ial or airborne surveying, but in a timelier and less expensive manner. In other words the availability of remotely sensed data can provide a unique solution where other techniques would be impractical.

A geographic information system (GIS) is a computer system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. This system contains both data identified according to their locations, graphic and non- graphic data.[8] GIS is used in this study to create various maps, data analysis and for creating change detection maps.GIS is a fundamental part of modern geography and it is extensively used by environmental planners.GIS has emerged as useful computer-based tools for spatial description and manipulation. Functions of GIS include data entry, data display, data management information retrieval and analysis.[9] The applications of GIS include mapping locations, quantities and densities, finding distances and mapping and monitoring change.

A GIS can manage different data types occupying the same geographic space The ability to depict different, spatially coincident features is not unique to a GIS, as various computer aided drafting (CAD) applications can achieve the same result. The power of a GIS lies in its ability to analyze relationships between features and their associated data. This analytical ability results in the generation of new information, as patterns and spatial relationships are revealed.

1.1. NEED OF THE STUDY

- To help in planning of river training and management.
- To aid in mitigating the effects of improper channelization and river engineering structures construction.
- To increase the productivity of the river by effective and efficient utilization of the free flowing water to maximized irrigation and other anthropogenic activities.
- To increase the crop productivity and improve the irrigation management**.**

1.2. OBJECTIVES OF THE STUDY

- To study and analyze river course changes
- To estimate the crop command area

II. STUDY AREA ANA DATA DESCRIPTION

2.1. GENERAL

Manimuthar River is a major tributary of the Thamirabarani. It arises from the dense forest a top Senkutheri in Ambasamudram taluk at the height of about 1300 m. from MSL. The tributaries of the Manimuthar are the Keezha Manimuthar (lower or eastern Manimuthar) and the Varattar. The river runs from its source for a distance of 9 km. and confluences with the Thamirabarani near Kallidaikurichi. In its 9km. course, it makes minor cataracts. The river contributes a lot, as tributary; to enhance the water level of Thamirabarani as it is always in full spate and perennial. In the year 1957, Manimuthar anaicut was built across the river just three km. above its confluence with Thamirabarani. Ambasamudram is a taluk in Tirunelveli district in the state of Tamil Nadu.

2.2. LOCATION OF STUDY AREA

The command area of Ambasamudram, passing through Tirunelveli District in Tamil Nadu, India. Region lies between 8.7°N 77.47°E the entire taluk had a population of 392,226 as of 2001, with 42.5% classified as rural. Area coverage is 734.84sq.kms with population density 142187. Manimuthar river lies between 8□ 40□57□ □N to 8□ 68□25□ □N latitude and 77□ 23□15□ □E to 77□ 38□75□ □E longitude. .Length of the total river course is 85km. The Ambasamudram command has gross command area of 11652 Ha. Region has two major cropping seasons Rabi from October to February and Kharif from March to June. The majority of irrigation is done during Rabi season.

