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A SPATIO-TEMPORAL LAND USE CHANGE ANALYSIS OF WAGHODIA TALUKA USING RS AND GIS

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Abstract- The land use/land cover pattern of a region is an outcome of an interaction of natural, social and economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to agricultural and demographic pressure. Hence, information on land use/land cover and potential for their best possible use is necessary for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. Satellite Remote Sensing plays an important role in generating information about the latest land use-land cover pattern in its spatial and temporal changes. The information being in digital form can be integrated into Geographical Information System (GIS) to provide a suitable platform for data analysis, update and retrieval.
The present study highlights a coordinated significance of Remote Sensing and GIS techniques in detecting land use changes in Waghodia taluka. Also statistical analysis on Land Consumption Rate and Land Absorption Coefficient is computed.
Key words- Land use change, Spatio-temporal, RS, GIS, Land Consumption Rate, Land Absorption Coefficient

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Introduction

Land use refers to the ways in which, and the purpose for which, human beings employ land and its resources [1]. (Analysis of Land Use Change: Theoretical and Modeling Approaches. Regional Research Institute. West Virginia University, USA,)"Timely and accurate change detection of Earth's surface features provides the foundation for better understanding relationships and interactions between human and natural phenomena to better manage and use resources" [2]. Land use and land cover are two separate terminologies which are often used interchangeably [3].
Change detection in land use and land cover can be performed on a temporal scale such as a decade to assess landscape change caused due to anthropogenic activities on the land [4].These anthropogenic activities on land are as a result of rapid urbanisation and industrialisation. Land use and land cover change have been recognised as important drivers of global environment change [5]. Thus land use change have a critical impact on the environment.
The changes quantified using remote sensing technologies provide observations which may also show adverse negative impacts, hence are essential for sustainable land management policies and practice. Temporal change map and data base provides the base line information for the planner and decision-makers to monitor and predict the patterns and future trends of urbanization.
Remote sensing and Geographic Information Science (GIS) technologies have been utilised effectively to detect and quantify changes in the landscape and the significant impacts of such changes. The technologies of Geographical Information Systems (GIS) and Remote Sensing have beencombined to detect and control urban encroachment in a way which is easier and faster then the traditional methods of surveying the urban environment [6]. The spatial, temporal and spectral characteristics of the remote sensing data are effectively used in land use and land cover change mapping, hence helping in decision making for sustainable land resource management [7].

Study area

Waghodia Taluka is located in Vadodara district. Geographically the area lies between 73°17' to 73°33'E longitude and 22°12'to

22°21'N latitude. The total geographical area of the Taluka is 585.12km 2 with a population 1, 33,240 (Census of India 2001).There are 96 villages with one town Waghodia, which is Taluka head quarter.

The development of the industrial estate in Waghodia by the Gujarat Industrial Development Corporation has facilitated the industrial expansion in this area. A number of private concerns are also located in this taluka. SEZ is also identified in taluka. Thus, Waghodia taluka has witnessed remarkable extension, growth and developmental activities. The result is increased land consumption and a modification and alterations in the status of land use land cover over time. Land Use over the study area has been analyzed for the time periods of 1972-2000.

Objective

The specific objectives are:

1. To quantify the type and degree of Land cover and Land use Change.
2. To generate data on land consumption rate and land absorption coefficient.

Methodology and data set

Land use change is detected by using Landsat data for the years between 1972, 1990 and 2000.The ancillary data used for the study includes topographic maps, and the software used were ERDAS IMAGINE and ArcGIS. To fulfill the objectives the methods adopted are shown in Figure 1. Changes in land use pattern were studied based on comparison of the time series data. Visual interpretation technique was used for land use/land cover mapping for three time period from the remote sensing data of the study area. The land use/land cover maps of said period were integrated into GIS. The increase or decrease in different land use/land cover was thus obtained. Calculation of the Area in sq/kms of the resulting land use/land cover types has been done for each study year and subsequently comparing the results. The results have been presented in tables, graphs and maps. The land consumption rate and absorption co efficient is also calculated.

