

Land Use Changes in Kalmunai Municipal Council (KMC), Sri Lanka

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Abstract

Kalmunai Municipal Council (KMC) is on the eastern coastal fringe in Ampara District, boarding the on the east of Indian Ocean, on the north of the Batticaloa District, on the south of the Karaitivu Divisional Secretariat Division (DSD) and Sammanthurai, on the west of Navithanveli DSDs. According to the Resource Profile Report 2007, the total population of KMC is 97,402. It is predominantly a Muslim area because they form 71.93 percent of total population, whereas the Tamils form 27.16 percent and other communities form 0.91 percent of the total population in KMC. The total land area of the KMC is 22.68 square kilometre (sq. km). Geographically; it is located at an elevation of about 9 meters above mean sea level. The KMC consists of 75 Grama Niladhri Divisions (GND). The population density of the KMC is 4,294 sq. km. It is characterized by an agricultural economy from ancient time. The informal sector plays a dominant role; because underemployment and non-paid employment are common. Population growth and modern socio-economic developments have shown heavy impacts on the land use patterns of the area. The object of this study is to examine and asses the changes in the land use patterns from 1981 to 2006. Data were collected from primary and secondary sources and analysed by using statistical software and images were analysed by ERDAS Image software and mapped using ArcGIS. The main land use patterns in KMC are agricultural (for example, paddy coconut, other field crops and horticulture), Ocean and inland fisheries, livestock rearing, trade and business, micro-industries, small and medium industries based on local raw materials. The tsunami of 2004 has adversely affected the economic prospects, land use patterns of the area and the land use structure of the KMC is well-endowed with built-up area, paddy fields, coconut plantations, inland water bodies, wetlands and beaches.

Key words: *Land Use pattern, Agricultural, Population growth, Paddy field, Wetlands*

Introduction

Land is a natural resource that get primary importance in the economy of any country and agricultural resources have remained the principal occupation of humans since their hoary past. In the early days, population was small and necessities were correspondingly limited. With an enormous increase in human population, the increase of their requirements become complex. To fulfil the increasing human demands, he has learnt to make the use of arid and semi-arid lands for his own

advantage by applying improved methodology and modern technology. Each stage of change due to such application has accompanied by many might problem paving the path towards uneven use of the land to have any harmony with the involving structure of man's life and economy. As a consequence of increasing pressure of population and changes are taking place in the land use and farming patterns. Owing to the increasing pressure of human population as well as livestock farming on the land, ever-

growing demand for food and raw materials, rational and economic use of every piece of land, without disturbing the economic as well as socio-economic balance of the area (Mohammed, 1981).

In the urban areas, the problems related to the rapid transformation that are taking place in term of the land cover and land use are now very much pronounced (Okunuki, 2001). Urbanization has often been viewed as a sign of the vitality of the regional economy; however, the urbanization had greatly accelerated the environmental pressure on the ecosystems, thus placing enormous burden on responsibility of organization for the planning and management of urban areas authority (Herald *et al.*, 2003).

Earth observation techniques widely known as remote sensing technique (image analysis) have already shown their value of mapping urban areas and as a data sources for the analysis, modelling of urban growth and land use changes (Jensen & Cowen, 1999). Remote sensing provides especially consistent data set of cover of large areas with both high special details high temporal frequency (Herald *et al.*, 2002).

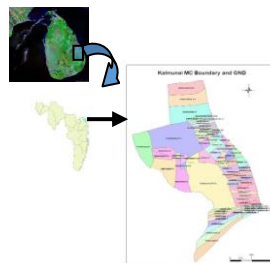
It is observed fact that the land cover classes of the Kalmunai MC have undergone extreme changes in the recent past. As such, the need of the estimate extent and change dynamics of each land cover class in this area is essential to enable the proper

management strategy that is necessary to ensure effective planning for sustainable development. The principal aim of this research is to assess the present special extent of each land cover classes (e.g. reduction of paddy and wetland due to anthropogenic).

In order to achieve this aim, the objective of study is mapping out of present and past land use patterns of KMC area and to compare them with past and present and to assess the patterns of changes in the land class cover. It has grown up to be urban town in the south-east region with it slim of its municipality.

