Mapping of land transformation Purba Medinipur district: using Remote sensing and GIS techniques

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Abstract

Mapping of land use / land cover (LULC) and change detection by using Remote Sensing and Geographical Information System method specially its anthropogenic relationship is an area of interest that has been attracting attention. It is an important factor for planning and managing activities concerning the use of land surface on the earth. Remote sensing techniques have improved mapping and interpretation of data as a means of understanding and effectively managing the present resources for sustainable development. This paper is an attempt to assess the changing pattern in land use / land cover in Egra-I block of Purba Medinipur district, West Bengal on during the period from 1990 to 2011 and to explore their contemporary economic significances. In the present study Landsat 4, 5 Thematic Mapper (TM) data is used. The TM sensor collects surface reflectance data in the visible and near infrared (bands 1-5, 7), and the thermal infrared (band 6) portions of the electromagnetic spectrum. Spatial resolution of the TM data is 30 meters per pixel. This study to assessed land use change with descries of the study area 1831.97 hectors (7.77%) is the surface agricultural fallow land. The results of this research are going to provide reference for trend of land use change and management in this area. Present highlights the changing pattern of land use and land cover by the remote sensing and GIS techniques in apprehending the position in the region.

Keywords: 1.Land use and land cover changes (LULCC), 2.Landsat, 3.Thematic Mapper (TM), and 4. Land Utilization, 5. ERDAS Imagine software.

Introduction

Land is important resources, as its put to divers used by man. It is three dimensional dynamic body and product of nature. The land is not only vital forces developing our civilization but it have contributed a lot betterment of our living standard. Land is one of the indicial and functional natural resources, which included extend of territory, its surface and underground resources, its mineral, soil, vegetation, forest, bio-resources etc. It is that resources which have been prove essential for development of society. This why human society could has developed upon life.[1] Global land use has significantly changed in the past decades. Historically, the driving force for most land use changes is population growth (Ramankutty et al., 2002)[2]although there are several interacting factors involved (Lambin et al., 2001, 2003)[3]. At the global and supranational scales,

population growth is often used as a proxy for land use change (Kok, 2004)[4] but at lower scales a set of complex drivers are important (Lambin et al., 2001). Land use change is mainly caused by human activities.

Objectives for land use change differ between the developed and developing countries. In developed countries, land use change is based on economic reasons such as large-scale farming or urban development and an increasing need to conserve biodiversity and environmental quality for current and future generations (Bouma et al., 1998)[5], whereas in the developing countries, rapid population growth, poverty and the economic situation are the main driving forces (Lambin et al., 2003; Meertens et al., 1996; [6]Ramankutty and Foley, 1999)[7].

The need for increased food production results, amongst others, in the conversion of forest and grassland to cropland. A region or country's ability to supply food is determined by productive cropland, the ability to maintain crop yields, or the ability to purchase imported food. Globally, cropland decreased from 0.75 ha person–1 in 1900 to 0.35 ha person–1 in 1990 (Ramankutty et al., 2002) and most of the production increases in the past decades have resulted from higher crop yields (Greenland, 1997)[8]. There are, however, large differences between different countries and regions—both in the extent that land use has changed and human population and crop yields have increased. Some areas in the world appear to be more affected by rapid land-cover change because they are studied more intensively (Lambin et al., 2003).

Remote sensing has become a significant tool appropriate to developing and understanding the global, physical processes affecting the earth [9]. Recent development in the use of satellite data is to take advantage of increasing amounts of geographical data available in conjunction with GIS to assist in interpretation[10].GIS is an integrated system of computer hardware and software capable of capturing, storing, retrieving, manipulating, analyzing, and displaying geographically referenced (spatial) information for the purpose of aiding development-oriented management and decision-making processes[11] .Remote sensing and GIS have covered wide range of applications in the fields of agriculture [12], environments [13], and integrated eco-environment assessment[14]. Several researchers have focused on LU/LC studies because of their adverse effects on ecology of the area and vegetation [15-18]. This paper is an attempt to assess the changing pattern in land use / land cover in Egra-I block of Purba Medinipur district, West Bengal on during the period from 1990 to 2011 and to explore their contemporary economic significances by the remote sensing and GIS techniques.

