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Agricultural mapping and statistical analysis of Thanjavur district using remote sensing and GIS

Thangaperumal S.

goldgct@gmail.com

St. Joseph's College of Engineering,
Chennai, Tamil Nadu

T. Velan

vel27kabil@gmail.com

St. Joseph's College of Engineering,
Chennai, Tamil Nadu

J. Gnana Jeeva

gnanajeeva5@gmail.com

St. Joseph's College of Engineering,
Chennai, Tamil Nadu

ABSTRACT

Mapping and analyzing the agricultural lands using remote sensing and GIS technique is faster and cost-effective compared to conventional site verification method. Thanjavur is a district in Tamil Nadu which rich in agriculture. It is a lower riparian of Cauvery river. It is rich in alluvial soil, but its crop production is falling due to urbanization and water insufficiency. Failure of monsoon and insufficient river water are also major reasons. Since agricultural lands are depleting, the cost of agricultural products is increasing. LANDSAT 7 imagery is processed using ARC MAP 10.4 and classified using ERDAS IMAGINE 2014. By analyzing the results obtained through the process for decade 2009-2018 we concluded the percentage in area change for agricultural lands with crops and without crops, barren lands, urban areas, and water bodies. The study is to determine the drop in agricultural lands and its causes.

Keywords— GIS, LANDSAT, ERDSAS, Urbanization, Remote sensing

1. INTRODUCTION

Agriculture means the cultivation of land for getting food crops and cash crops. Tamil Nadu is producing agricultural crops from the ancient days. Some of the important rivers of Tamil Nadu are Kauveri, Vaigai, Chittar, Palar, Cheyyar, Bhavani, Amaravathi and Tamaraparani. Major food crops are rice, ragi, bajra, jowar, maize, and pulses. Coconut, sugarcane, cotton, tea and coffee, as well as various horticulture crops like bananas and mangoes, are cash crops. Oilseed crops like groundnuts, sesame, sunflower are also grown. The crops are generally classified into three groups. The first one is 'Kurvali'. It has a cropping period of up to four months. It is grown in the month of June – July to Oct- Nov. the second one is 'Thaladi'. It has a cropping period is 5-6 months. It is cultivated in months Oct – Nov to Feb – March. The third one is 'samba' which has a cropping period of 6 months. It is cultivated in the months August to January.

We are using remote sensing for analyzing crop production for the decade 2009 to 2018. The modern GIS technologies use digital information for which an enormous amount of digitization methods are used. There some common methods of data are digitization, where hard copy format is converted to digital format by use of cad drawings. In GIS the wide variety of imagery are available are a satellite, aircrafts helices etc. GIS applications are tools that allow users to perform spatial query, analysis, edit spatial data and create hard copy maps. GIS use spatiotemporal, in simple way GIS can be defined as an image that has x and y coordinate and its attribute values are stored in the table ores referenced to the earth. These coordinates systems are based on the different projection system and these are of various types.

A geographic information system (GIS) lets us visualize, question, analyze, and interpret data to understand relationships, patterns, and trends. GIS-based Network Analyst is an efficient extension that gives network-based spatial analysis which includes routing, travel directions, closest facility, and service area analysis. We can achieve sustainable infrastructure planning when the spatial entity is interlinked with non-spatial attributes. This is a key factor for applying GIS technology as a tool in mapping and statistical analyzing of agricultural crops

2. OBJECTIVES

- To create agricultural maps for Thanjavur district in the year 2009-2018
- To view the time series change in agriculture land utility
- To analysis statistical data for agriculture land in Thanjavur district in the year 2009-2018.

3. STUDY AREA

Tanjavur has a geographic coordinates Lat/Lon: 10°47'8.16"N 79°8'24.36"E/ 10.7856000°N 79.1401000°E. It has a population of 2,405,890 with a gender ratio of 1035 females to 1000 males as per 2011 Sensex. This district lies in the Cauvery delta region which is rich in fertile soil. This district mainly produces rice and hence called the rice bowl of Tamil Nadu. Apart from paddy farmers produce sugarcane and coconut. It is also the large producer of coconut in Tamil Nadu.