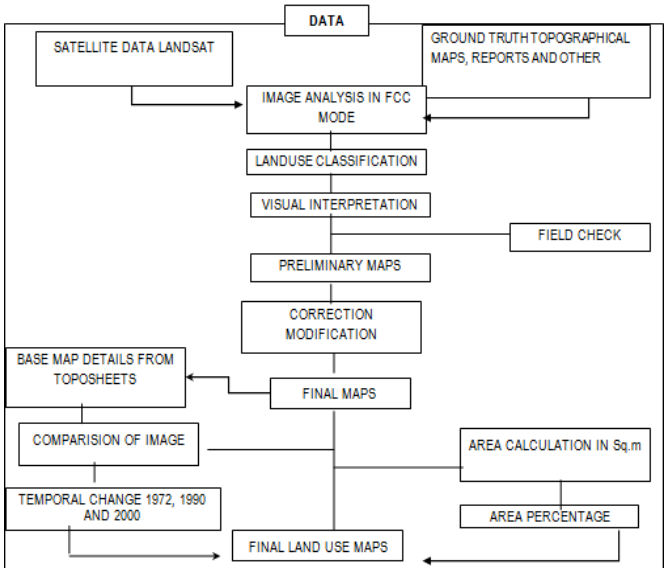

Fig. 1- The results are presented in form of maps, charts and statistical tables

The Land consumption rate,

$$L.A.C. = \frac{A2 - A1}{P2 - P1}$$

A1 and A2 are the areal extents for the early and later years and P1 and P2 are population figure for the early and later years espectively [8]

The Land absorption coefficient formula

$$L.C.R = \frac{A}{P} = \frac{A = \text{areal extent of the city in meters}}{P = \text{population}}$$

L.C.R = A measure of compactness of an area which is indicating a progressive spatial expansion of that city.

L.A.C = A measure of change in consumption of new urban land by each unit increase in urban population [9].

Analysis and results

Land use and land cover classification statistics obtained are presented in Tables 2, 3 and 4 for years 1972, 1990, 2000 respectively and the change detection maps are presented as Fig. 2,3, and 4 for three time period.

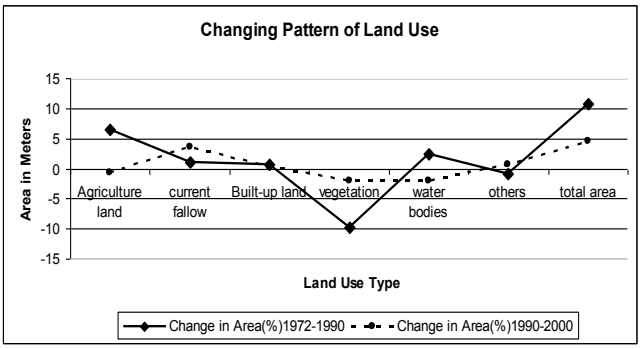

Fig. 2- Change in Land use (1972-2000)

Table 1- Land Use/Land Cover Changes (1972-1990)

Land use Category	Area In Meters (1972)	Area In Meters (1990)	Area In Meters (2000)
Agriculture Land	422402310 (75.48%)	458829920.5 (81.99%)	455146744.9 (81.33%)
Current Fallow	35785327.23 (6.39%)	41555111.8 (7.43%)	61122837.78 (10.92%)
Build-up Land	1196751 (0.21%)	5351178 (0.96%)	7529650 (1.35%)
Vegetation	76836323.35 (13.73%)	21767370.4 (3.89%)	10383508.19 (1.86%)
Water Bodies	14762372.95 (2.64%)	28102231.16 (5.02%)	17238555.18 (3.08%)
Others	8637879 (1.54%)	4015069 (0.72%)	8199493.49 (1.47%)
Total Area	559620963.5 (100)	559620880.9 (100)	559620789.5(100)

As observed the area under agriculture has increased by 6.51% with 2% increase in water bodies and slight increase in current fallow and built up land. But there is significant decrease in vegetation which have reduced by 9.84%. This is the reflection of bringing vegetated area under agriculture. The increasing population pressure is also a major contributing factor to the observed classification and its change. (Table 2), Fig 5.