Study area

Egra block I of Purba Medinipur, W.B are located on latitudinal extension 21°30'25''N-21°45'N and longitudinal extension 86°45'E-87°45'E. Geomorphologic ally this area located in a part of 'Digha –Kanthi' coastal plain, that which lower part of coastal tract in West Bengal. On the other hand this study area situated under the 'Dubda basin' at lower part of Rasulpur River. Coastal alluvial and older alluvial plain covered with all over the study area during the Quaternary period of geological time scale, Geomorphic process base sandy and sandy-loamy soil are formed due to long term of weathering , erosion and depositional process on during time. Egra block I consistence of 8 rural gram- pachayats. Total geographical study area is 23554.3 hectors.

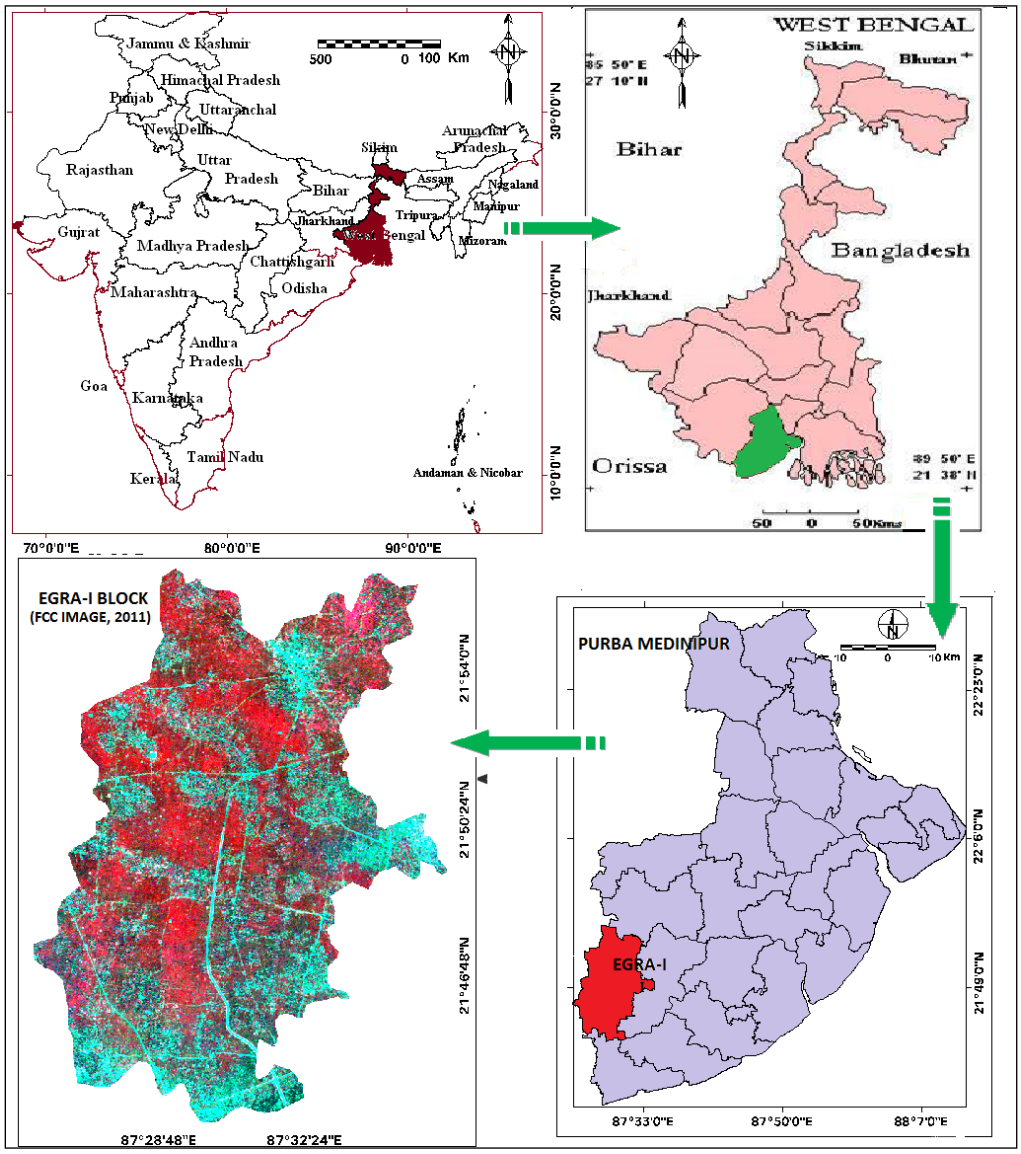

Figure 1. Location map of the study area

Methodology

In the present study Landsat 4, 5 Thematic Mapper (TM) data is used. The TM sensor collects surface reflectance data in the visible and near infrared (bands 1-5, 7), and the thermal infrared (band 6) portions of the electromagnetic spectrum. Spatial resolution of the TM data is 30 meters per pixel. Subsets of satellite images were rectified first for their inherent geometric errors using digital topographic maps in Universal Transverse Mercator coordinate system obtained as above as the reference material. Landsat Thematic Mapper (TM) image was first registered to the digital topographic maps using distinctive features such as road intersections and stream confluences that are also clearly visible in the image. A first-degree Rotation Scaling and Translation transformation function and the Nearest Neighbor resembling method were applied. This resampling method uses the nearest pixel without any interpolation to create the warped image (Richards, 1994). A total of 18 points were used for registration of TM image. The total root mean square (RMS) error for the each image was approximately less than 5 meters.

Change detection has been applied in different application areas ranging from monitoring general land cover change using multi-temporal imageries to anomaly detection on hazardous waste sites (Jensen et al. 2005)[6]. One of the most common applications of change detection is determining urban land use change and assessing urban sprawl. This would assist urban planners and decision makers to implement sound solution for environmental management. A number of approaches have emerged and applied in various studies to determine the spatial extent of land cover changes. It is also reviewed that different methods of detection produce different change maps (Araya and Cabral 2008)[7]. The selection of an appropriate technique depends on knowledge of the algorithms and characteristic features of the study area (Benazir et al. 2004), and accurate registration of the satellite input data. Change detection approaches based on expert systems, artificial