KMC is situated in the eastern part of Sri Lanka laying longitude of $7^{\circ} 25' 24''$ to $7^{\circ} 27' 25''$ and on the east latitude $81^{\circ} 45' 31''$ to $81^{\circ} 50' 32''$ that on the coastal belt of Bengal in the south eastern coastal region (Figure 1). It is residential, commercial, agricultural and fisheries area from the pre-set of land use. The study area is bounded by Batticaloa District (North) and Karaitivu Divisional Secretariat and Sammanthurai (South) and Navithenvely Divisional Secretariat (West).

Figure 1: Location of Study Area



(Source: Retrieved on Arc GIS, 2015)

According to the Census and Statistics Department, the general profile of the study area shows that the population in 1981 was 65,803; 2006 was 97,024 and annual growth was 2.1 percent in 2006 as well as population density was 4,277 per sq.km.

Research Methodology

The research is design in the logic that connects the empirical data to the initial research questions and ultimately to its conclusion (Yin, 1994). This study explains the importance of methodologies and how researchers in the past used different kinds of methods and techniques in the pursuit of knowledge. In many researches, there have been quantitative and qualitative methods in order to get all the necessary data from various sources. It is to be noted that a combination of methodology is necessary when doing research in developing countries where availability, validity and reliability of the latest data is always in question. Therefore, we have used various tools to collect and interpret the data.

Field Reconnaissance

A discussion was held with the Divisional Secretaries of the KMC. It was followed by interviews with senior and frontline officials at the office. The interviews were held on a general nature and it aimed at obtaining information on the land use and settlement. Further, a preliminary assessment of the loss of both physical

and social infrastructures due to the tsunami disaster and the regional effect of such losses was also undertaken. The interviews also enabled the researchers to apprise the officials of the objectives of the study and to solicit their cooperation for their execution.

Data collection and Processing

In the matter of collection of necessary information and data for the study, the researcher had to focus on both qualitative and quantitative data from both primary and secondary sources.

Quantitative Research Methodology

Quantitative Research Methodology usually deals with a variety of variables and statistic. The principal aim of quantitative methodology is to prove certain hypotheses or theories by treating and interpreting the collected data with statistical concepts.

Qualitative Research Methodology

Exploratory studies generally seek to understand a certain phenomenon. It can be done through inductive methodology which generally advocates quantitative methodology and technique. Qualitative researchers deploy a variety of interconnected methodologies to bring their data out in the process of research to attain the aim. Qualitative researchers see to problems on a wide scale. They normally search for patterns (similarity and differences) and relationships in a particular phenomenon for comparative study.

Primary Data Collection

The primary data were collected through questionnaires as well as by personal observations, by interviewing dealers and old local inhabitants. The primary data used in the study was thus taken from a social survey of households using a questionnaire. The data were generated from 3 Divisional Secretariats namely Kalmunai MD, Kalmunai TD and Sainthamaruthu, 260 samples randomly selected from 11 villages. The minimum and the sample size of each village was 20. Data collection from those sample households through questionnaire were analysed to look into land use changes.

Secondary Data

The secondary data were collected from the published and unpublished sources. Published sources are listed in the bibliography. The basic mappings of geology, physiography and land use were carried out from the sources available at the Survey Department, Colombo, Sri Lanka from which the village information on land use population and occupational structures.

Data analysis

The urban growth KMC from 1981 to 2001 was analysed with equal intervals (1981, 1991, 2001 and also in 2006). The selection of time series was strictly due to the availability of both spatial and non-spatial data, especially, questionnaire data collection from one

percent of the households, orthophotos and satellite image.

The primary data used in the study was Landsat ETM+ image acquired in the 2001 and 2006. Site observation was done using 1:50,000 scale topographic maps and demarcation plots as also geo-rectification of satellite images was carried out with the differential Global Position Systems (GPS). Acquired satellite images geometrically rectified into UTM (Universal Transverse Mercator) projection and datum WGS84 using ground control points observing through GPS together with 1:50,000 scale topographic maps. ArcGIS and ERDAS Imagine were used to perform classification of the land use and GIS analysis.

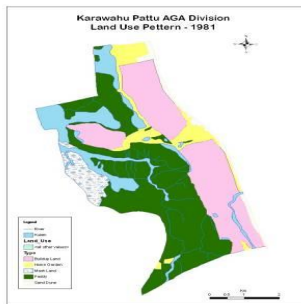
Land Use Changes in KMC

Land use patterns in KMC can be categorized into built-up area, wetland, agriculture (paddy, coconut and other crops), and marshy land. At present, KMC faces the threat of the land and environmental degradation due to the unplanned urban system. Due to the influence of various factors of many origins, land cover has undergone dynamic changes (for example, creating heat island).

