Land Use/Land Cover Change Detection of Wellington Tank Irrigation Watershed of Tittagudi Taluk, Tamilnadu, India.

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Abstract:

This study reveals to identify the changes of Land Use / Land Cover (LU/LC) of rural agricultural watershed of Tamilnadu mapping serve as a basic inventory of land resources throughout the world. The development activities, dynamic usage of land, increasing growth of population and varying occupation pattern of the society has resulted in reduction of land devoted to agricultural activities. This study attempted to expose the impact of changes in land use/land cover of Wellington watershed of Vellar River basin, Tittagudi Taluk, Cuddalore District, Tamil Nadu. The relationship between Land Use Changes and its trend is analysed using IRS IC LISS III data to know the past land use pattern. Similarly, the LU/LC map of various years, namely, 1998, 2003 and 2007, which was obtained from Institute of Remote Sensing, Anna University (IRS) and digitized using Arc GIS 9.1 and Mapinfo 8.5 software. The agricultural practices under agricultural land and cropland has most important crash over the hydrogeological process of watershed. About 85.04 per cent of land is devoted to agricultural practices in the study area. The basic reason for rapid LU/LC changes in the study area are due to conversion of paddy fields, under-utilization of potential croplands, increasing population and finally lack of guidance to the farmers has lead to land management.

Key words: Wellington Tank irrigation watershed, Land Use / Land Cover Change, Land management, Remote sensing and GIS

Introduction

The knowledge of spatial land cover information is essential for proper management, planning and monitoring of natural resources (Zhu 1997) and considered as essential element for modeling and understanding the earth as a system. Land cover maps have presently developed from local to national to global scales. The use of panchromatic, medium-scale aerial photographs to map land use has been as accepted practice since the 1940s. More recently, small-scale aerial photographs and satellite images have utilized for land use/land cover mapping (Thomas et al 2004). Land-use information, coupled with the hydrologic characteristics of soils on the land surface, can also provide measures of expected percolation and water holding capacity (Nagarajan and Poongothai 2011). It is a desired input for many agricultural, geological, hydrological and ecological models. In addition, any natural hazard study such as landslide hazard zonation (Gupta et al 1999; Saha et al 2002) highly depends on the availability of accurate and up-to-date land cover information. Due to synoptic view, map like format and repetitive coverage, satellite remote sensing imagery is a viable source of gathering quality of land cover information at local, regional and global scales (Csaplovics 1998; Foody 2002). In other words, the remote sensing satellite data in multi-resolution and multi-spectral means to provide spatial information for land cover / land use at different levels for various aspects as built-up land, agricultural land, forests, wastelands and water bodies etc. So, the land cover / land use maps prepared using multi-date and multi-spectral data provides different levels of spatial information which are used in change detection studies (Burrough 1996). Land use of an area is a resultant of human controls over the land resources in relatively systematic manner (Vink 1975). The land an important resource, it only determines the rate of development of man's economic and social activities (Rayamane 2001). The 'land cover describes the physical appearance of the earth's surface, while land use is a land right related category of economically using the land' (Konecny 2003). Techniques and methods of using satellite imageries as data sources have been developed and successfully applied for land use classification and change detection in various environments including rural, urban and urban fringe areas Shepard 1964; Robinove et al 1981; Jensen and Toll 1982; Fung 1990-13).The high growth of population, climate change and overconsumption of ecosystem services emerges to be the greatest threat and tends to the biggest challenge for the society (Sachs et al 2009). Land is an area of the earth's surface, human interference and interaction with this natural environment result in land use. The equilibrium of nature was maintained, by maintaining all types of land such as forestland, wetland, wasteland, cultivable land, etc. in a balanced way. The in-depth knowledge gained through the categorization and case studies of land use change will become handy in developing regional and global LULCC models. The amount of expected runoff from vegetated land-use types, such as forest, which are not affected by the surface and soil physical properties, but by the uptake capacity of the vegetation present (Lynn E. Johnson 2009). Thus, the knowledge of both land use and land cover can be important for land planning and land management activities. The USGS devised a land use and land cover classification system for use with remote sensor data in the mid-1970s (Anderson et al 1976). The basic concepts and structure of this system are still valid today. Land use and land cover change (LULCC), associated with climate changes have became a focus of the study on the interactions between human activities and natural environment. Land cover changes can observe as one of the most sensitive indicators that come back these interactions (Zhou et al 2008.) The impact of changing land uses relies on the prevailing surface and subsurface hydrologic conditions. Within a basin, the dynamics of hydrologic processes governed partially by the temporal and spatial characteristics of inputs and outputs and the land use conditions (Shih 1996). Often it is forests, which are at risk in the process of LULCC (Munsi et al 2010). The synoptic view of the area allows better monitoring capability, especially when the coverage is repetitive, interval is short and resolution of the image is high. Remote sensing can be a good tool for getting wide impression on land cover change. Change detection on land cover focuses mainly on four aspects, (1) detecting if a change has occurred, (2) identifying the nature of the change, (3) measuring the area extent of the change, and (4) assessing the spatial pattern of the change (MacLeod et al 1998).Many remote sensing change detection methods has been developed to monitor land cover change and to build spatio-temporal patterns of change, in order to derive better understanding of causes and consequences of the change, and to model the tendency of the change. In general, remote sensing change detection method can be dividing into two broad classes, termed as bi-temporal change detection and temporal trajectory analysis (Coppin et al 2004). However, to understand causes of land cover change, study often focuses on the metrics (Crews-Meyer 2004; Crews-Meyer 2006) of land cover types that form a part of input parameters together with other environmental or human factors.