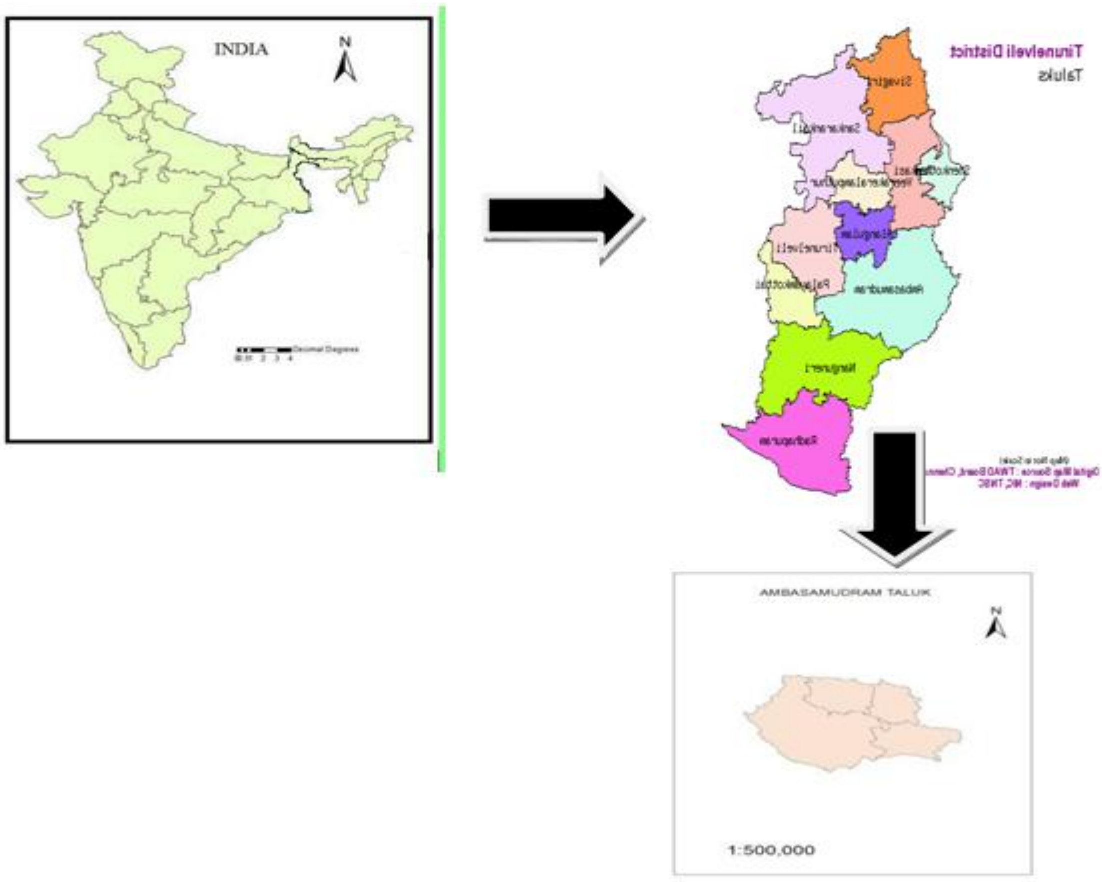


Fig.1 Location Map of the Study Area

2.3. CLIMATIC CONDITION

Temperature In the day time the coastal regions are cooler than the interior parts by about a degree in summer and southwest monsoon seasons and 96warmer by one to two degrees during the rest of the year. From about the middle of February, temperature increases steadily. In May, which is usually the hottest month in the interior, the mean daily maximum temperature is 37.1 degree Celsius. The weather is quite hot in May and June and the maximum temperature sometimes reaches 45 degree Celsius. With the onset of the southwest monsoon by the end of May or beginning of June, there is some drop in temperature. By about the middle of October, both day and night temperatures decrease appreciably. The period from November to January is the coolest period of the year with the mean daily maximum temperature of about 30 to 31 degree Celsius in the interior parts. The mean daily minimum in these months is about 22 to 23 degree Celsius in the district in general.

The relative humidity, in general, during the year is between 55 and 65 per cent in the interior parts of the district, except during the northeast monsoon season, when it is over 65 per cent. The coastal parts are comparatively more humid. Cloudiness During the months of April and May, the skies become heavily clouded and threatening in the afternoons on many days when thunderstorms follow. In the southwest and northeast monsoon seasons, the sky is heavily clouded or overcast. Winds are generally light to moderate in strength. Between May and September winds are mainly north westerly or westerly. From October to February winds are mainly north easterly or northerly. Main rainy season is from October to the middle of January. During these southwest monsoon seasons the rainfall is more in the western parts of the district. November is generally the rainiest month. The heaviest rainfall in 24 hours recorded in the district was 371.5 mm at Sivagiri on 29.10.1929. The average rainfall in the district is 814.8 mm per Annum.

Tirunelveli has fertile soils only in scattered regions. Less fertile red soils are found distributed over most of the regions. The network of the irrigation system marks full use of the water resources; the natural deficiency has been overcome to a greater extent. The cropping pattern of the district is essentially of the type characterizing dry regions. It normally varies from taluk to taluk. In dry regions, diversified cropping patterns exist and no single crop claims a large share of the gross cropped area. Dry cultivation which characterizes these regions is also basically millet and cash crop cultivation. Even in dry regions wherever water is available, it is the paddy crop that is sown by the farmers. Paddy occupies the largest area of cultivation, followed by cotton. Paddy is cultivated mainly in Tirunelveli, Palayamkottai, Tenkasi, Shenkottai, Ambasamudram and Nanguneri Taluks. Other crops grown in the district are cambu, ragi, pulses, groundnut, gingelly, coconut, chillies and indigo. Portions of Sankarankoil Taluk have the rich, fertile black soil which is highly suitable for cotton cultivation. Factors such as type of soil, climatic conditions, irrigation facilities etc., determine the cropping pattern in a region. Most of the rain fed areas is cultivated in both the seasons. Most of the crops are on the ground for three or four months except chillies and cotton which take more than five month. Paddy occupies the largest area of cultivation, followed by cotton. Paddy is cultivated mainly in Tirunelveli, Palayamkottai, Tenkasi, Shenkottai, Ambasamudram and Nanguneri Taluks.