The land use classification shown in Table 1 was selected as the basis for the analysis here. All land use types were divided into 3 groups: Urban, Agricultural and other. The amalgamated area covers the following types: Residential, Industrial, Institutional, Recreational,

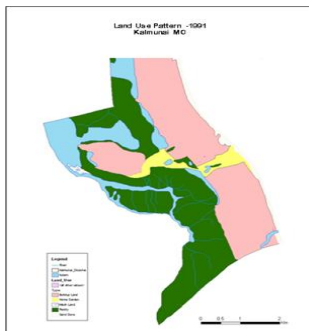
Transportation and undeveloped. After selecting proper classification system, the area encompassed (in km²) by each land use type for all years (1981, 1991, 2001 and 2006) were computed. Total urban cover for each year was calculated by total area including by all urban land use types (Table 2). The urban growth rate and land use changes were computed for the selected time periods (from 1981 to 1991 and from 2001 to 2006). Subsequently, urban maps were drawn for each year and visual assessment as made to analysed the spatial patterns of urban growth as experienced from 1981 to 2006 (Figures 01 to 04).

Figure 2: Deviation of Land Use – 1981



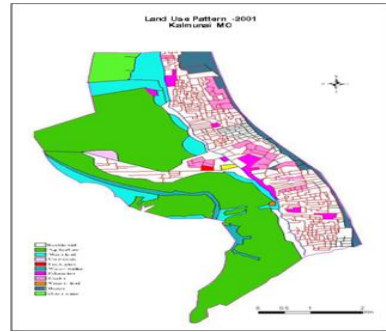
(Source: Retrieved on GIS, 2015)

Figure 3: Deviation of Land Use – 1991



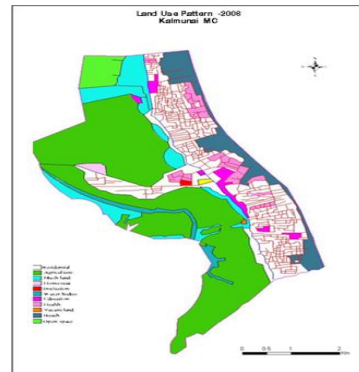
(Source: Retrieved on GIS, 2015)

Figure 4: Deviation of Land Use – 2001



(Source: Retrieved on GIS, 2015)

Figure 5: Deviation of Land Use – 2006



(Source: Retrieved on GIS, 2015)

Results and Discussion

The results of change detection clearly demonstrate that the total urban use pattern has increased approximately from 5.62 km² in 1981 to 9.62 km² with an annual growth rate of 5% in addition to the overall urban growth, which has taken place during the 25 years from 1981 to 2006. The total urban cover has increased within the time spans from 1981 to 1991, from 1991 to 2001 and from 2001 to 2006, during this period the extent of human

influence also gradually increased (10.64 km²). There is significant reduction in the agricultural land and wetland that have been identified as paddy land in this study. The result shows that the trend of land use changes is not favourable for the MC as it is moving towards a more human influenced environment. The consequence of these changes could be helpful to identify uneven and unapproved human activities that disturb natural land cover. The reduction of the paddy lands and area and increased human settlements with adverse consequences on the unbalanced environment and food security in the MC are due to a rapid increase of industrial land use.

Most land use patterns have experienced extensions at different rate; through both non-built-up and the beach have refused these, the category beach declared a remarkable decline by recording 0.78 km² in 1981 and 0.42 km² in 2001. The urban expansion has taken place in an iso-tropical manner. However, it is remarkable that expansion has significantly spread along the coast without leaving enough set back zone from the coast. This fact raises some vital question such as “Would we able to reduce deaths and property damages from 2004 tsunami disaster. So, we have to take necessary action to control urban extension along the coast with an adequate set back area, which is important.

The special features noted are some of the lowlands stagnated with water from

rainfall and getting filled with human activities leaving no lowlands for holding flood waters to prevent flooding during the rainy seasons.

Conclusion

The area of human influence has drastically increased during the study period in KMC. Reductions of paddy land and wetland cover have also taken place during the period of study. The trend of the change shows that the MC is getting transformed from natural environment to man-made environment.

