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Spatial Configuration, Temporal Composition and Probability of Changes in Land use & Land cover mapping through Geospatial technology- A pilot study of Dabawali block of Sirsa district

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Abstract

The monitoring and mapping of LULC changes through the multi-temporal IRS-P6 AWiFS satellite data provides detailed information about the land use land cover changes [3]. The knowledge about the LULC change generated through the geo-statistical and geo-informatics techniques is significant for sustainable land use planning, their management and utilization [16]. The anthropogenic activities and technological advancements are considered to be responsible for a changed dynamics in study area. This paper explores the temporal composition of the main Land-use/Land-cover (LULC) categories, examines the spatial configuration of the categories, and derives the probabilities of transitions in the Dabawali block of Sirsa district, Haryana. The knowledge about the LULC change generated through the geo-statistical and geo-informatics techniques is significant for the sustainable land use planning, management and utilization [2].

The present study aims to investigate the LU/LC changes using multi-temporal IRS P6 AWiFS satellite data (2006-07- 2009-10) of Dabawali block of Sirsa district and to identify the hot spots of land use changes pertaining to various categories. At the same time, land use and land cover transfer matrixes are used to assess the dynamic change trends for different land cover types [10]. Double crop class covered 723.01 sq. km area in 2006-07 & 733.34 sq. km area in 2009-10. Double crop is the dominant class in both years i.e. 2006-07 and 2009-10 in Dabawali block. Other dominant class is rabi only & kharif only. The major shifting was observed in rabi only class of 2006-07 whose 32.98 sq. km area was changed into double crop area during 2009-10. Wastelands class was observed 18.86 sq. km in 2006-07 that was 2.27 percentages of total geographical area of the study area and 11.25 sq. km area was observed in 2009-10 that was 1.35 percentage of total geographical area of the study area.

Keywords: *Spatial configuration, Temporal composition, AWiFS satellite data, Land use/ land cover, Geospatial technology.*

1. Introduction

India is bestowed with the bounty of natural resources including minerals, soils, water and forests [17]. The urban population pressure has led to spatial and hazardous growth of urban centres into peripheral agriculture lands. Such changes in land use/land cover have resulted in a serious environmental degradation, namely soil erosion by water and wind, salinization and/or alkalinization, waterlogging, etc [12][13]. For ensuring food security, fertile land needs to be prevented from degradation and degraded land may to be brought under cultivation after reclamation. In fact, India needs to produce about 100 million tones of additional food grains by 2020 [11][19].

Remote sensing data, Geographical Information System (GIS) and Global Positioning System (GPS) techniques have capability to provide reliable information for spatial modeling [5]. The synoptic large area repetitive coverage provided by satellite sensors can provide appropriate data base for LU/LC mapping [6].

The present study aims to analysis the spatial analysis and temporal composition under different LU/LC categories during the period 2006-07to 2009-10.

2. Study Area

The Dabwali block situated between 29°40’30” to 29°54’32” N latitude and 74°27’24” to 74°50’35 E longitude [8]. The total geographical area of the Dabwali block is 832.66 sq. km [9]. It is located on the border of Haryana and Punjab, and is just a few minutes travel from Rajasthan border. It is surrounded by Odhan block in the east and Rania block in the south. The summer months are very hot with maximum temperature ranging from 41 °C to 46 °C in May and June. June is the period of highest incidence of dust storm [14]. About 72 percent of the annual normal rainfall in the district is received during the short south east monsoon period, July to September, July and August being the rainiest months. Sometimes, the temperature rises up to 48 °C. The study is dominated by dry lands with presence of sandy plains, shifting sand dunes, stabilized sand dunes, dissected upland tracts. There are 47 Panchayats in Dabawali block [18]. Location map of study area is displayed in figure-1.