III. MATERIALS AND METHODS

3.1 Topographic map

A topographic map is a type of map characterized by large scale detail and quantitative representation of relief, usually using contour lines. The topographic map used in this project is 1:50000 scale of 58H06, 58H10, 58H14 and 58L2

3.2 Remote Sensing Data

Temporal fluctuations in water resources occur in different season of the year, with great variations in water spread area of water bodies during monsoon to summer. Capturing these variation and systematic inventorying on regular basis is operationally difficult task through conventional techniques. However, with the availability of satellite data at multiple spatial resolutions and at regular time intervals, surface water bodies can be mapped and monitored in terms of their occurrence and spatial extent. Generation of such information provides continuous audit of surface water resource over space and time. The typical spectral response of water facilitates its accurate identification and delineation on remotely sensed images. The time relies data provides a records of change in these storages. The unique capabilities of satellite based sensors in providing a wide spectrum of information available through the electromagnetic spectrum in repetition and synoptic coverage over in accessible and larger areas in frequent intervals made the remote sensing technology an efficient tool in the sustainable development and management of environment and resources of ecological diversity.

The satellite data used in this study are IRS P6 LISS III,IRS 1D LISS III and to detect changes in the course. IRS LISS III provide data in 4 spectral bands; Green, red, near infra red and short wave infra red, with 23.5m spatial resolution and
24 day repeat cycle

Description	IRS P6	IRS 1D
Satellite	**Resource sat 1**	
Sensor	**LISS III**	**LISS III**
Image Layout	**BSQ**	**BSQ**
Path-Row	**101-068**	**101-068**
Swath	**141km**	**141km**
Number of Bands	**4**	**4**
Spatial Resolution	**23.5m**	**23.5m**

Table 1 Description of Satellite Characteristics

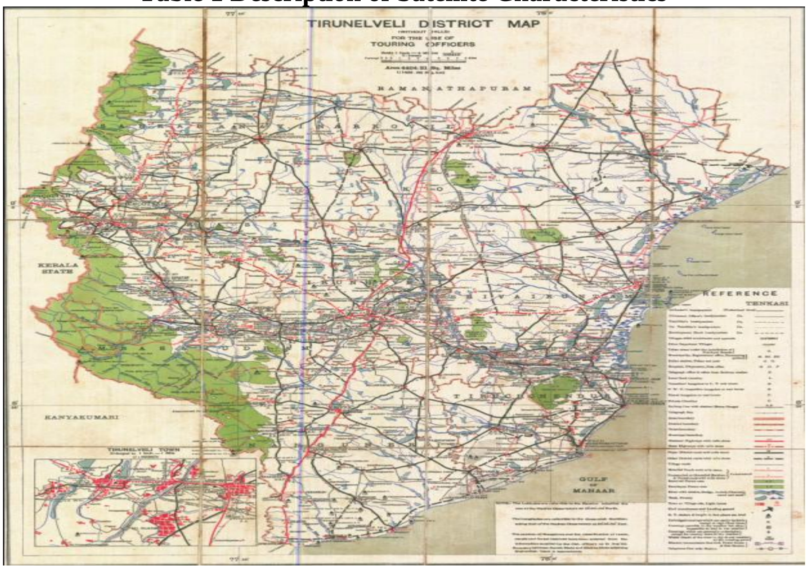
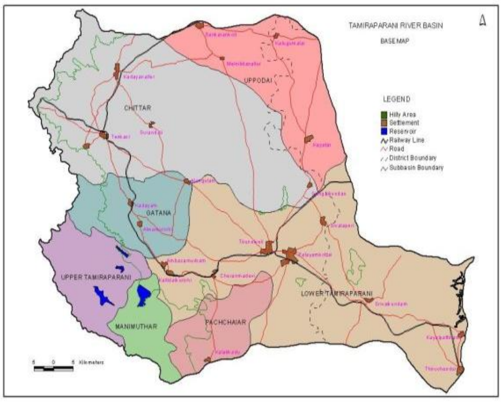