networks, fuzzy sets and object-oriented methods are also vailable in different software platforms (Jensen et al. 2005)[8]. In addition, various researchers (Berkavoa 2007)[9] have attempted to group change detection methods into different broad categories based on the data transformation procedures and the analysis of techniques applied. According to (Berkavoa 2007), for example, change detection can be divided into two main groups: pre-classification and post-classification methods. The following section discusses some of the techniques that are available in various software platforms.

Result and discussion

Area under major land use/land cover categories was calculated for the year 1990, 2002 & 2011. Land use/Land cover has been categorised into eight different classes that are built up land, moist fallow land, forest land, surface water bodies, crop land, agricultural fallow land, land under miscellaneous tree and groves and rural settlement, pastures and other grazing land etc. The result of our analysis showed most of the study area (> 56%) is covered with the agricultural fallow land and land under miscellaneous tree and groves. The results also showed built up land, crop land, forest land, land under miscellaneous tree and groves and rural settlement and pastures and other grazing land are increasing trend during the period between 1990 and 2011. Consequently, moist fallow land, surface water bodies, moist fallow land and agricultural fallow land showed decreasing in trend.

Change in forest area

In this study, it was found that there is 1467.92 hectares area of forest cover increased since last 21 years i.e. from 1990 to 2011, however this change is more from 2002 to 2011 but from year 1990 to 2000 there is slow rate of change showing positive awareness of environment in people living nearby by the forest area.

Table no. 1, Land use/land cover class and their percent of distribution in Egra-i Block

Land use/land cover class	1990	Percent	2002	PERCENT	2011	Percent
Built up area	158.72	0.67	221.89	0.94	325.89	1.38
Moist fallow land	3592.71	15.25	2425.22	10.30	1015.65	4.31
Forest area	1014.58	4.31	1470.62	6.24	2482.50	10.54
Surface waterbody	793.83	3.37	789.86	3.35	559.17	2.37
Land under miscellaneous tree groves, rural settlements	5369.49	22.80	5929.70	25.17	8280.00	35.15
Agricultural fallow land	7884.73	33.47	7392.03	31.38	6052.76	25.70

Pastures and other grazing land	3219.38	13.67	2755.14	11.70	2154.05	9.15
Crop land	1520.82	6.46	2569.80	10.91	2684.24	11.40
Sources: Landsat thematic mapper satellite imagery analysis						

Change in surface water bodies

The streams/rivers, canals, ponds etc is considered under this category. The prominent ponds/lakes are easily detected on satellite imagery by their black and dark blue tones. The changing rate of water bodies of this area is also showing decreasing trend. There is 234.66 hectares area decrease of water bodies from year 1990 to 2011.