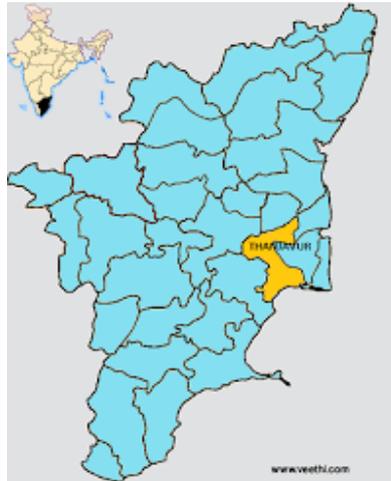


Fig. 1: Study area

Tamil Nadu. It is one of the main centres for silk weaving. The traditional occupation of this district is agriculture and the inhabitant's occupation of the city is tourism and service-oriented industry. There were around 200 silk weaving industries in 1991 and almost 80,000 people were working. Increased production cost and competition from large scale industry have reduced the number of people involved in the production. The city produces ball metal crafts like Tanjavur metal plates, bronze images, bowls, powder boxes made of copper and bronze. The city is good in manufacturing pith works consisting of models of the mosque, Hindu idols and other bird figurines. It has a uniqueness that a UNESCO world heritage site is located at Tanjavur. Peruvudaiyaar Temple is built by Cholas. UNESCO declared world heritage site as Airavateswara temple near Kumbakonam.

4. THE SCOPE OF THE STUDY

Land use and Land cover changes are some of the most sensitive indicators of environmental changes as it reflects the impacts of human activities on the environment. Land cover refers to the physical and biological cover over the surface of the land, including water, vegetation and/or artificial structures. For many planning and management activities concerning the surface of the Earth, Acquiring information about an object from a far distance or not making contact with it is called remote sensing. Surface boundaries of the earth which include water bodies and land surfaces can be easily processed by remote sensing. Various applications of remote sensing are agriculture, hydrology, irrigation, surveying, forestry, weather forecasting, transport, environment, biodiversity, mineralogy, soil classification. Using remote sensing instead of the conventional method of site visiting will greatly reduce cost and increase the economy of the government⁵

5. NEED FOR THE STUDY

Tanjavur district's main source is agriculture. Most of the farmers depend on their agricultural lands. Nowadays agricultural lands are depleted with the increase in urban areas. Due to water insufficiency, more than half of the agricultural lands are left as empty ground. Some of the lands abandoned by farmers. The agricultural products are decreasing due to the fail of monsoon and land acquisition. It affects the economy of the country. Using GIS we can easily solve agricultural problems. GIS can effectively use for the classification and analysis of agricultural crops. We can find the areas which lack facilities for agriculture and with the results obtained we can give a solution to regain production.

6. MATERIALS AND METHODS

6.1 Data collection

Satellites with sensors operating in space platform will collect and transmit data from earth to a ground station. It will consist of various parts of the electromagnetic spectrum. It enables the researcher to get the rightful information. In this project, we use the Landsat 7 Enhanced Thematic Mapper plus (ETM+) data are done the various process. The land sat images comprises of various types of bands. They are:

- Band 1 Visible (0.45-0.52 μ m)-30m
- Band 2 Visible (0.52-0.60 μ m)-30m
- Band 3 Visible (0.63-0.69 μ m)-30m
- Band 4 Near Infrared(0.77-0.90 μ m)-30m
- Band 5 Near Infrared(1.55-1.75 μ m)-30m
- Band 6 Thermal(10.40-12.50 μ m)-30m
- Band 7 Mid Infrared(2.08-2.35 μ m)-30m
- Band 8 Panchromatic(0.52-0.90 μ m)-15m

Landsat 7 is operating so far from April 1999. It is still working for the collection of earth's data. Satellite imagery in remote sensing has four types. They are spectral, spatial, temporal and radiometric.