In 1990 to 2000 where agricultural land decreased by 0.66%, Vegetation decreased by further 2.03% and water bodies by 1.94% were transform into current fellow (with increase of 3.49%) and build up land by 0.38%. The decrease in vegetation and increased

current fallow is a matter of serious consideration.
Land consumption rate which is a measure of compactness which indicates a progressive spatial expansion of a city was high in 1972 to 1990 (0.42% decadal increased) but growth rate is increased during 1990-2000 (0.38% decadal increased. (Table3)
Land absorption coefficient being a measure of consumption of new urban land by each unit increase in urban population which was high between 1972 -1990, reduced during 1990-2000. The population growth and expansion of area is not at the same rate. This also shows that the new area would be required to meet the demand and need of population pressure in this area. Looking at this it is necessary to have planned growth to avoid the haphazard expansion

Table 2- Analysis of Land Use/Land Cover Changes in (%) (1972-2000)

	Change in Area (%) 1972-1990		Change in Area (%) 1990-2000	
Land use Type	Increase Area	Decrease Area	Increase Area	Decrease Area
Agriculture Land	6.51%	-	-	0.66%
Current Fallow	1.04%	-	3.49%	-
Built-up Land	0.75%	-	0.38%	-
Vegetation	-	9.84%	-	2.03%
Water Bodies	2.38%	-	-	1.94%
Others	-	0.83%	0.76%	
Total Area	10.67	10.67	4.63	4.63

Table 3- Land Consumption Rate and Absorption Coefficient Ratio

Years	Population	Land Consumption Rate	Year	Land Absorption Coefficient
1972(1971)	89269	0.015	1972-1990	0.114
1990(1991)	115543	0.047	1990-2000	0.066
2000(2001)	132279	0.052		

Conclusion

Satellite Remote Sensing has proved to be a vital tool for continuous observation and quantification across varied spatial and temporal scales which are otherwise not possible to attempt through traditional mapping techniques. Un-planned decisions may result into misery for large segment of the local population and destruction of valuable eco-system. Techniques for the planning and management of land resources specifically integrated and holistic will check long term quality of the land for human use, their prevention or resolution of social conflicts related to land use, and the conversion of ecosystem. Thus it is, essential to review the conventional planning methods and introduce innovative measures like geo- referencing technologies in this regard.

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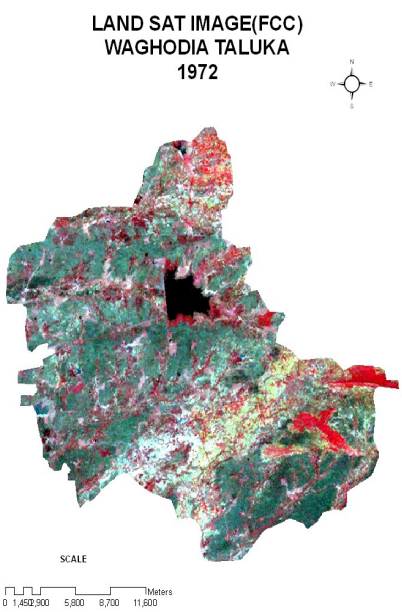