Change in settlement

This study shows that there is about 104 hectare area increased of built up area from 1990 to 2011. In 1990, the area under settlement was 0.67% of the total covered area, which was further increased in 0.94% in year 2002 to 1.38 % in year 2011 of the total area. One noticeable change behind this change is only increasing human population year by year.

Change in agricultural fallow lands

The observation gained through the image interpretation reveals that the study area is predominantly comes under single crop cultivation and paddy is the predominantly crop of this area. Percent of agricultural fallow land is decreased during the study entire study period (1990-2011). In 1990, 33.47% was agricultural land, whereas in 2011, the percent of agricultural fallow land was 25.70% (1339.27 hectares).It may be due to direct or indirect increasing human population and there need's.

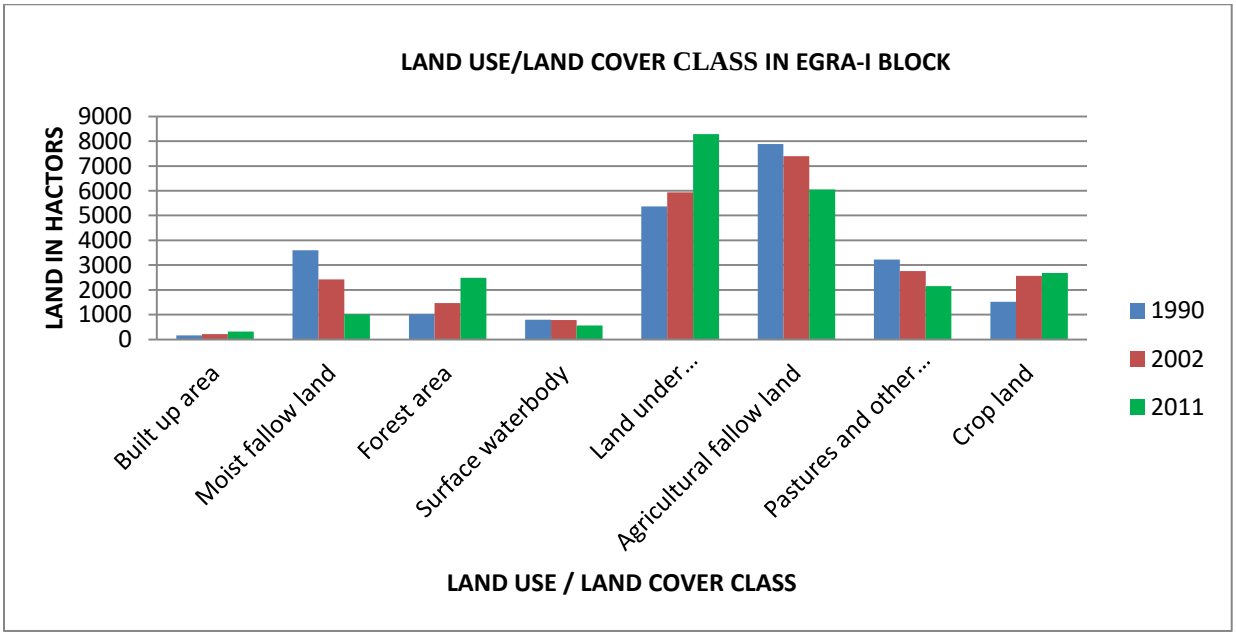

Figure 2, Distribution of land use/Land cover classes of egra-i block in 1990-2011

Change in pastures and other grazing land

The result of this study is showing that there is overall decrease (1065.33 hectares) of pastures and other grazing Land during the period between 1990 and 2011. 13.67% pastures and other grazing land was recorded in 1990, whereas, 9.14% was recorded in 2011.

Change in crop land

In this study it was found that crop land in part of Egra block is showing increasing trend. This may be because of increasing human population on land. The intensive cultivation has extended even to areas under agricultural fallow land and pastures and other grazing land. In 1990, 6.46% of the total area is under the crop land, whereas in 2011, the percent of crop land was 11.40%.