6.2 Preprocessing

Image preprocessing is a common method usually done before doing any work on the obtained image. By doing pre-processing the image will get improved in quality for data extraction. Image processing treats the image as two-dimensional signals and it will correct the irregularities. Radiometric correction is done for errors which arise due to sensor irregularities and atmospheric noise. The focal analysis tool is used to rectify line band error

6.3 Image classification

Image classification is done to convert all the pixels of the pre-processed data into a digitized form. By doing this we can accurately classify the required data. There are two types of classification. They are Supervised and unsupervised classification. We are using supervised classification. Tanjavur district is classified according to the following class.

- Agricultural lands with vegetation.
- Agricultural lands without vegetation.
- Barren Lands.
- Urban areas.
- Water bodies.

6.4 Supervised Classification

Supervised and unsupervised classification is often employed in a combination manner; classifying the image based on the user-specified land cover classes will be allowed by the remote sensing program, classification of other less common or lesser known cover types into separate groups will also be done. Maximum Likelihood classification has been employed in this project. The tool will take both the variance and covariance into account while each cell has been assigned to one of the classes as mentioned in the signature file. The class sample distribution is assumed to be normal and the mean vector and the co-variance will characterize the class.

7. RESULTS AND DISCUSSIONS

7.1 Kharif crops

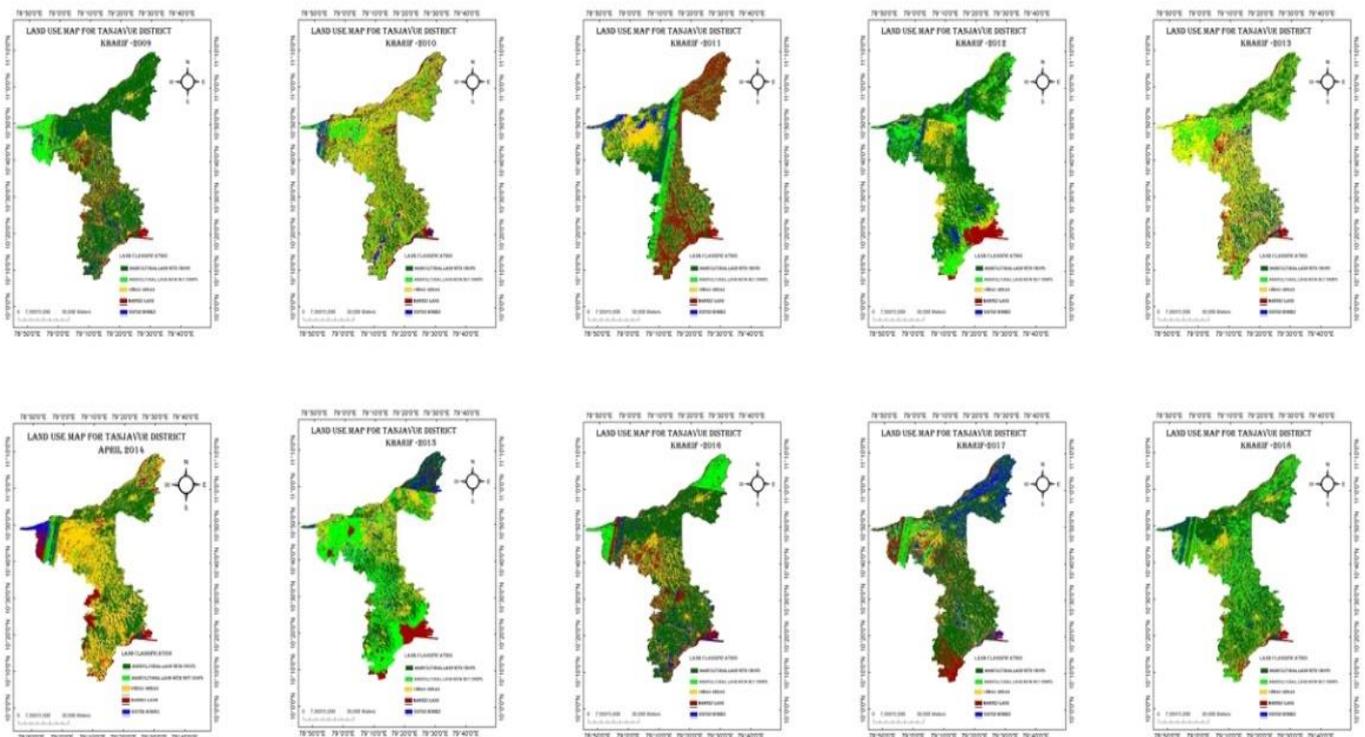


Fig. 2: Image classification of Kharif crops from 2009-2018

Kharif season is otherwise known as the autumn season. The crop period starts during the first rain of June or start of south-west monsoon in parts of India and Bangladesh. Cultivation is done in dry season. Examples for Kharif crops are Paddy, Maize, Millet, Jower, Bajra, Soybean. The season for Kharif changes with crop and state. The season starts at early may and ends in late October. But conventionally it starts in June and ends in October. At the start of the monsoon, the sowing of seed starts and harvest takes place during the end of monsoon.

7.2 Rabi crops

In Asia, rabi crops are sown in the start of winter and it is harvested during the spring season. It is also called as “winter crop”. Sowing of rabi crops takes place in the mid of November. It harvest takes place between the months of April/May. Lands having river beside will be watered using irrigation water. Otherwise, it purely depends on rainwater only. Some major crops of rabi are wheat, mustard, barely and peas. In Tanjavur district most of the crops are cultivated in both Kharif and Rabi season.