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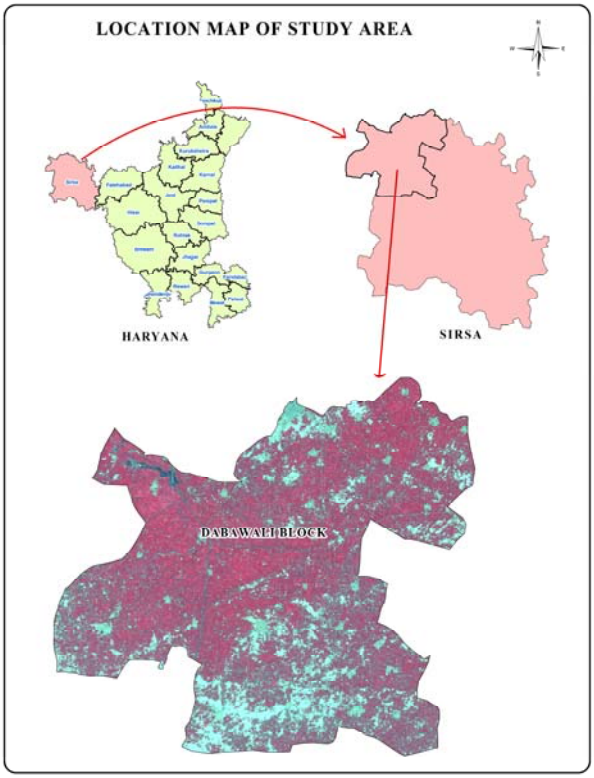

Figure-1

3. Materials & Methodology

3.1 Satellite Data

Mainly Indian Remote Sensing Satellite P6 - AWiFS satellite data of both rabi and kharif seasons was used for the present study. This satellite data for both seasons & years (2006-07 & 2009-10) was downloaded from Bhuvan and used to prepare thematic layers [7]. The specification of remote sensing satellite data is given in the table-1.

Table 1: Specification of satellite data used during 2006-07 and 2009-10

Sr. No.	***Satellite***	***Sensor***	***Date of acquisition***
1	IRS-P6	AWiFS	March 2007 & October 2006
2	IRS-P6	AWiFS	September 2009 & March 2010

3.2 Software Used

ERDAS IMAGINE 9.3, ARC GIS Desktop 9.3, Microsoft Office 2006-07.

3.3 Scale

The present change mapping was prepared on 1:50,000 scale to monitor land use / land cover change during the year 2006-07 to 2009-10.

3.4 Ground Truth

Doubtful areas are checked by field verification. Land use /land cover classification methodology for study area is presented in figure-2 and table-2 [1][4][5].

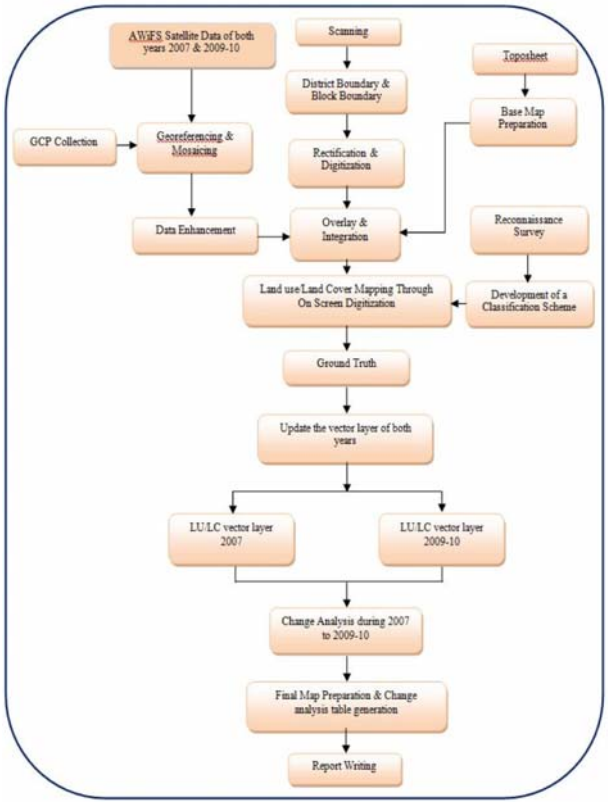

Figure-2

4. Results & Discussions

Dabawali block covers an area of 832.66 sq. km. Based on the interpretation of two season satellite data, the land use/ land cover categories identified in this block were double cropped area, rabi only, kharif only, current fallow, strip plantation, horticultural plantation, degraded grazing land, land with open scrub, sandy area, single/ group building, waterbody and village settlement. The interpreted satellite maps for the years 2006-07 and 2009-10 are shown as figure-3 & 4. The areal extent of these categories during both the years alongwith change in their area is given in table-3.

