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Impacts of Urbanization on Water Resources and Vegetation on the Delta Region of Tamilnadu Using Remote Sensing and GIS

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Research Article

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ABSTRACT

Background: The fast urbanization and related anthropogenic activities has been devouring the adjacent natural resources leading to a greater decline of the complex ecosystem. This in turn leads to loss of habitat and decline in species associated with this ecosystem. The resulting loss is not only a burden on the environment but acts as an economic and social burden among the public whose lives are directly dependant on the natural resources. Therefore regular monitoring of the depletion of natural resources is a forefront task.

Statement of the problem: The study areas Tiruchirapalli, Thanjavur, and Tiruvarur districts are located in the Cauvery delta region, with fertile soil and endowed with rich water resources. Agriculture is the chief occupation in these areas. The depletion of water resources affects the irrigation of the agricultural lands which in turn lowers the agricultural productivity. This increases the cost of agricultural production and also increases the economic burden on the poor. The inflation of costs of natural food resources and water is a result of such environmental damage. Therefore proper planning, monitoring and management of infrastructural development and urbanization in these areas become crucial.

Objectives: The present study aims at assessing the depletion of natural resources such as water resources and vegetation in the delta region i.e., Tiruchirapalli, Thanjavur, and Tiruvarur using spatial technologies tools like remote sensing and Geographical Information System (GIS). GIS is an interactive computer based tool which has gained importance in recent decades to aid easy monitoring of natural resources.

Data use and Methodology: The Survey of India toposheet of the year 1972 at the scale of 1:50000 for the study area were geo registered and projected using Universal Transverse Mercator projection. The administration boundaries of Tiruchirapalli, Thanjavur, and Tiruvarur were digitized including the vegetative area and water bodies. The recent satellite images (IRS, LISS III) of the study were extracted from ISRO Bhuvan (2009). The near infrared red and green bands were layer stacked to obtain a false color composite. The images were classified using supervised classification (maximum likelihood) in to four classes' i.e., urban settlements, drainages, vegetation and water body. Change detection analysis was performed to detect the rates of depletion among water and vegetative resources.

Results: A comparison of the areas estimated for urban, water bodies and vegetation was done to identify the land increase and decrease over a period of 37 years. The results show that the urban areas increased by

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421.61 km^2 and the water bodies had drastically decreased by 107.844 km^2, and the land under vegetation had drastically decreased by 6075.78 km^2. This pattern was accounted as a total sum for the entire three districts.

Conclusion: From the present study, it is revealed that the natural resource has greatly declined over the period of 37 years due to the urbanization activities. This value exceeds the naturally estimated decline for the same region. Hence conservation measures have to be adopted for the optimal utilization of these resources without compromising the economic benefits and sustainability of these resources.

INTRODUCTION

Water occupies a unique place of all the planet's renewable energy sources. Water resources of a country constitute one of its vital assets [1]. Properly managed water resources are a critical component for all forms of life, food production, economic growth, poverty reduction and general wellbeing. The livelihoods of the poorest are critically associated with access to water services. It is impossible to substitute for most of its uses, difficult to de-pollute, expensive to transport, and it is truly a unique gift to mankind from nature. Water is also one of the most manageable of the natural resources as it is capable of diversion, transport, storage, and recycling. All these properties impart to water its great utility for human beings. The surface water and groundwater resources of the country play a major role in agriculture, hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation, recreational activities, etc. According to National Water Policy in the planning and operation of systems, water allocation priorities should be broadly as: (i) drinking water, (ii) irrigation, (iii) hydropower, (iv) ecology, (v) agro-industries and non-agricultural industries, and (vi) navigation.

Anthropogenic activities are of a major force in impacting the hydrological cycle as well as the climate. Assessing the impacts of human activities on hydrological environments is becoming a wide-focused topic. Accelerated groundwater exploitation over the past few decades has resulted in great social and economic benefits by providing low-cost, drought-reliable and high quality water supplies for urban areas, rural populations and crop irrigation. The rapidly increasing large cities in semiarid and semi-humid regions raise many problems in water resources management

The Cauvery Delta region viz., Thanjavur, Tiruchirappalli and Thiruvarur districts recorded deficit rainfall from -3 to -61% and an overall deficit is around -16.8% over the past four years. Though this deficit has been recently occurred due to fast urbanization, other reasons such as climate change, failure in monsoons and global warming are also pointed out. Out of these urbanization plays a very important role in the depletion of water resources.