Fig 2 Toposheet



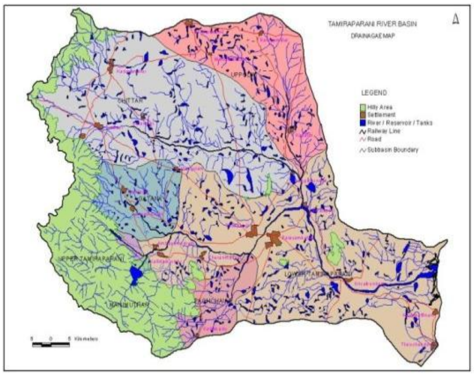


Fig 3 Drainage Map **Fig. 4 Thamirabarani River Basin Map**

Fig.5 IRS P6 LISS III Image Acquired February 2 ,2013

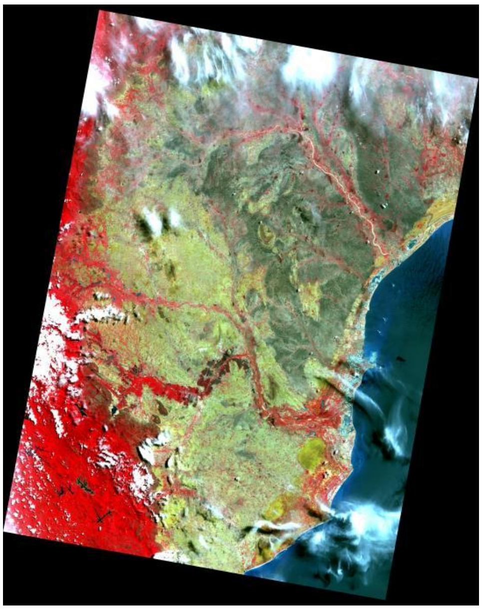


Fig. 6 IRS 1D LISS III Image Acquired on on September 2001

3.3 SOFTWARE USED

3.3.1 ArcGIS 10.1

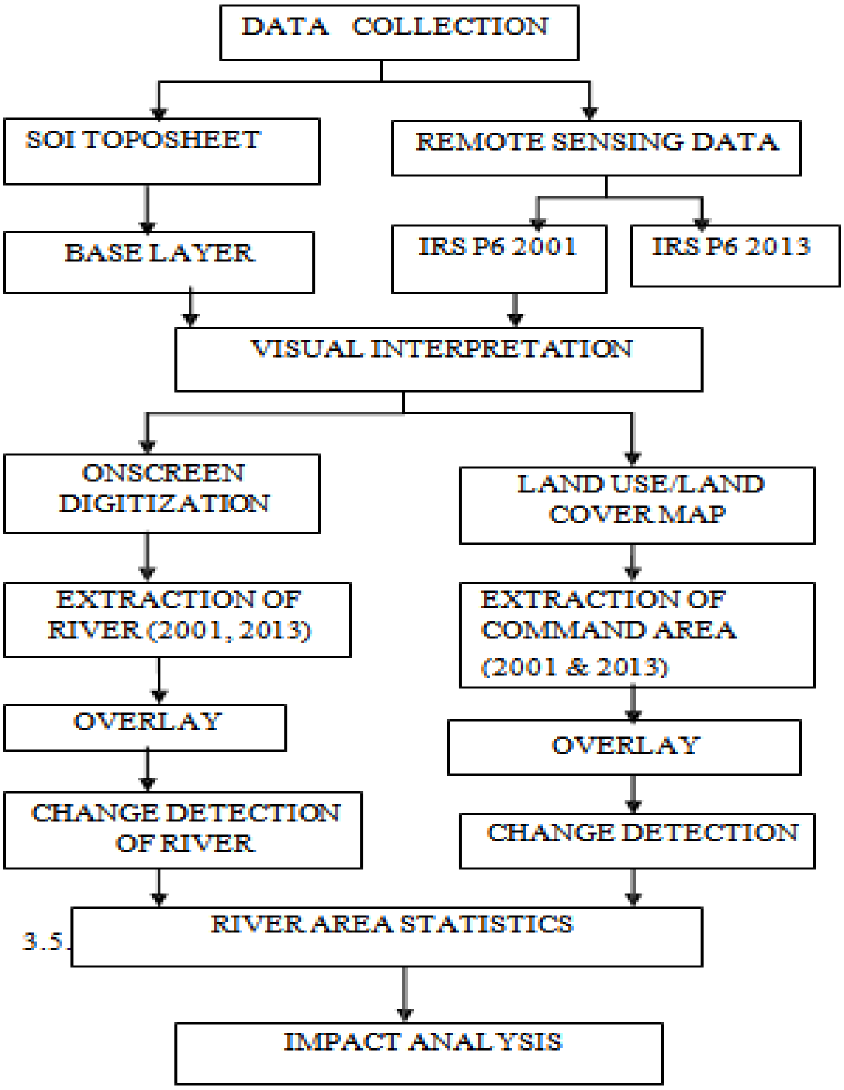
ARCGIS is a geographic information system (GIS) useful for creating and using maps compiling geographic data. It also helpful for analyzing mapped information sharing and discovering geographic information using maps and geographic information in a range of applications and managing geographic information in a database.