Objectives of the study

The present study includes preparation of LULCC during the last few decades, understanding the influences of human interventions in the basin and formulating comprehensive and effective mitigation strategies for land conservation in the study area using Remote Sensing and GIS,

1. To identify the nature and extent of Land Use/Land Cover Changes for the past 10 years,
2. To identify the major components that promotes in land uses (1998 – 2007).

To analyse the nature and extent of Land Use/Land Cover Changes of the study area in the past 9 years (1998-2007). To identify the major components that promotes for trend in land uses (1998-2007).

Study area

Wellington Reservoir is situated (Figure 1) in Tittagudi Taluk of Cuddalore District at a distance of 240 Km in the South West of Madras and it is covered by 495.3 Sq.km. The Reservoir is located in Vellar Basin across a tributary stream Periya Odai of Vellar River. It receives Regulated Supply diverted from Vellar River at Tholdur Regulator and an additional catchment area of 129 Sq. Km., of its own during North East Monsoon. The Reservoir was constructed during 1913-1923 and irrigates an ayacut of 11,200 Hectare. The Reservoir was formed with available earth at site which was not suitable for the formation of Reservoir such formation with nonsuitable soil leads lot of problems such as slips etc year by year.

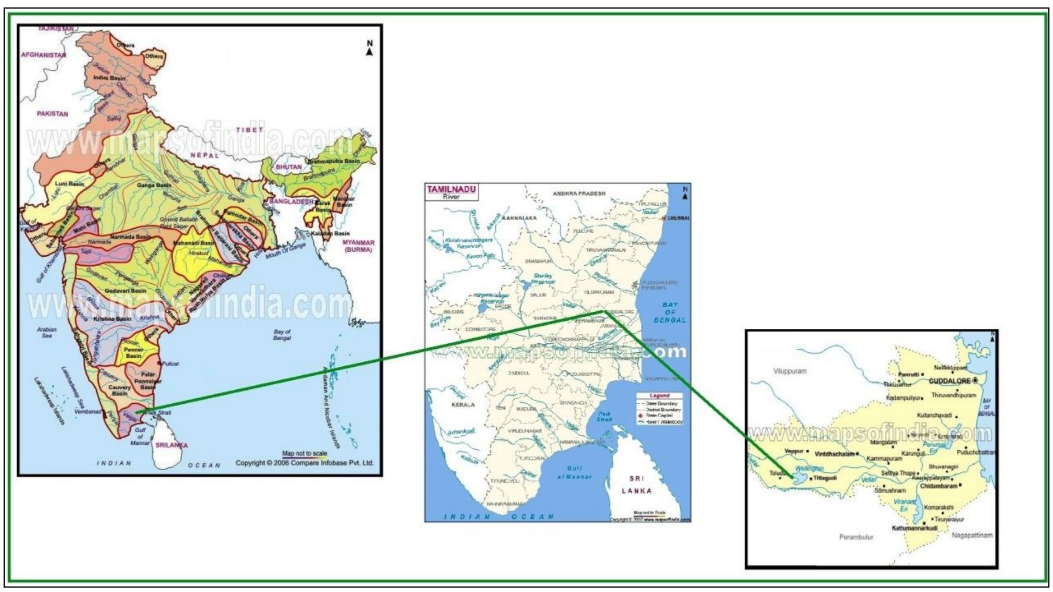

Fig.1.Location map of the study area

Soils

The soils of the district are classified as the black, red, ferruginous and arenacious. They are again subdivided into clays, loam and sands. Black soils are observed in the chidambaram and Vriddhachalam taluks. They sandy soils are seen along the coast in Cuddalore and Chidambaram taluks. The younger alluvial soils are found as small patches along the stream and river courses in the district. Red sandy soil is seen covering the Cuddalore sandstone, laterite and lateritic gravels occur in parts of Vriddhachalam, Panruti and Cuddalore taluks. The entire wellington Reservoir can be covered by Western pediplains

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of entire area covered by Mangalur and Nallur blocks. This area is occupied by denudational landforms like shallow buried pediment, deep buried pediment and pediments.