Table no. 2, land use/Land cover change area during the period between 1990 – 2011 in egra-i block

LAND USE/LAND COVER CLASSES	1990-2002	2002-2011	1990-2011
Built up area	63.17	104	167.17
Moist fallow land	-1167.49	-1409.57	-2577.06
Forest area	456.04	1011.88	1467.92
Surface water body	-3.97	-230.69	-234.66
Land under miscellaneous tree groves, rural settlements	560.21	2350.3	2910.51
Agricultural fallow land	-492.7	-1339.27	-1831.97
Pastures and other grazing land	-464.24	-601.09	-1065.33
Crop land	1048.98	114.44	1163.42
Sources: landsat thematic mapper satellite imagery analysis by author calculate			

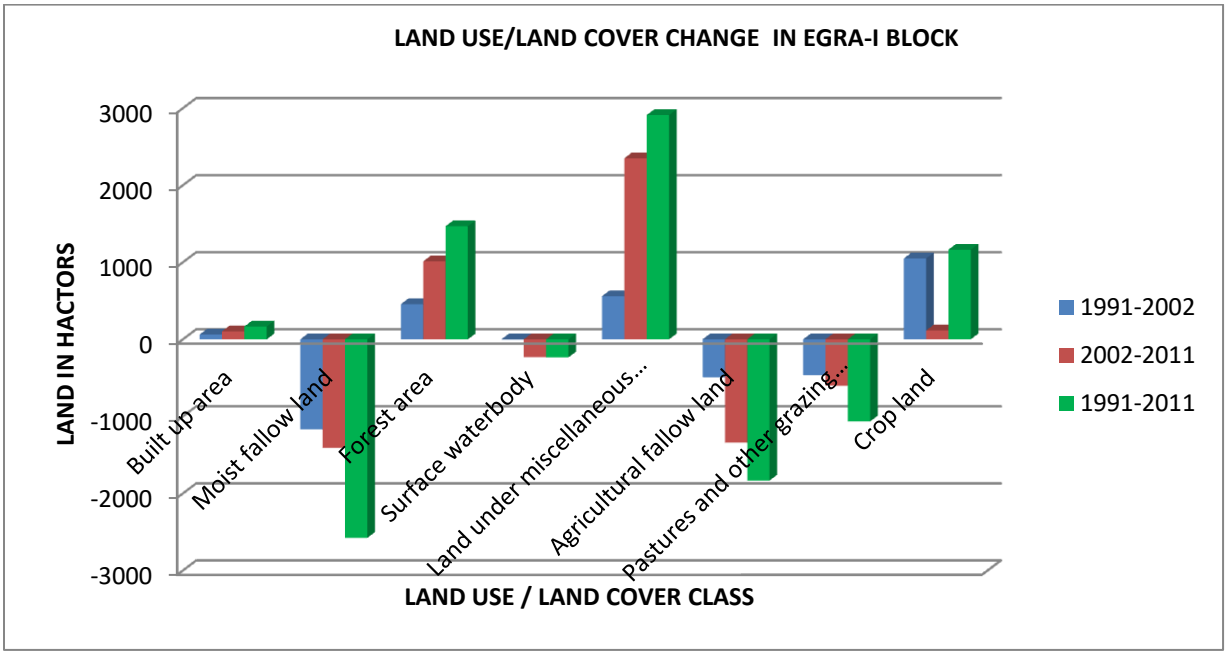

Figure 3, Changing pattern of land use/land cover classes egra-i block in 1990-2011