3.3.2 ENVI 4.7

ENVI is the ideal software for the visualization, analysis and presentation of all types of digital imagery. Its unique appro ach to image processing combines file based and band based techniques with interactive functions. It includes essential tools required for image processing across multiple disciplines, and it has the flexibility to allow implementation of customized analysis strategies.

3.4 Methodology

The present study is aimed to detect and estimate the changes that have been taken place in the area of interest both in terms of spatial and temporal variation circumstances. This chapter deals with the methodology adopted in the present study .It describes the present mechanism followed in the study area. It also estimates the change detection estimation which explains the proper monitoring of river course and command area.



The acquired images from the satellite sensors are subject to atmospheric distortions. Such distorted images are not liable to perfect data analysis. So corrections are needed to performed such as

- Radiometric correction
- Atmospheric correction

The above mentioned corrective actions make the satellite imagery free from distortions and errors. The pre-processed images are then to be calibrated to utilize it for spatial measurements. The calibrated images are given as input to the software for effective processing and analysis.

3.6. GEOREFERENCING.

To georeference something means to define its existence in physical space. That is, establishing its location in terms of map projection or co ordinate system. The term is used both when establishing the relation between raster or vector images and coordinates, and when determining the spatial location of other geographical features. Examples would i nclude establishing the correct position of an aerial photograph within a map or finding the geographical coordinates of a place or name or street address This procedure is thus imperative to data modeling the field of (GIS) and other cartographic methods. When data from different sources need to be combined and then used in a GIS application, it becomes essential to have a common referencing system. This is brought about by using various georeferencing techniques.

3.7. DIGITIZATION PROCESS

Digitizing is the process of converting analog information into a digital representation. In regards to spatial information one application of this is the process of creating a vector digital database by creating point, line and polygon objects. Scanning a map can also be considered digitizing (turning colors shades on the map into digital values), but for this class when we refe r to digitizing this for the most part refers to creating vector datasets. Digitizing is the process by which coordinates from a map, image, or other sources of data are converted into a digital format in a GIS this process becomes necessary when available data is gathered in formats that cannot be immediately integrated with other GIS data**.**

3.8. OVERLAY METHODS

In general, there are two methods for performing overlay analysis—feature overlay (overlaying points, lines, or polygons) and raster overlay. Some types of overlay analysis lend themselves to one or the other of these methods. Overlay analysis to find locations meeting certain criteria is often best done using raster overlay (although you can do it with feature data). Of course, this also depends on whether your data is already stored as features or raster. It may be worthwhile to con vert the data from one format to the other to perform the analysis.

Feature overlay: The key elements in feature overlay are the input layer, the overlay layer, and the output layer. The overlay function splits features in the input layer where they are overlapped by features in the overlay layer. New areas are created where polygons intersect. If the input layer contains lines, the lines are split where polygons cross them. These new features are stored in the output layer—the original input layer is not modified. The attributes of features in the overlay layer are assigned to the appropriate new features in the output layer, along with the original attributes from the input layer.

Raster overlay: In raster overlay, each cell of each layer references the same geographic location. That makes it well suited to combining characteristics for numerous layers into a single layer. Usually, numeric values are assigned to each characteristic, allowing you to mathematically combine the layers and assign a new value to each cell in the output layer.