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Table-2. Codification of classification system

Level-I	*Level-II*	*Level-III*	*Code*
Built up	Rural	Village (Rural)	1
		Single/Group Building	2
	Urban	City (Urban)	3
Agriculture Land	Cropland	Kharif only	4
		Rabi only	5
		Double cropped	6
	Fallow land	Current Fallow	8
Plantation	Agriculture Plantation	Strip Plantation	9
		Horticulture Plantation	10
	Block Plantation	Block Plantation	11
		Bund plantation	12
Wastelands	Scrub lands	Land with open scrub	13
		Land with dense scrub	14
	Mining dump	Brick kiln/stone mining dump	15
	Grazing Land	Degraded Grazing land	16
	Waterlogged	Seasonal waterlogged	17
		Permanent waterlogged	18
	Sandy area	Sandy area	19
	Salt affected	Salt affected area	20
Water body	Pond/River	Pond	21

The brief description of various classes is as follows:

Built Up Land: This class is further divided into village, urban built up, single/group building.

Built up Rural & Urban – Out of the total built up rural land or settlement area of Dabawali block was 5.53 sq. km. in 2006-07. During the year 2009-10, it was found that there is increase of 7.79 sq. km in the settlement area of these villages i.e. 13.32 sq. km. Built up urban of Dabawali block was 2.16 sq. km founded in 2006-07 and in 2009-10, it was increased to 4.10 sq. km.

Single/Group Building – This class includes those buildings which are scattered in the study area and may be the tubewell or poultry farms in the farmers' fields. In 2009-10, this class covered 0.05 sq. km area.

Agricultural land: Agricultural land may be defined broadly as land used primarily for production of food grains and fodder. This category is further divided into double crop, rabi only, kharif only and current fallow sub-classes [19].

Double crop- This sub-class includes an area which is cultivated during both rabi and kharif seasons in a year [19]. Double crop is the dominant category in Dabawali block. The area under this class during 2006-07 was 723.01 sq. km. whereas it became 733.34 sq. km. in 2009-10. The increment of 6.64 sq. km. is also justified from the decrease of rabi only & strip plantation classes in this block.

Rabi only - The area cultivated only during rabi season and remains fallow during kharif season is classified as rabi only [19]. This class covered an area of 48.54 sq. km in 2006-07 and 8.94 sq. km in 2009-10. The decrease of 39.60 sq. km. in this category may be due to the shifting of this area in kharif only category.

Kharif only - The area which is cultivated only during kharif season and remains fallow during rabi season is called kharif only. It covered an area of 5.03 sq. km in 2006-07 and 32.35 sq. km in 2019-10 i.e. a increase of 27.32 sq. km due to decreased the class rabi only.

Current Fallow - Land which is kept fallow in both rabi and kharif seasons due to one or the other reasons falls under this category. A small area of 27.18 sq. km. of this class was found during 2006-07 whereas this class was decreased to 13.65 sq. km. in 2009-10. This class decreased 13.53 sq. km during 2006-07 to 2009-10.

Plantation: This category includes Agricultural plantation, Strip plantation and Horticultural plantation classes also[19] .

Agricultural *plantation*- Agricultural plantation is done around the crop field. Agricultural plantation covered an area of 2.29 sq. km in 2006-07 and this class covered 1.15 sq. km. area in 2009-10. Mostly, this class was changed in horticultural plantation class. Horticultural plantation covered 0.84 sq. km. area.

Strip plantation - Strip plantation is mainly done on both sides of roads/ kachcha ways. Strip plantation covered an area of 9.72 sq. km area in 2009-10.

Wastelands: The term wastelands refer to degraded lands that are currently underutilized, and are deteriorating for lack of appropriate soil & water management or on account of natural causes [5] [6]. These are further divided into degraded grazing land, scrub land and sandy area.

Degraded Grazing Land- These lands are the Panchayat lands, irregular in shape, and are found close to settlement fringes. The areal extent of this class during 2006-07 was 13.28 sq. km and it decreased by 4.41 sq. km. during 2006-07 to 2011-12 due to increase in settlement area of the villages.

