Land Use Changes in Catchment Area and its Impact on Tank Command Irrigated Area

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Abstract— Land use changes are varying the hydrologic system and have possibly large impacts on water resources which in turn affect irrigation. In addition, the changes in climate such as rainfall effect the irrigation. The purpose of this study is to identify and assess long-term changes of land use in catchment area and its impact on command irrigated area of tank which falls under Lower Krishna Sub-basin of Krishna Basin. The land use pattern is changing year to year. Land use changes can be identified from multi-temporal land use classifications. The land use maps of different years are prepared by digital image classification method using satellite imageries of Landsat 5 & 8. Land use of different classes is calculated using the classified multi-temporal imageries. By calculating the areas of assigned classes, we can determine the changes that have undergone in the catchment area over a period of time. The Land use maps of both Catchment area and Command area of the Tank are prepared, and the comparative analysis is carried out to find the changes occurred. The major changes that takes place in Catchment area due to various reasons like rainfall, runoff, soil erosion, deforestation etc., which will impact the command irrigated area of the tank can be assessed, which may increase or decrease the irrigation potential and the remedies can be made for sustainable irrigation and maximum utilization of irrigation potential created in the command area.

Keywords: Land use, Hydrologic system, Multi-temporal, Tank Command Area

I. INTRODUCTION

Land is a crucial natural resource of a country's socio-economic and ecological health. Considering the finite supply of land resources, suitable use and management of land resources are required for the welfare of the people of a country. Land-use change has various impacts, with a potential for shaping economic growth, quality of life, management of environmental resources, and national food supply. A country's socio-economic priorities always influence the land use change. India being a developing country is accelerating its industrial and service sector to generate favourable conditions for the production and consumption of goods and services. Urban areas are mostly recognized, are favorite spots for the utilization and production of a large number of these goods and services. With the rising rate of urbanization, more changes in land-use are taking place to supplement evolving demands and expectations.

"The relationship of economic growth with that of urbanization is not well established; it is the backdrop for any nation's economic growth" (Tolley 1987).

A tank is a basic storage or reservoir which can be used for irrigation purpose; it may be natural or man-made. Approximately 3% of net irrigated area in India falls under Tank irrigation. Tank irrigation is predominant in South India, mainly popular in Telangana, Andhra Pradesh and Tamilnadu.

II. OBJECTIVES

1) Preparation of Base maps like Stream network, Canal network, Contour map, Water bodies of the study area using SOI toposheets as reference.
2) Generation of Land use maps of catchment area and command area of the tank using Multi-temporal satellite imagery of Landsat – 5 TM & Landsat – 8 OLI.
3) Comparative analysis of classes, identify and assess land use changes in catchment area and its impact on irrigated area of the tank over a period of time.

III. STUDY AREA

The Geographical positional details of Nalgonda:
North latitudes 16° 25' and 17° 50'
East longitudes 78° 40' and 80° 05'
Geographical area of Nalgonda is 7122 sq.km.
The average annual rainfall of Nalgonda District is 751mm.

Udayasamudram Reservoir, also known as Panagal Reservoir (17.07777778 N & 79.30277778 E) located on the eastern side of Panagal Village, near the town of Nalgonda.

The catchment area of the tank covers certain area of three mandals i.e. Nalgonda, Narketpalle, and Kattangur. The main source of water in the reservoir is the inflow from the Krishna River through open-canal systems constructed for drinking and irrigation water supply. The reservoir is dependent on the water from the tributaries of the River Krishna and inundation due to monsoon rains. The surrounding area of the reservoir is used for agricultural purposes. Currently an ongoing project is being constructed on this Udayasamudram i.e, Udayasamudram Lift Irrigation Scheme. After the completion of this Lift irrigation project additional 1.00 lakh Acres of ayacut in chronically drought affected areas of Nakrekal, Nalgonda, Mungode, Thungathurthy Assembly Constituencies of Nalgonda District covering eight mandals can be irrigated.

The command area of this reservoir within the Lower Krishna sub-basin of the Krishna river basin provides irrigation for some major parts of Nalgonda, Tipparthy, Madugulapally, Tripuraram, Miryalaguda, Damaracherla, and also few parts of Nidamanoor, and Adavidevulapally mandals through canal network. So many mandals of Nalgonda gets benefit from this reservoir.