This approach is often used to rank attribute values by suitability or risk and then add them, to produce an overall rank for each cell. The various layers can also be assigned a relative importance to create a weighted ranking (the ranks in each layer are multiplied by that layer's weight value before being summed with the other layers)

3.9 Classification Method

Image classification is an important part of remote sensing, Image analysis, and pattern recognition. In some instances, the classification itself may be the object analysis. Image classification, in the field of remote sensing is the process of assigning pixels or the basic units of an image to classes. It is likely to assemble groups of identical pixels found in remotely sense d data into classes that match the informational categories of user interest by comparing pixels to one another and to those of known identity. The classification can serve only as an intermediate steps such as land degradation studies, process studies, land cover modeling, resource management, coastal zone management, and other environment monitoring applications (7). There are two ways to classify pixel into different categories, Unsupervised and Supervised classification.

Classification using maximum likelihood classifiers is well established as a technique for the interpretation of satellite and airborne remotely- sensed images and there are very well developed software packages that provide a range of sophisticated tools for the whole process of image-processing.

IV. RESULTS AND DISCUSSION

The present study attempts to estimate the river course change incurred by the Manimuthar River over a period of twelve yearsusing Remote Sensing and GIS techniques and also estimate the crop command area.Changes have been identified using overlay analysis .This chapter deals with the Results obtained in thepresent study. The area and other related parameters indicating change in the river course and crop command area is estimated and is described here.

4.1GENERATED MAPS

The following maps were generated from the available satellite images of LISS III sensor. It showed great spatial variation and depicted better understandability on visual interpretation.