Materials and Methods

Survey of India (SOI) topographic maps (58 M/2, 58 M/6, 58 M/7 and 58 M/10) on a scale of 1:50,000, IRS-IC-LISS III data acquired on May 5, 1998, IRS-IC-LISS-III and LISS, PAN merged data acquired for the year 2003 and 2007 were used for land use classification. Base maps including road, railway, settlement, village location and watershed boundary extracted from the topographic sheets and converted into GIS database and further the modifications in the LULC map updated by cross correlating with Remote Sensing Imageries. The image elements correlated with ground truth verification and tonal variation representing the different classes was marked on the hard copy image 1998 (Figure 2), 2003(Figure 3), and 2007 (Figure 4). The functionalities of GIS namely, Overlay analysis was applied to identify the areas of changes taken place.

Land use/ land cover mapping:

The major common Land Use categories such as agriculture, river bed, water, urban, fallow, wasteland identified and mapped from the SOI topographic sheets. The land use of the year 1998 was mapped, classified and calculated accurately from the toposheets, it was compared with those prepared from the satellite imageries (IRS 1C LISS III) and IRS Pan merged data. The IRS 1C LISS III data used as the source for the land use/land cover mapping. The registration and digitization of the watershed was done using mapinfo 8.5 Software to create land use coverage. Six land use categories i.e. agriculture, urban, fallow, water; river bed and wasteland are identified. Land use/Land cover map of 1998 was prepared from toposheets while those of 1998, 2003 and 2007 were prepared from the satellite imageries based on ground observations.

Results and Discussion

The Change Detection of Land use/ Land cover of the study area (1998 - 2007) and its areal extent were given in Table 1. The total study area is 495.3 sq.km. The most salient change in land use has been the quick augment in area under agricultural land, Cropland from 77.06 % in 1998 to 85.09 % of the total area in 2007, with a related increase in agricultural plantation from 1.68 % of the area in 2003 to now 4.4 % in 2007. There was small increase in built-up land and mining area from 37.69% in 1998 to 3.03 % in 2007 and Canal fully abolished because increasing of population, Agri fallow, plantation and build up Land, possibly due to improve forestland for dense and degraded forest. There was little change in the wasteland such as upland with or without scrub and salt affected land from 1998 to 2007.The waste land was 2.96 % in 1998, 2.89 % in 2003 and 1.74 % in 2007 and the Cropland was 77.06% in 1998, 79.81% in 2003 and 85.09 % in 2007. The geographical conditions of the study area in the district are quite suitable for paddy and sugarcane cultivation. The land use/ land cover changes for the year 1998 to 2007 are shown in Figure 2, 3 and 4. The conversion of fallow/harvested lands, which are reducing for excess water, to other purposes increases the flood hazard. Because of the reduction in water holding areas (wetlands), the wellington reservoir is also facing the threat of drought. Thus, management of land, especially the conversion of paddy fields in to building sites/other crops, under-utilization of potential croplands.

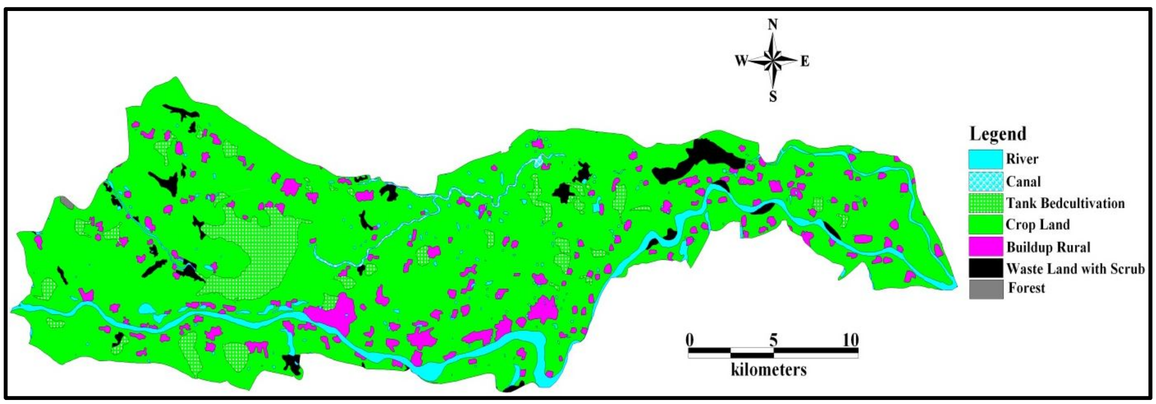

Fig 2.Land Use Map (1998)