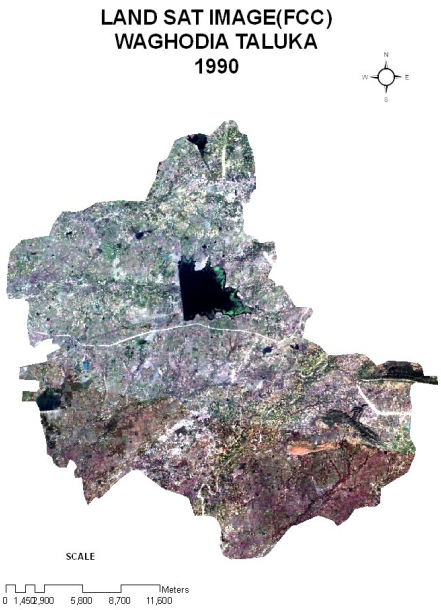

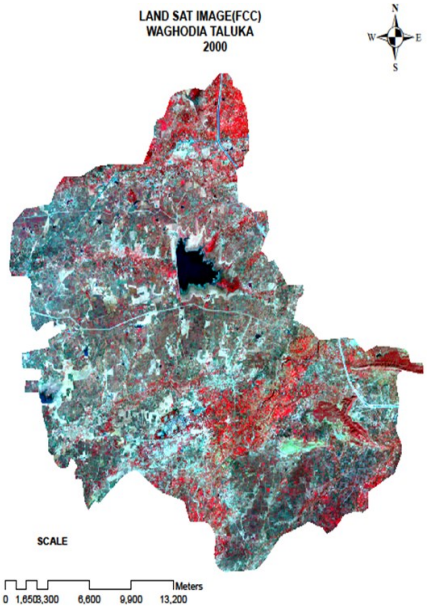

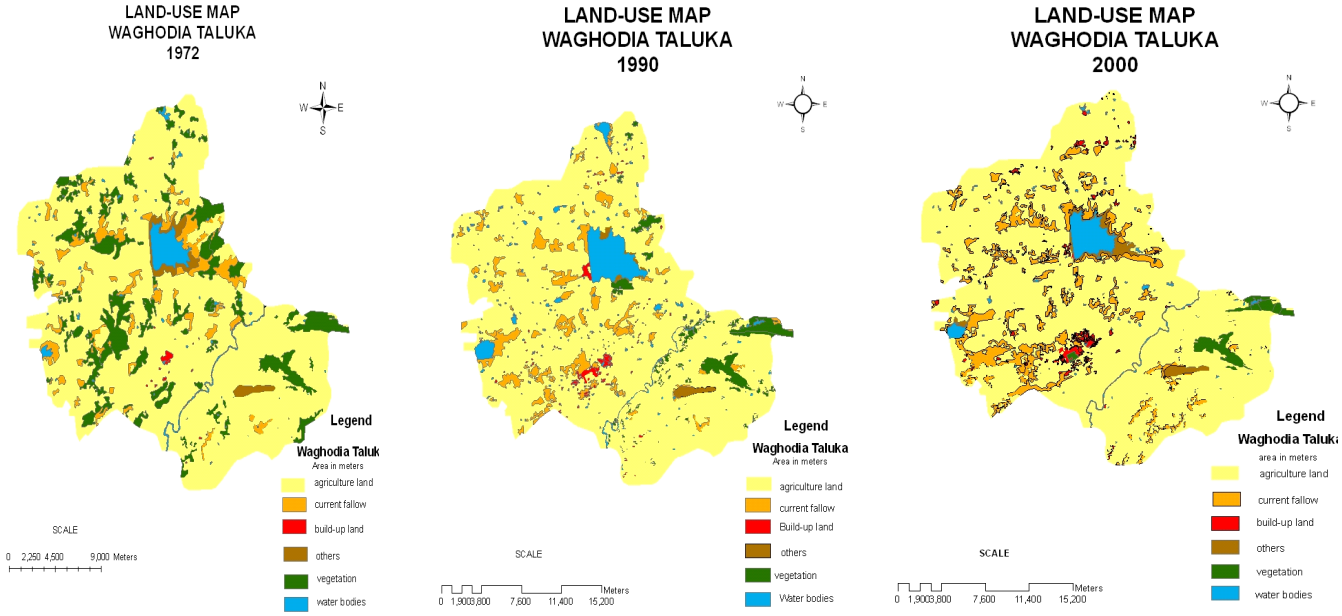

Fig. 3- Change detection maps (1972-2000)