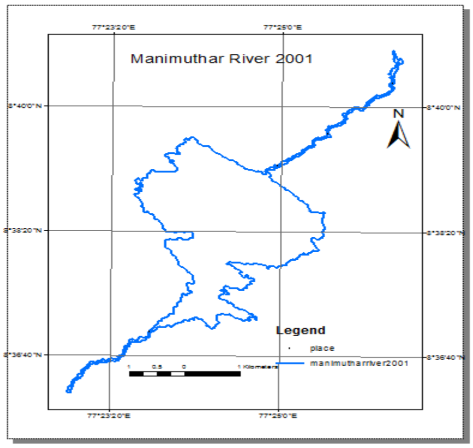


Fig 7 River Map For The Year 2001

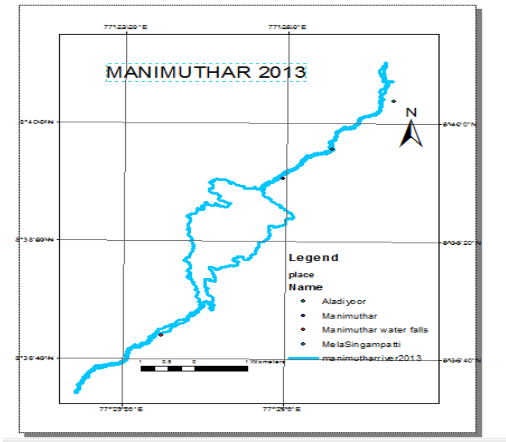


Fig 8 River Map For The Year 2013

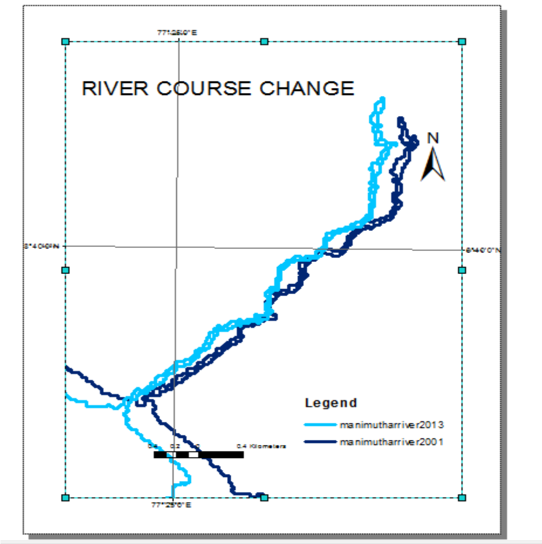


Fig. 9 River Channel Changes Map

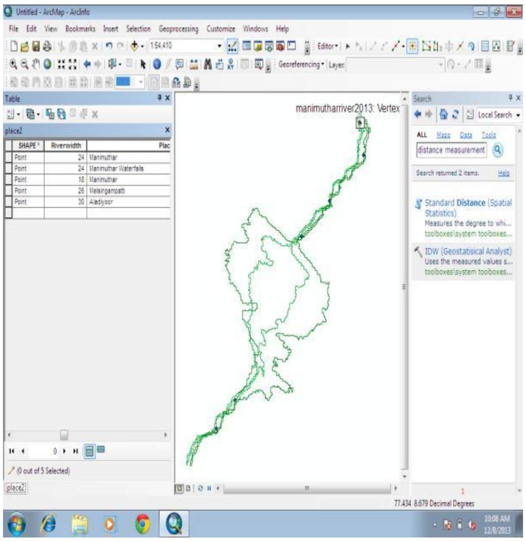


Fig. 10 Screen Shot For Estimating the River Width

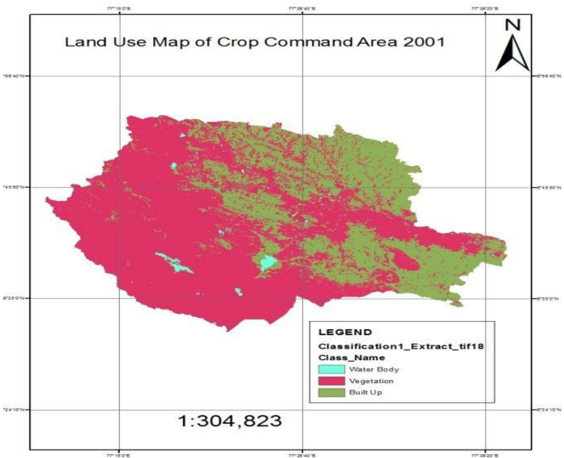


Fig 11 Land Use Map of Crop Command Area 2001

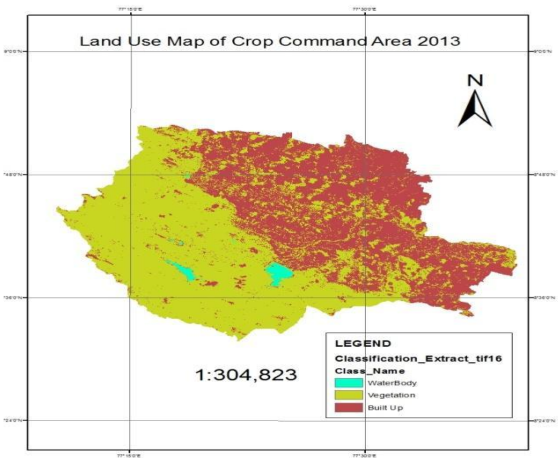


Fig. 12 Land Use Map of Crop Command Area 2013

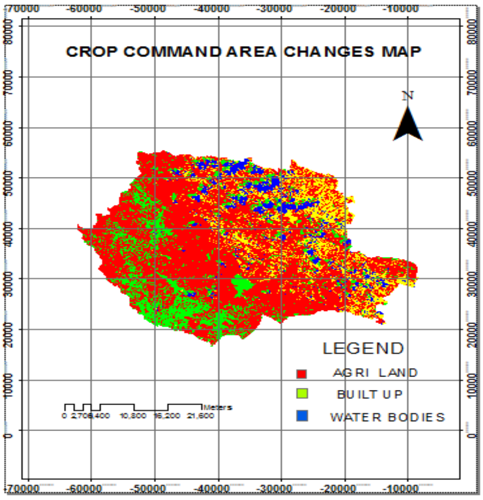


Fig. 13 Crop Command Area Changes Map

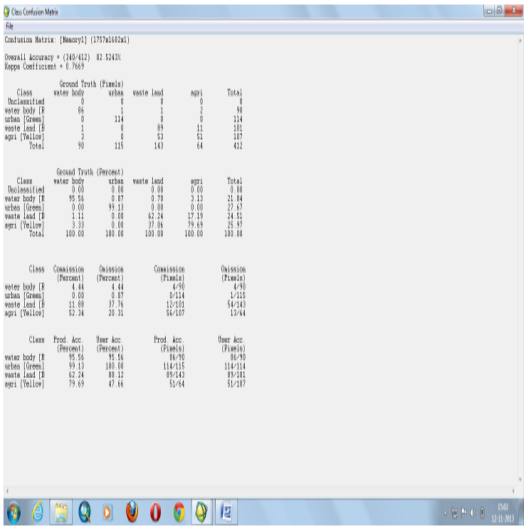


Fig.14 Screen Shot for Accuracy Asessment

4.2 COMPUTED RESULTS

Using Overlay analysis, the layers of the river channel courses in 2001 and 2013 respectively were compared and analyzed. The comparision indicates changes in terms of deviation in the reservoir area. from the inference which can be justified along with the field survey points is that the river has a reasonable shrinkage in its width owing to the interfering human activities near the river bank line.