The last 50 years of its growth have witnessed large scale destruction of this physical heritage of study area. Large scale encroachments have leads to filling up of lakebeds and conversion to built up area by both the government and private agencies over the last few decades. Land clearing, primarily for agriculture in earlier days, but recently due to urbanization is perhaps the single most important cause of environmental degradation, loss of species, and depletion of ecological communities. Forest loss and degradation are particular problems for conservation biology because forests are some of the most species-rich environments on the planet [2], particularly for birds [3] and invertebrates [4]. The United Nations Food and Agriculture Organization reviewed global forest clearance, and found that between 1990 and 2000, the average rate of forest loss was 16.1 million hectares per year [5]. The causes of desertification and vegetation destruction are usually grouped into natural and human causes. Desertification has been blamed on long-term climatic changes, cyclic fluctuations in climate, and periodic droughts and destructive consequences of human activities

In an arid environment, the main limiting factor for plant production is the amount of water in the soil available to the vegetation. Droughts are common in arid regions. It occurs when a region has insufficient moisture to meet the demands of plants, people, livestock or wildlife. The absence or shortage of rain and the temporary character of the problem are the most visible elements. Drought may be a meteorological drought when rains fail to reach a certain level over a particular period of time in a given area; agricultural drought when the combined effects of amounts and distribution of rainfall, soil water reserves, and evaporation bring about a drastic reduction of agricultural yields and livestock leading to food scarcity and other associated problems; or hydrological drought due to changes that reduce the absorption and storage of moisture in the soil. The objective aimed in the present study is to analyze the extent to which urbanization has affected the small water resources in this area and to provide appropriate and affordable strategies for conserving the water resource and quality in this community.

STUDY AREA DESCRIPTION

The study area selected for the present work are Tiruchirapalli, Thanjavur and Tiruvarur regions of Tamil Nadu **(Table 1)** with a geographical extension that lies between 10 to 11.30' N lat and 77-45' to 78-50' E, 9.50' to 11.25' N and 78.45' to 79.25' E,

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10.20' to 11.07' N and 79.15' to 79.45' E. The total geographic study area covers about 10177.4 km^2. The districts Tiruchirapalli consists of 9 taluks, Thanjavur-8 taluks and Thiruvarur-7 taluks. The districts are surrounded by Pudukottai, Karur, Namakkal, Perambalur, Ariyalur, Nagapattinam district as per clock wise directions and the Bay of Bengal on the south east **(Figure 1).**

Table 1. Water Resources potential of basin-Surface Water.

S. No.	Major River Basins	Minor River Basins	Water Resources potential of basin-Surface Water
1	Cauvery	Vennar Vettar Kudamurutti Koraiyaru Odampoki	7067

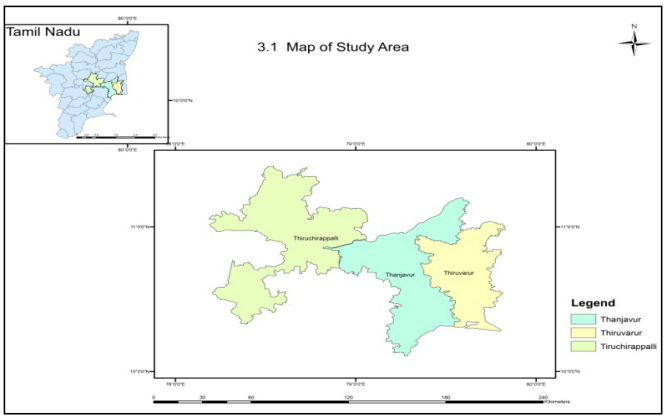

Figure 1. Study Area Location.

These districts lie at the Cauvery delta region, the most fertile region in the state. The water resources potential of the region is presented as **Table 1**

DATA SOURCES AND METHODOLOGY

The data used for the present study are Survey of India toposheets of the year 1972 at the scale 1:50,000 which included 34 maps to cover the entire study area. The IRS LISS III images for the study area were downloaded through the portal ISRO Bhuvan and used for further processing .The near infrared red and green bands were layer stacked to obtain a false color composite. The images were classified using supervised classification (maximum likelihood) in to four classes' i.e., urban settlements, drainages, vegetation and water body. Change detection analysis was performed to detect the rates of depletion among water and vegetative resources. The methodology flowchart is presented as **Figure 2.**

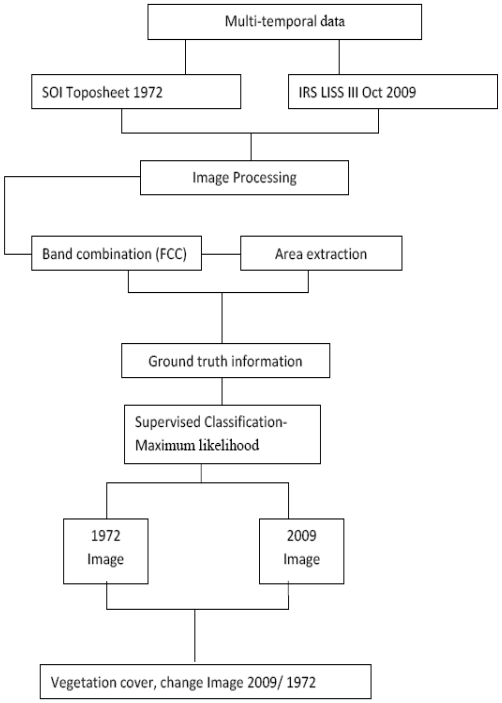

Figure 2. Methodology Flowchart.