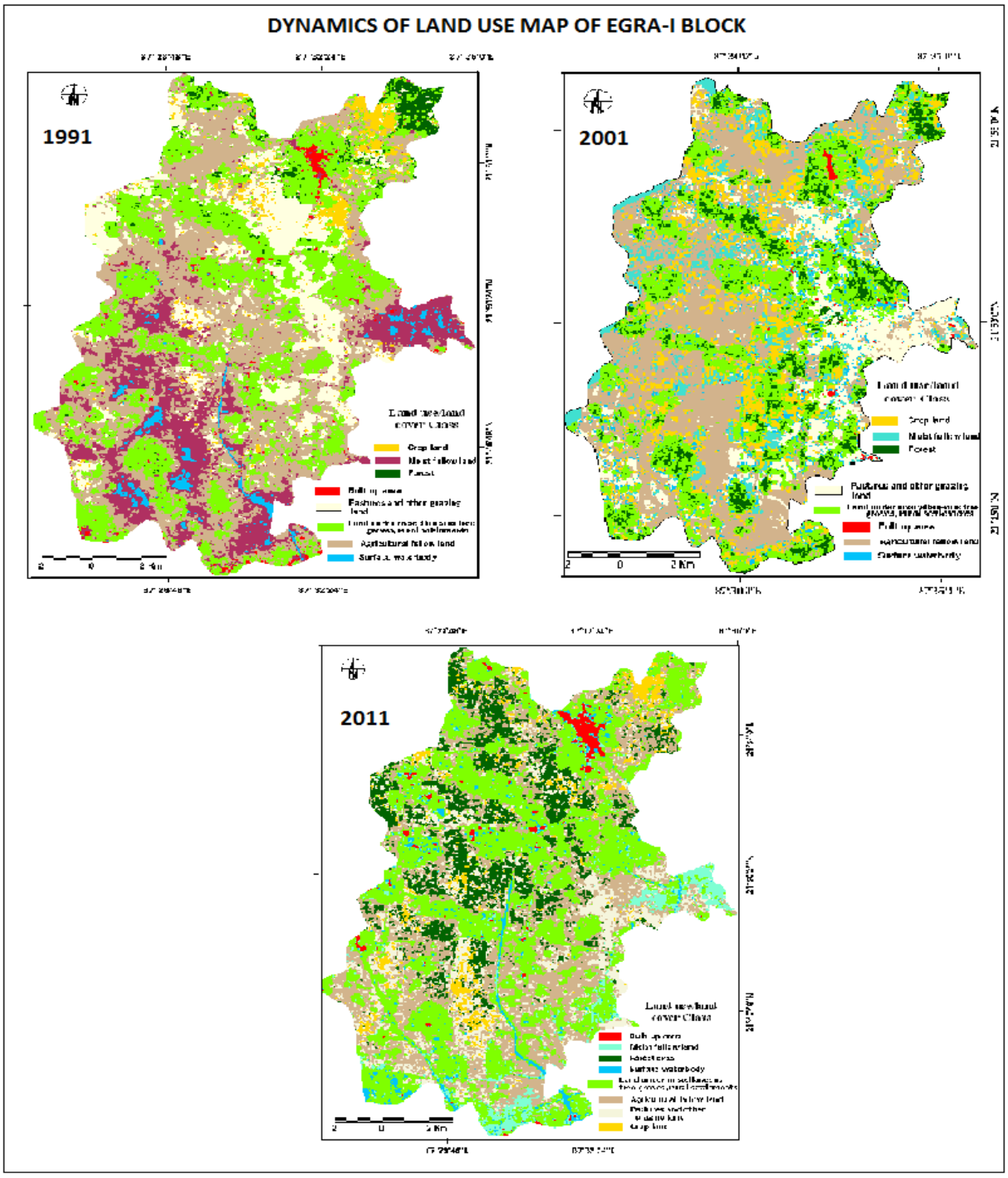

Figure 4, Land use/land cover map of Egra-i Block, 1991, 2001& 2011

Conclusion

The regional mapping of land use and land cover is essential as a major step to understanding and checking land use change in the study area. The land use dynamics transformation of the region was studied using time

series of remote sensing data, with settlement expansion rising as the major force driving land use change. The impact of such changes were examined, the most significant being forest degradation. The result of our analysis showed most of the study area (> 56%) is covered with the agricultural fallow land and land under miscellaneous tree and groves. The results also showed built up land, crop land, forest land, land under miscellaneous tree and groves and rural settlement and pastures and other grazing land are increasing trend during the period between 1990 and 2011. Consequently, moist fallow land, surface water bodies, moist fallow land and agricultural fallow land showed decreasing in trend. So various type of problems arise of this study area, that which shown above points. Firstly, some recommendation for food crop crisis. It is large scale problem for primary needs as a food. Secondly, the problem is degradation of environmental condition to affect the human society. As a commercial crop field is highly covered with jangle environment, so various type of poisonous snake are habited in this field and effect on human society. Lastly, forest land converted to agricultural land, etc.

Since the study area under the threat of certain problems raised due to improper management of land, the free gift of nature, the government should come forward to take effective measures to protect the lands especially under forest and agricultural land. Here proper land use /land cover planning is needed; otherwise the results would be critical for the environment of the study area and the economy of the people in the near future.

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