S.NO	Site	River Width Changes Compute from GIS(meters)	Manual Change Identified (meter)
1	Manimuthar	24.62	28.5
2	MelaChingampat	26.4	28
3	Aladiyoor	30	34

Table. *2* Change identified from the command area

Land use/ Land cover	2001			2013			Change detected (%)
	No. of pixels	Area in ha	%	No.of pixels	Area in ha	%	
Built up land	53671	2964	25	90363	4990.3	43	-18
Agriculture	98723	5452	47	82593	4561.2	39	-8
Water body	58596	3236	28	38035	2100.5	18	-10

Table.3 Land use/Land cover change detection

From the table 3 it is observed that in 2001, agricultural land was 98723 pixels and 5452 ha. In 2013, agricultural land was
82593 pixels and 4561.2 ha. Thus it is noticed that agricultural area is decreased by 8%

In 2001, water body was 58596 pixels and 3236 ha. In 2013, water body was 38035 pixels and 2100.5 ha. Thus it is noticed that water body is decreased by 10%.

In 2001, Built-up land was 53671 pixels and 2964 ha. In 2013, built-up land was 90363 pixels and 4990.3 ha. Thus it is noticed that built-up land is increased by 18%.
This changes are due to low rainfall, population increase, small scale industrial influence such as beedi rolling, safety matches making, mat weaving and articles from palm tree etc., Remote sensing techniques can be successfully utilized for deriving the spatial and temporal agricultural information in irrigated command area

4.3 GLOBAL POSITIONING SYSTEM

GPS technology has provided an indispensable tool for management of agricultural and natural resources. GPS is a satellite- and ground-based radio navigation and location system that enables the user to determine very accurate locations on the surface of the Earth. Although GPS is a complex and sophisticated technology, user interfaces have evolved to become very accessible to the non-technical user.

1	**Manimuthar water falls**	**8□ 40□49.26□ □N** **77□ 26□03.09□□E**
2	**Manimuthar**	**8□ 37□24.58□ □N** **77□ 23□59.02□□E**
3	**Mela Chingampetti**	**8□ 39□45.998□ □N** **77□**
4	**Aladiyoor**	**8□ 41□01.74□ □N** **77□ 26□06.26□□E**
5	**Ambasamudram PWD**	**8□ 42□11.516□ □N** **77□**
6	**Agriculture**	**8□ 39□39.811□ □N** **77□**

Table 4 Field Co-ordinates of various location

4.4. PROBLEMS OBSERVED IN THE STUDY AREA

On field investigation the following problems remain at constraints for solving the improper river management activity which causes impeccable river course changes.

Fig. 15 Location of the Mela Chingampetti

Fig. *16* Location of the Aladiyoor

V. CONCLUSION

The present study was carried out to demarcate the changed areas in the study site for identifying possible river course change using GIS. The data integration, management and visualization in GIS environment were relatively efficient. GIS combines spatial data with other quantitative, qualitative and descriptive information databases. This technology offers an analytical framework for data capture, storage management, retrieval, analysis and display. So, the integrated approach of GIS and remote sensing was used to locate the change in rive and estimated the crop in command area relatively accurate. This chapter gives a brief about the findings of the present study. It gives in detail about the conclusion from the present study and also the suggestions of the present study.

Remote Sensing is one of the excellent tool for inventory and analysis of environment and its resources, owing to its unique ability of providing the synoptic view of a large area of the earth□s surface and its capacity of rep etitive coverage.Techonological development in computer science has introduced geographic information system(GIS) as a innovative tool in surface water monitoring process. When remotely sensed data are combined with other surface water variables organized with in a GIS.They result of the identified changes indicates that enormous changes in river course have occurred in the areas namely Manimuthar, mela chingampetti and Aladiyoor which are susceptible to great changes in near future. The result of crop command area estimation decrease in 8% due to low rainfall, high population and small scale industry influences.

C.SUGGESTIONS

The suggestions for the future river management are as follows

- The current study has developed a deeper understanding about the susceptible nature of the free flowing rivers and its tendency to change courses, which in turn affects the related human and ecological activities „
- The results of the GIS-Based study showed that the affected sites posses extreme impact on the irrigation plans that had been in operation for the last few decades. This can be development by proper river management plan, which minimizes social conflict and environmental impacts.

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