Fig. 1: Location of Udayasamudram, Nalgonda District, Telangana

IV. METHODOLOGY

The methodology adopted for the progress of the work to achieve the objectives is shown in the Fig.2 in form of flowchart.

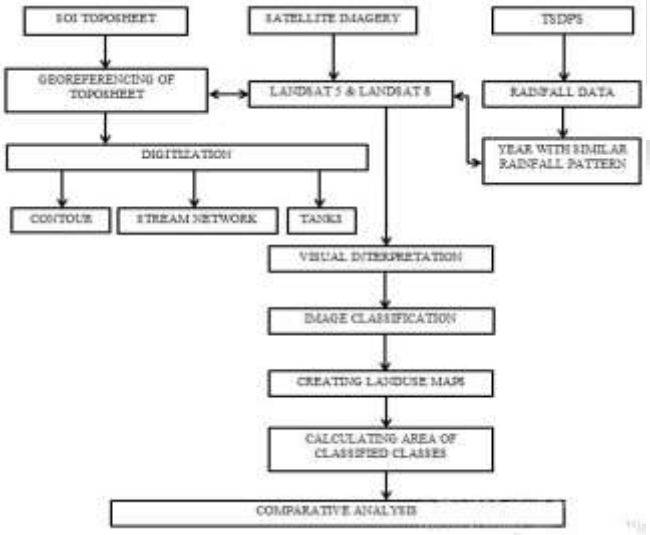

Fig. 2: Flowchart of Methodology

Topographic maps of scale 1:25000 are acquired from Survey of India (SOI) department. For the present study Multi-spectral, Multi-temporal Satellite imagery of Landsat 5 Thematic Mapper (TM) & Landsat 8 Operational Land Imager (OLI) are acquired from Earth Explorer of USGS. Rainfall data of the mandals which fall under the study area are collected over a period of 16 years from Telangana State Development Planning Society (TSDPS), to make sure the Land use classification is done for the years having almost same amount of rainfall or similar rainfall pattern, so that the Agricultural land can be compared.

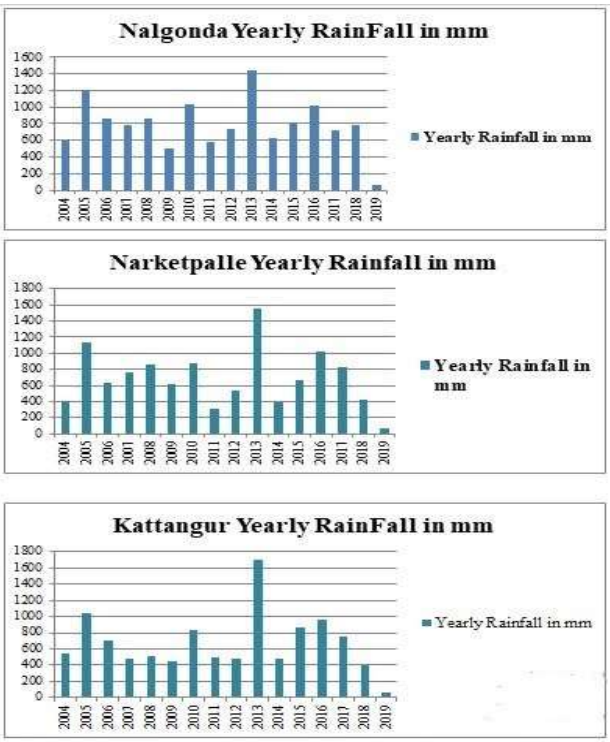

Fig. 3: Annual Rainfall of mandal's Covering

The delineation of the study area is carried out by creating a shapefile and digitizing the area of interest using toposheets which are georeferenced using ArcMap 10.2.2. Using this georeferenced topographic data, basemaps such as Tanks/waterbodies, Stream network, Contour map of 10m interval, Built-up area map are prepared which are useful for overlay analysis with satellite imagery.

The catchment area and the command area of the tank is extracted by using clip tool from ArcToolbox. Catchment area is delineated by overlaying irrigation tanks data which are located within the catchment area as cascade of tanks, stream network, and contour map over the topo-sheet. The command area of the udayasamudram reservoir is demarcated using various layers of base maps like stream network and canal network, that is linked to this tank i.e., the water distribution of this reservoir is interpreted by contour network, canal network using toposheet, imagery and the area is extracted for further image classification process. However plotting the exact boundary of the command area without ground data will not be accurate, so the study of the command area of this udayasamudram reservoir is restricted to the Lower Krishna sub-basin of the Krishna river Basin.