Land with Open scrub- These lands generally occupy topographically high locations and possess sparse

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vegetation. This class occupied an area of 4.77 sq. km. in 2006-07 and 2.11 sq. km. in 2009-10 i.e. decreased of 2.66 sq. km. during this period.

Sandy area- A small area of 0.66 sq. km was found during 2006-07 in the Dabawali block. In 2009-10, 0.27 sq. km area was covered by this class. Most of the sandy wastelands have been leveled and put under cultivation.

Seasonally waterlogged- Seasonally waterlogged areas are those where the water logging condition prevails usually during the monsoon period. These lands are mostly located in plain areas associated with the drainage congestion. A small area of 0.15 sq. km area of this class was found during 2006-07 whereas this class was not found during 2009-10.

Water Body: This class includes ponds and lakes present in the study area. Ponds were observed in this block covering an area of 0.06 sq. km. in 2006-07 and 3.95 sq. km in 2009-10.

Table-3 Spatial and temporal analysis of land use/ land cover categories of Dabawali Block

Land use/Land cover Categories		***Area in Sq. km. (2006-07)***	***Area in Sq. km. (2009-10)***	***Change***
Built Up Land	Rural	5.53	13.32	7.79
	Urban	2.16	4.10	1.94
	Single Group Building	0	0.05	0.05
Agricultural Crops	Double Crop	723.01	733.34	10.33
	Rabi Only	48.54	8.94	-39.60
	Kharif Only	5.03	32.35	27.32
	Current Fallow	27.18	13.65	-13.53
Plantations	Horticultural Plantation	0.00	0.84	0.84
	Agricultural Plantation	2.29	1.15	-1.14
	Strip Plantation	0.00	9.72	9.72
Wastelands	Land with Open Scrub	4.77	2.11	-2.66
	Degraded Grazing & Grass land	13.28	8.87	-4.41
	Waterlogged Seasonal	0.15	0	-0.15
	Sand Desertic	0.66	0.27	-0.39
Waterbody	Waterbody	0.06	3.95	3.89
Total		832.66	832.66	0.00