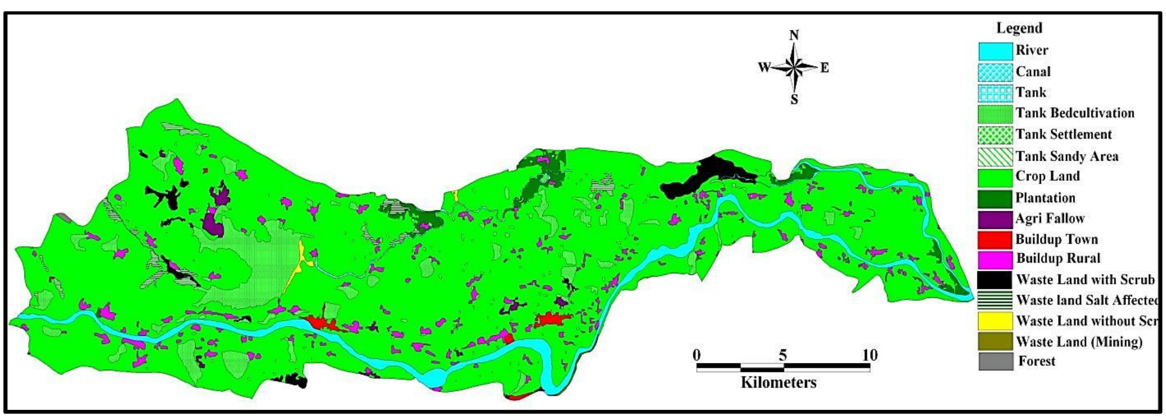

Fig 3.Land Use Map (2003)

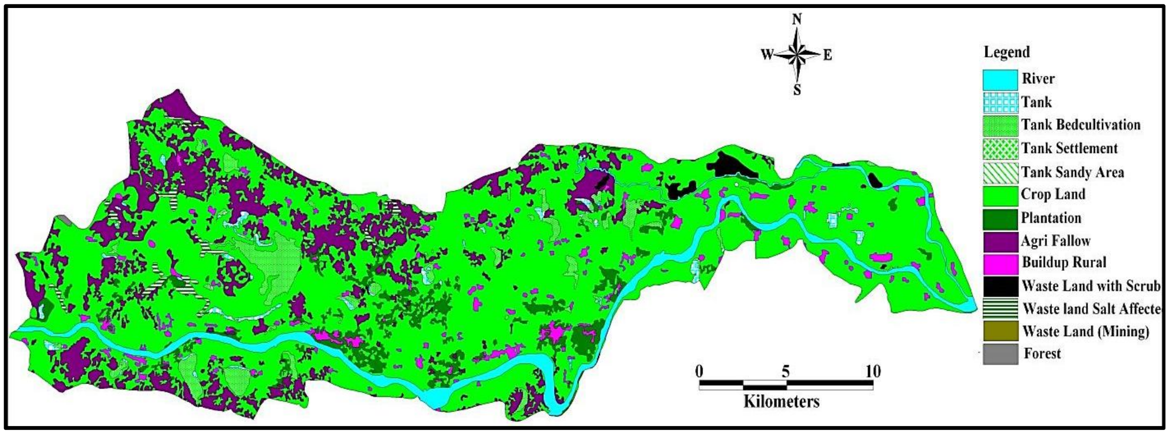

Fig 4.Land Use Map (2007)

Table 1: Change Detection of Land use/ Land cover of the study area (1998 - 2007)

S. No	**Level**	**1998 (SOI, Topo)**		**2003(IRS-1C) LISS III)**		**2007 (IRS-1C, LISS III)**	
		Area (Sq.Km)	% Area (Sq.Km)	Area (Sq.Km)	% Area (Sq.Km)	Area (Sq.Km)	% Area (Sq.Km)
1	Forest Land	0.31	0.07	0.23	0.05	0.24	0.05
2	Waste Land	14.68	2.96	14.32	2.89	8.63	1.74
3	Water Bodies River	23.54	4.75	25.23	5.09	26.71	5.39
	Canal	2.71	0.55	1.36	0.27	0.23	0.05
4	Agricultural Land	381.7	77.06	395.43	79.81	421.43	85.04
5	Tank Bedcultivation	34.67	7.0	37.73	7.62	23.29	4.70
6	Buildup Land	37.69	7.61	21.00	4.23	15.00	3.03
	Total	495.3	100	495.3	100	495.53	100

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Fig.4 Different views of the Wellington Reservoir

Conclusions

Consideration of the existing socio-economic scenario is necessary before implementing any sort of land use practices in the study area in future. It is expected that the findings of the investigation will undoubtedly be of use to planners and local bodies to implement suitable land use plans in the watershed, thereby achieving eco-preservation and enabling the restoration of degraded land units to the maximum possible extent. Local people must be made aware of the consequences of conversion of paddy fields. Land and water management activities must be conducted only after detailed land use planning, sand mining from rivers should be regulated and further expansion of agricultural.

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