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RESULTS

The surface of the land is an important resource in which human activities are continually modifying. Rapid population expansion has placed great demands for living space leading to increasing urbanization and exploitation of marginal lands. The latter has led to problems such as deforestation, land degradation and desertification, flooding and other associated problems in many tropical and subtropical areas. In cold regions the landscape is particularly sensitive and disturbance to the thermal equilibrium of permafrost has led to the development of thermokarst. The increasing pace of urbanization has also led to major engineering works on slopes and coastal reclamation. The former can lead to increased landslide hazard while the latter usually occurs at the expense of coastal fisheries and ecologically important wetlands. Urbanization leads to changes in the hydrology, geomorphology, water quality and riparian vegetation of rivers, leading to degraded sites and reduced biodiversity on comparison of the multi temporal GIS data depletion of water bodies in the study area was enumerated over a period of 37 years. From the results, the estimation of the water bodies is 175.94 km^2. Similarly the urban area or area under construction was observed to be 226.9 km^2 **(Figure 3).**

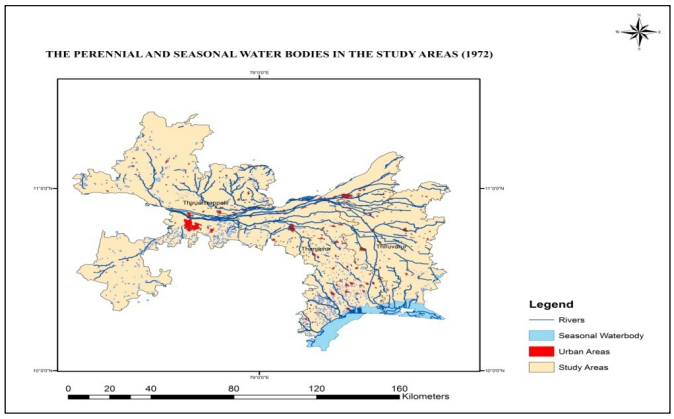

Figure 3. Perennial and Seasonal Water Bodies in the study area.

The IRS LISS III image for the year 2009 was subjected to supervised classification using visual interpretation method. The land use classes such as vegetation, urban areas and water bodies were extracted from the supervised classes and the area in km^2 was estimated for each class **(Figure 4).** From the results, it was observed that the water body was covered an area of 68.09 km^2. The urban area was covered an area of 648.51 km^2. The observed results are presented in **Table 2.**

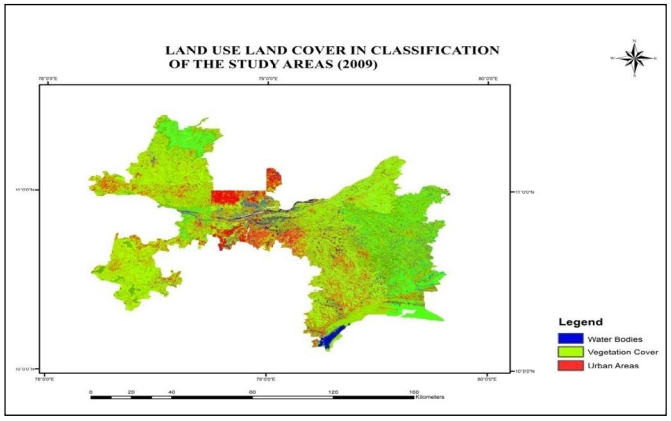

Figure 4. Land use land cover classification of the study area (2009).

Table 2. Changes in land use/ land cover in study area.

LULC Class	Year 1972 Area in km^2	Year 2009 Area in km^2	Changes in Area (km^2)
Urban	226.9	648.51	421.61 (+)
Water bodies	175.943	68.0982	107.844 (-)
Vegetation	9492.25	3418.47	6075.78 (-)

A comparison of the areas estimated for urban and a water body was done to identify the land under increase and decrease over a period of 37years. The tabulated results shows that the urban areas have increased by 421.61 km^2 and the water bodies had drastically decreased by 107.844 km^2. the land under vegetation hard decreased by 6075.78 km^2.

To study the depletion of vegetation cover, the same procedure was adopted. It was estimated that the area under vegetation cover is 9492.25 km^2 during 1972 and the urban area or area under construction was observed to be 226.9 km^2. For the year 2009, it was observed that the vegetation cover was had an area of 3418.47 km^2 and the urban area covered 648.51 km^2.

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CONCLUSION

From the present study, it is revealed that the natural resource has greatly declined over the period of 37 years due to the urbanization activities. This value exceeds the naturally estimated decline for the same region. Hence conservation measures have to be adopted for the optimal utilization of these resources without compromising the economic benefits and sustainability of these resources.

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