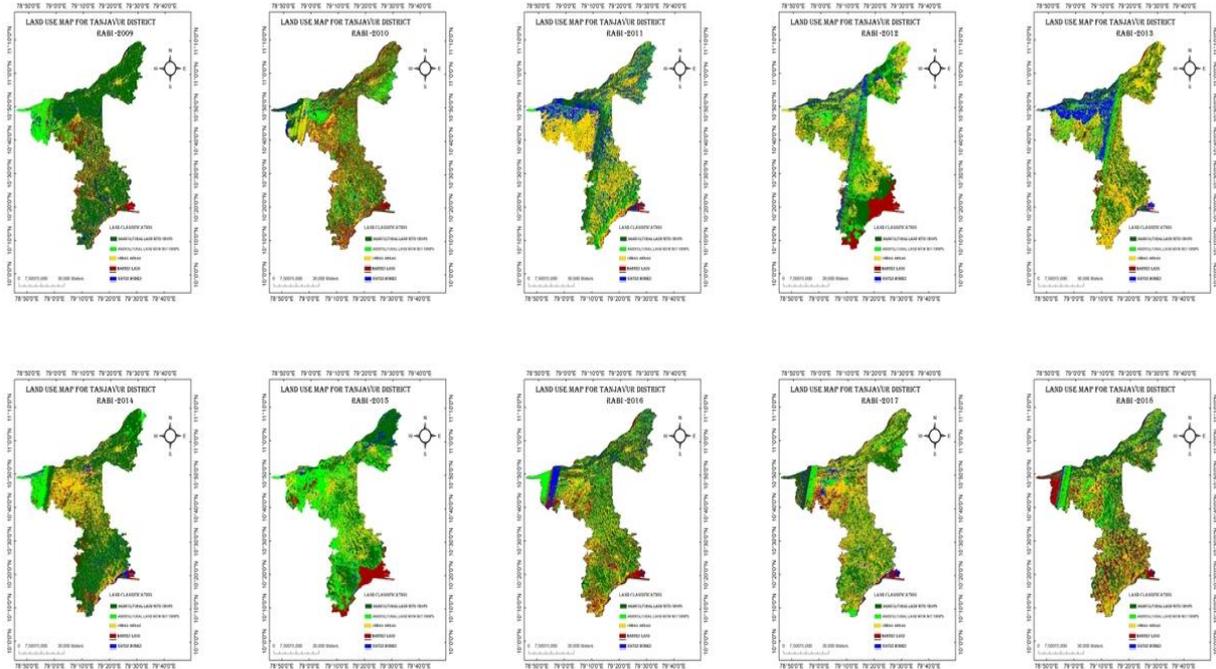


Fig. 3: Image classification of Rabi crops from 2009-2018

7.3 Graphical representation of Kharif and Rabi crops

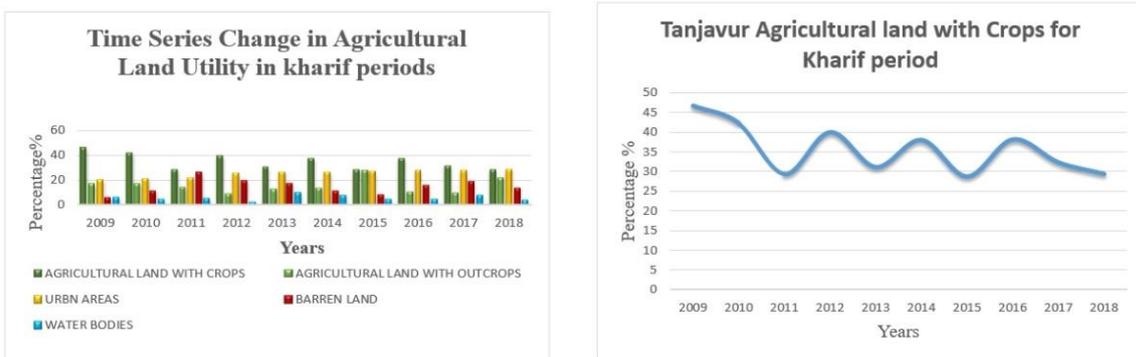


Fig. 4: Graphical representation of Kharif crops

The Kharif crops display time-series change of agricultural land and urban areas. As well in the rabi season, Kharif also has the peak in agricultural production in the year 2009. After this, it decreases with a drastic increase in the year 2014. In succeeding years it is decreasing. The urban areas are in parallel with the rabi season. It is increasing throughout the decade with the slight increase in increasing rate in the year 2012. After that the rate of increase in urban areas is constant. The barren lands are decreasing from the year 2010 to 2015. This is due to the utilization of barren land for agricultural crops. But after that, it is increasing. In contrast to the Kharif season, it has the least water bodies in the year 2013-2014. It has high water storage in 2011. After the least in 2015, it slightly increases to 2018. The map which displays the Tanjavur agricultural land with crops for Kharif crops which displays the maximum percentage of crops grown in the Tanjavur District. The maximum Percentage obtained in the year 2012, where the percentage did not decrease less than 24%. These values are compared only for a decade of years. Due to the less amount of rainfall and the urbanization crop shows the delineation in the graph shown above.