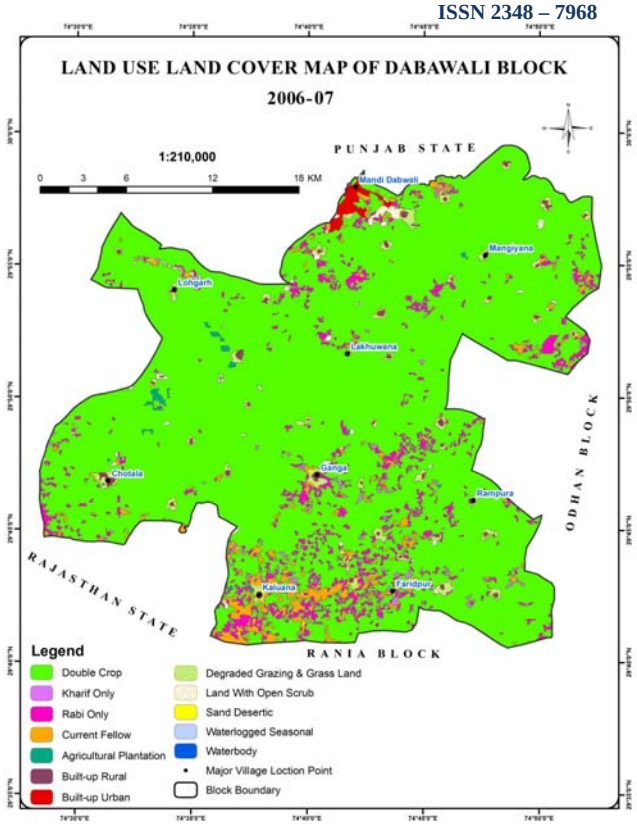

Figure-3

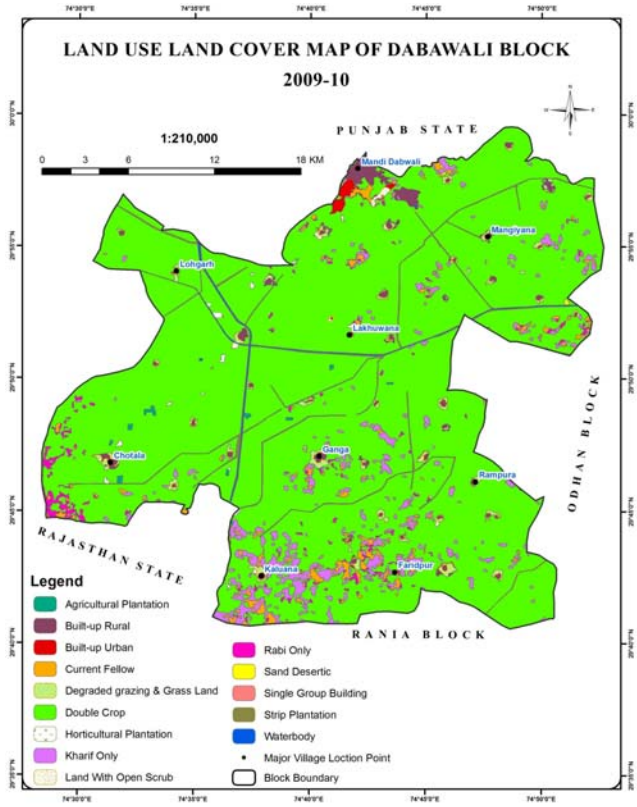

Figure-4

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Change Analysis:

A common or union layer was generated on the basis of vector layers of both years 2006-07 & 2009-10. With this common vector layer, changes between all land use/ land cover categories during 2006-07 and 2009-10 were calculated as shown in table-4 and the change map was prepared as shown in figure-5. The change analysis data shows that 685.77 sq. km. area of double crop remained unchanged but a reasonable area i.e. 9.59 sq. km. area of double crop changed into strip plantation category. 4.49 sq. km. area changed into built up rural & 2.41 sq, km area changed from double crop. 32.98 sq. km. changed in to double crop from rabi only. On the other hand in 2009-10 year data 9.87 sq. km. area of double crop was shifted into kharif only.

Table-4 Category wise temporal analysis of land use/ land cover classes during 2006-07 to 2009-10 of Dabawali Block
(Area in sq. km.)

2006-07 \ 2009-10	Agricultural Plantation	Built-up Rural	Built-up Urban	Current Fallow	Degraded grass & Grazing Land	Degraded grazing & Grass Land	Double Crop	Horticultural Plantation	Kharif Only	Land With Open Scrub	Rabi Only	Sand Desertic	Single Group Building	Strip Plantation	Waterbody	Grand Total
Agricultural Plantation	0.19	0.00	0.00	0.02	0.00	0.00	1.50	0.21	0.05	0.27	0.00	0.00	0.00	0.00	0.05	2.29
Built-up Rural	0.00	5.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.53
Built-up Urban	0.00	0.00	1.69	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.16
Current Fallow	0.00	0.39	0.00	6.20	0.00	0.00	6.61	0.01	12.73	0.21	0.93	0.09	0.00	0.01	0.00	27.18
Degraded grass & Grazing Land	0.00	2.27	0.00	0.05	0.04	8.74	2.00	0.00	0.09	0.00	0.01	0.00	0.00	0.01	0.06	13.28
Double Crop	0.85	4.49	2.41	1.68	0.00	0.00	685.77	0.53	9.87	0.00	3.98	0.03	0.04	9.59	3.77	723.01
Kharif Only	0.00	0.00	0.00	0.56	0.00	0.09	1.94	0.00	2.32	0.01	0.11	0.01	0.00	0.00	0.00	5.03
Land With Open Scrub	0.04	0.45	0.00	0.11	0.00	0.00	2.39	0.09	0.27	1.38	0.03	0.00	0.00	0.00	0.00	4.77
Rabi Only	0.07	0.18	0.00	4.36	0.00	0.00	32.98	0.00	6.65	0.23	3.87	0.09	0.00	0.08	0.03	48.54
Sand Desertic	0.00	0.00	0.00	0.21	0.00	0.00	0.03	0.00	0.36		0.01	0.05	0.00	0.00	0.00	0.66
Waterbody	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.06
Waterlogged Seasonal	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.15
Grand Total	1.15	13.32	4.10	13.65	0.04	8.83	733.34	0.84	32.35	2.11	8.94	0.27	0.05	9.72	3.95	832.66