Since 1981, immediately after becoming a municipal town, the KMC practicing urban expansion spites the server damage by the tsunami disaster in 2004; unplanned urban expansion would cause adverse consequence on both human and natural environments. Urban growth modelling is a typically multi-disciplinary endeavour, requiring many types of data with spatial and temporal attributes that should be made accessible to local authorities in the right format for decision-making and planning.

The medium resolution Landsat satellite data helps us to identify general land use changes in the study area effectively. Ground truth information together with statistical records, information from local knowledge base and an analysis of a comprehensive time series of satellite data will assist a much clear understanding of the land use and

dynamic nature of the area. It will be helpful to develop management plans to identify areas for development in the future.

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Table 1: Land Use Pattern System

Urban	Agriculture	Other
Residential	Paddy	Tank
Industrial	Home garden	River
Institutional	Other crops	Beach
Recreational		Non built-up
Transportation		Marsh land

(Source: Statistical profile Ampara, 2014)

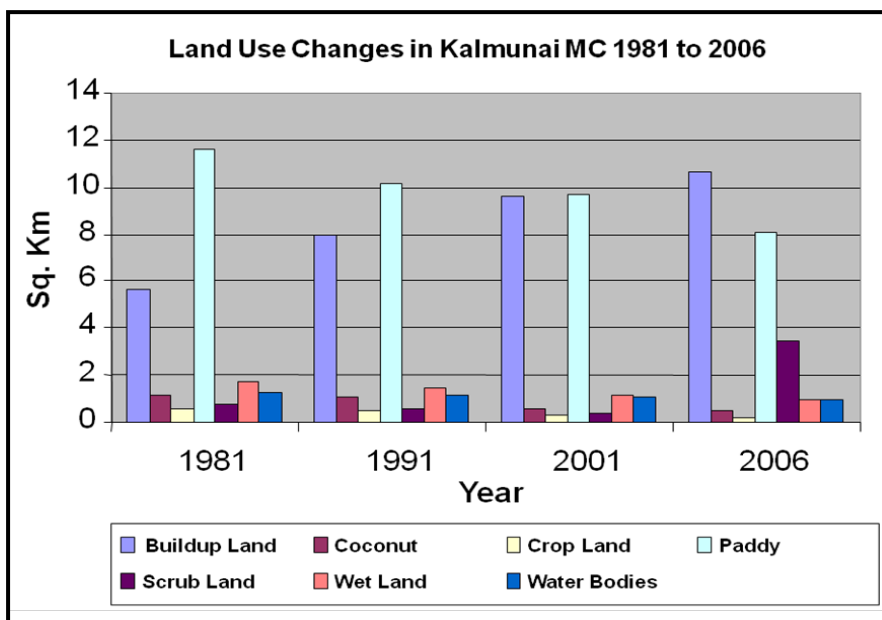
Table 2: Main Land Use Type (in sq. km)

Changes in Land Use 1981 - 2006

Kalmunai Urban

Category	1981		1991		2001		2006	
	Extent	%	Extent	%	Extent	%	Extent	%
Builtup	5.62	24.7	7.94	35.	9.62	42.4	10.64	38.
Coconut	1.13	4.98	1.07	4.7	0.60	2.65	0.48	2.1
Crop	0.55	2.43	0.45	1.9	0.24	1.06	0.16	0.7
Paddy	11.63	51.2	10.13	44.	9.65	42.5	8.02	35.
Scrub land	0.78	3.44	0.56	2.4	0.42	1.85	3.48	15.
Wet	1.74	7.67	1.41	6.2	1.14	5.03	0.98	4.3
Water	1.23	5.42	1.12	4.9	1.01	4.45	0.92	4.0
Total	22.68	100.	22.68	10	22.68	100.	22.68	10

Figure 1: Main Land Use Type (in sq. km)



(Source: Statistical profile Ampara, 2014)

Table 3: Urban Extension (in sq. km/year and Per cent/year)

Period	Built-up Area	Change		Time Span	Mean change	
	(sq. km)	(sq. km)	%	Years	sq. km/year	%/year
1981-1991	5.62 - 7.94	2.32	41.28	10	0.22	4.013
1991-2001	7.94 - 9.62	1.68	21.16	10	0.16	2.13
2001-2006	9.62 - 10.64	1.02	10.60	5	0.20	2.12

(Source: Statistical profile Ampara, 2014)