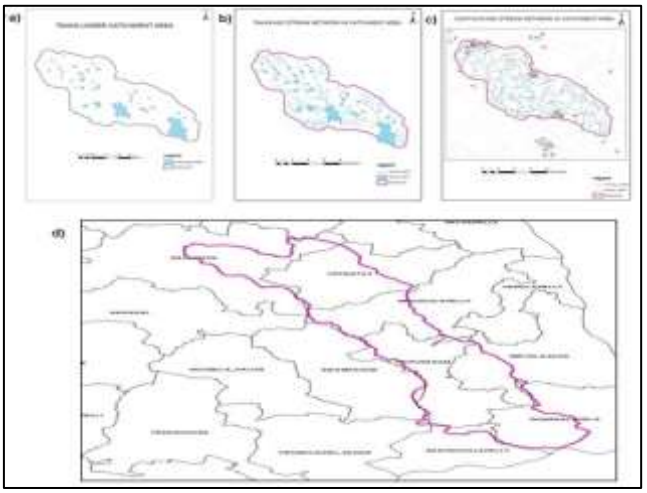

Fig. 4: a) Catchment area of Tank, b) Stream network & tanks in Catchment area, c) Contour Network in Catchment, d) Command area of the tank

The satellite imagery of MSS and TM that is obtained from USGS which is in GeoTIFF format will consists of several different bands of data with each band having particular significance. Each single band of the image one at a time can be seen as a grey scale image. Whereas, the combination of three individual bands together give us a colour composite image.

Image classification is done by adopting supervised image classification method. The satellite imagery which is of single individual bandwidth is stacked using layer stacking and the multi band raster image is created. Supervised classification is done by creating training data sets by visual interpretation of the satellite imagery and then a signature file is created. The algorithm used in classification is Maximum likelihood. Training samples like agriculture, agriculture in Forest, built-up, canal, forest, mining, stream, transportation, wastelands, and waterbodies are created. The satellite image is then classified and we can get the Land use maps. Landuse maps are generated by performing supervised image classification of multi-temporal satellite imagery of Landsat – 5 TM and Landsat – 8 OLI. Land use maps of both the catchment area and the command area of the sub-basin area of the Krishna river basin are generated of the years 2006 and 2015, whose rainfall pattern in the catchment area is similar.

Training sets as listed above are assigned to the pixels of the image by visual interpretation a signature file is created and the land use maps are generated. Land use maps of year 2006 are generated by performing supervised image classification on Landsat – 5 TM satellite image. Land use maps of year 2015 are generated by performing supervised image classification on Landsat – 8 OLI satellite image.

The land use of the command area of the tank within the Lower Krishna sub-basin of years 2006 & 2015 is obtained by classification of Landsat – 5 TM and Landsat – 8 OLI respectively.

The area of the individual landuse classes is calculated using tools like Field calculator and Calculate geometry in ArcGIS software. Then all the areas of similar landuse classes are added and the area of each landuse class is obtained using Microsoft excel, and the pivot table is used for comparison of the area

V. RESULT

The Land use maps of the catchment area of the tank for the years 2006 and 2015 are generated and are represented in Fig.5 & Fig.6 respectively.

Fig. 5: Landuse of Catchment Area in 2006

Fig. 6: Landuse of Catchment Area in 2015

The Land use maps of the command area of the tank within the boundary of the Lower Krishna Sub-basin for the years 2006 and 2015 are generated and are represented in Fig.7 & Fig.8 respectively.

Fig.7 Landuse of Command Area of Tank under Lower Krishna Sub-basin in 2006

Fig. 8: Landuse of Command Area of Tank under Lower Krishna Sub-basin in 2015

The Landuse classification of the lower Krishna sub-basin is done in order to study the changes that occur in both the catchment area and the command area of the tank, and also to understand the impact on the command area of the tank due to the changes that occurred in the catchment area of the tank over the period of time. This part of the lower Krishna sub-basin contains both the catchment and command area of the tank.