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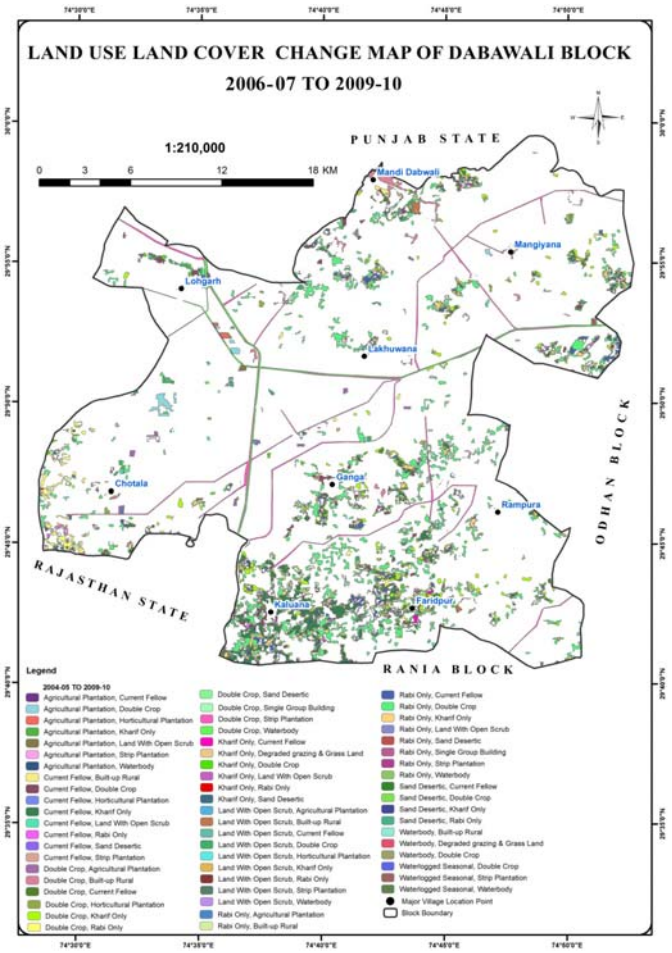

Figure-5

Conclusions

The present study was conducted to evaluate change analysis of Dabawali block of Sirsa district by using IRS-P6, AWiFS satellite data of both rabi and kharif seasons for the years 2006-07 & 2009-10. Dabawali block cover an area of 832.66 sq. km. The change analysis is based on the changes observed in land use/ land cover in study area between 2006-07 and 2009-10. After going through the final land use/land cover data of both years and the changes occurred during these years, following conclusions were drawn.

- Built-up area, agricultural crops, plantation, wastelands & waterbody are major LU/LC classes that were observed in both years 2006-07 & 2009-10.
- Agricultural crop class covered 803.76 sq. km area in 2006-07 & 788.28 sq. km area in 2009-10. This class covers 96.53 percentage area of study area in 2006-07 & 94.67 percentage area of study area in 2009-10.
- Built-up area was observed 7.69 sq. km in 2006-07 that was 0.92 percentages of total geographical area of study area and 17.47 sq. km area was observed in 2009-10 that was 2.10 percentage of total geographical area of study area.
- Wastelands class was observed 18.86 sq. km in 2006-07 that was 2.27 percentages of total geographical area of the Dabawali block and 11.25 sq. km area was observed in 2009-10 that was 1.35 percentage of total geographical area of the Dabawali block.
- Double crop is the dominant class in both years i.e. 2006-07 and 2009-10 in study area. The major shifting was observed in rabi only class of 2006-07 whose 32.98 sq. km area was changed into double crop area during 2009-10. 685.77 sq. km. area of double crop is remains unchanged.
- The data reveals that total agricultural area was decreased 15.48 sq. km during 2006-07 to 2009-10. This is due to increase in built up area & strip plantation classes. Minor changes were also observed in wastelands categories in the study area.

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