7.4 Graphical representation of Rabi period

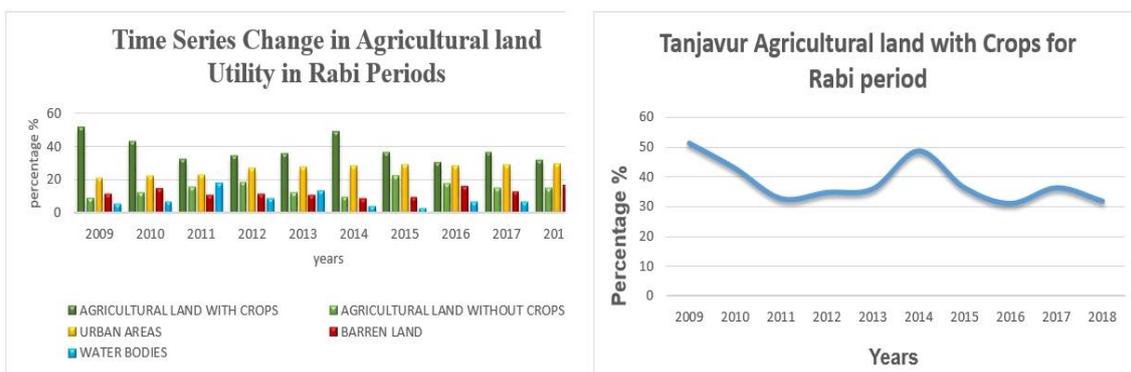


Fig. 5: Graphical representation Rabi crops

The above graph represents the time series change in agricultural land utility, that different classification of based on the percentage to the period of years. The continuous variation in the agricultural crops and other class shows the unevenness on the map. Percentage clearly shows the vegetation was a peak in the year 2009. after this, it decreases to 2012. For the next two years, it has a slight increase but it has a drastic decrease in the year 2014. After this, it decreases slightly with a small peak in the year 2017 and a decrease. While considering urban areas it is a gradually increasing graph showing that its increase rate is high during the year 2011 to 2012. After that the rate of increase in urban areas is constant. The barren lands are decreasing from the year 2010 to 2015. But after that, it is increasing. Water bodies are high during the year 2013-2014. In 2018 its quantity is very less. The graph is shown above clearly shows the agricultural land area in Tanjavur district. As mentioned above, crop production is a peak in the year 2009. After this, it is decreasing. The second increase in production is in the year 2014. Succeeding this year there is a fall in the crop production. This is due to various reasons but the two main, one is that the urban areas are increasing and the other is a due water shortage.

7.5 Comparison between Kharif and Rabi crops

From the graph shown below, it is clearly seen that agricultural lands without crops are more than agricultural lands with crops. Only in the year 2012, the agricultural lands with crop are more. In the year 2009 crop production is at maximum. From the graph, we can infer that both the agricultural lands with crops and without crops are decreasing, which is showing that agricultural lands are decreasing. It was mainly due to the increase in urban areas.

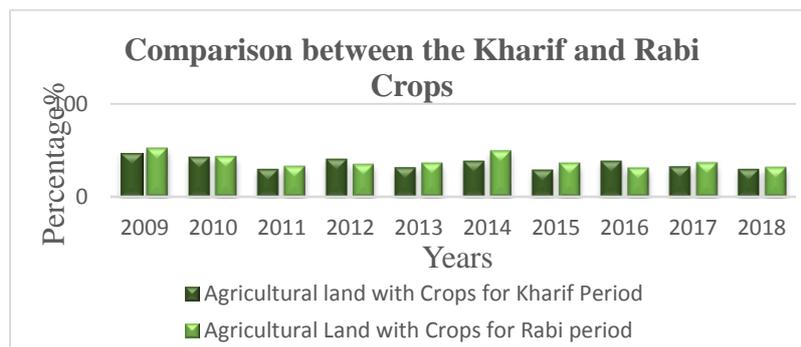


Fig. 6: Comparison of Kharif and Rabi crops

8. CONCLUSION

Tanjavur is a district with good crop production in Tamil Nadu. It is a lower riparian of Cauvery. We have analyzed the crop production of this district for a decade (2009-2018). From the above graphs and results, it is concluded that the agricultural lands and production of crops are falling from the year 2015 to 2018. From the classifications made above it is clearly shown that the decrease in agricultural lands is due to the increase in urban lands and decrease in water bodies. Barren lands are also increasing gradually. Due to all these reasons, crop production was decreased.

By interpreting the comparison chart between Kharif and Rabi crops it is clear that Rabi's production is a dominating one. This is because water is more available when Rabi crop's growing period. So we recommend the provision of additional water storage facilities will increase the production in the Kharif season.

We analyzed the reason for the drop in agricultural lands. Thus we recommend measures to regain production. Excavation of water bodies in the southern part of Tanjavur district mainly in Pervurani should be done. Canal lining and irrigation channels should be maintained properly. The souring of channel beds changes the discharge through channels. Extra care should be taken to this. Provide additional storage structures to store water when there is flow in Cauvery

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