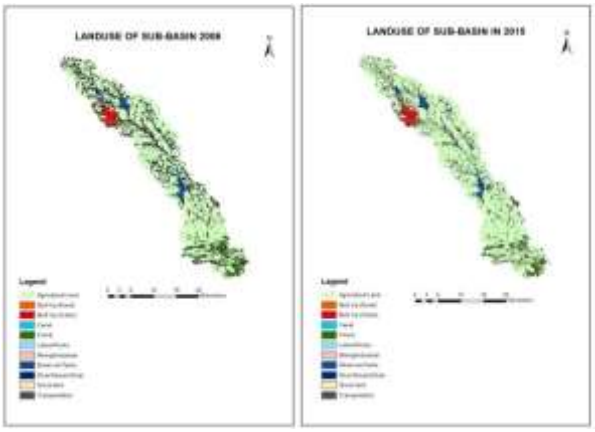

Fig. 9: Landuse of Lower Krishna Sub-basin in year 2006 & 2015

The areas of the individual landuse classes calculated from pivot table are illustrated in Table 1 & Table 2 for catchment area and command area correspondingly.

LAND USE CLASS	AREA (Ha)	
	2006	2015
Agriculture Land	20159	19754
Built up	232	449
Canal	147	193
Mining	0	33
Transportation	291	291
Wastelands	812	639
Waterbodies	1327	1609
TOTAL AREA	22968	22968

Table 1: Landuse of Catchment Area

LAND USE CLASS	AREA (Ha)	
	2006	2015
Agriculture Land	52426	51843
Agriculture in Forest	109	38
Built up	2682	3441
Canal	595	595
Forest	4018	3622
Mining	223	571
Stream	576	549
Transportation	277	329
Wastelands	2022	2009
Waterbodies	3018	2949
TOTAL AREA	65946	65946

Table 2: Landuse of Command Area

The pie charts in the Fig.10 represent the areas in percentage of various Land use classified of both the catchment area and command area for the years 2006 & 2015.

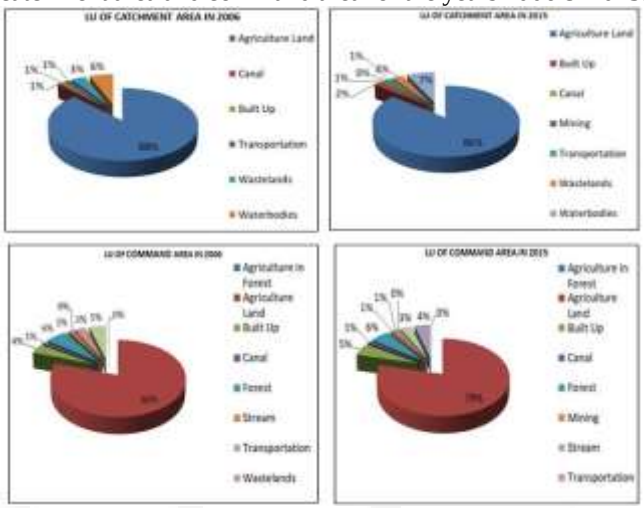

Fig. 10: Pie charts of Landuse areas of Catchment Area and Command Area of years 2006 & 2015

VI. CONCLUSION

After the Calculation of the areas and statistical analysis of classified classes, it is observed that many changes had taken place in both the catchment area and the command area of the reservoir. The major changes that were noticed in land use are:

Some parts of the Agricultural land are turned into Built-up land, Canal construction, waterbodies, and Mining area. Increase in population has accelerated the demand for land, increased the built up area and decreased agricultural land. Settlement development has also led to deforestation and thus reduced the forest area. Forest area has declined due to some agricultural practices nearby and also utilized for mining purposes. Encroachment of forest land is done by the people in order to acquire more land for agriculture and settlements. Some part of the waterbodies are encroached and used for various purposes like built-up, agricultural use. Wastelands are also converted into built-up area and at places used the extension of the canal network. Wastelands are also turned as quarrying or mining sites and for the construction of industries. This could also be attributed to the increase of population that in turn has increased the demand for shelters. Farmers in this area commonly removed forests and sub-divided plots to create houses and small farms. The resulting effect is the decrease of forest land and agricultural land. Major changes of canal network extension were observed in the catchment area. So the development of areas, population increase, encroachment, and change in land use triggered and ultimately responsible for the decline of the vegetation or agricultural land.

Upon observation, it is understood that the land use changes within the command area of the tank are more significant than the impact of land use changes happened in the catchment area over the period of time. So, the major driving reason for the impact in tank command irrigated area is the land-use changes within the command area of the tank itself which is then followed by the land-use changes in the catchment area.

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