

Remote Sensing and GIS for Assessing the Impact of Changes on Land Use/Land Cover in Dindigul District, Tamil Nadu, India

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Abstract

Land Use/Land Cover (LU/LC) is an important indicator to understand the impact of climate change as well as anthropogenic activities on earth surface. LU/LC can be assessed effectively and objectively with the use of new and emerging technologies like remote sensing and Geographical Information System (GIS). Therefore, an attempt has been made to assess and understand the changes LU/LC in Dindigul district, Tamil Nadu State using satellite images and GIS. Two sets of remotely sensed data, TM (1990), IRS-P6 LISS III images (2009) were used in the study. The study results show that there is an increasing trend in built-up area, especially in urban built-up. The areal extent of plantation has increased and the crop land and fallow land has decreased. The spatial distribution of forest area has showed decreasing trend, mainly the dense forest has decreased two times between 1990 and 2009.

Keywords: Land Use/Land Cover (LU/LC); Change detection; Remote sensing; GIS

Introduction

Land is one of the resources used in all primitive occupations particularly farming. In India due to pressure exerted by ever increasing population, every piece of land available in the villages is being used for farming. Land has been undergoing remarkable changes due to increase in area under cultivation, industrialization and urbanization. The Land Use/Land Cover (LU/LC) is one of the indicators used for better planning and management. There are different types of LU/LC existing on the earth for e.g., cultivable land, water bodies, fallow land, forest, built-up area etc. The changes in the use of land affect the land cover, land quality and capability, weather and climate, quantity of land that can be sustained and in short the environment and ecology. "Land cover is the observed (bio) physical natural cover on the earth's surface" when considering land cover in a very pure and strict sense, it should be restricted to natural vegetation, soil, water bodies etc Antonio Di Gregorio et al. [1]. Land use is the human use of land. Land use involves the modification and management of natural and manmade environment such as fields, industries and settlement.

The LU/LC analysis is one of the common methods for development; planning and management of natural resources particularly land. The remote sensing gives the synoptic view of the earth surface. The repetitive coverage of satellite has made possible to examine the changes on a regular interval of time. There are enormous LU/LC studies carried out by researchers/academician all over the world. The remote sensed data have also been used for LU/LC mapping in different parts of India Brahabhatt et al., [2]; Gautam et al., [3]; Sharma et al., [4]; Jain [5]; The present study has been carried out in order to understand the changes that have been taken place in LU/LC in Dindigul district, Tamil Nadu State to understand the impact of changes in LU/LC between 1990 and 2009.

The Study Area

The Dindigul District is bounded by Erode and Karur districts on the North, Sivaganga and Trichy districts on the East, Madurai and Theni districts on the South and Coimbatore district and Kerala State on the West. The geolocation of the study area is 10°0' and 10°45' north longitude and 77°15' and 78°15' east latitude. The total area of the district is about 6,083 Sq.km. It has three revenue divisions,

eight taluks, 14 blocks, 24 town panchayats, and 306 panchayat villages (Figure 1).

Materials and Methodology

For the present study, the geo referenced, LANDSAT Thematic Mapper (TM) image of 1990 with 30 mts spatial resolution, were download from an earth science data interface (<http://glcapp.umi.acs.umd.edu.8080/esdi/index.jsp>). The LISS-III image of 2009 with 23.5 mts spatial resolution, acquired from National Remote Sensing Centre (NRSC) (<http://bhuvan-noeda.nrsc.gov.in/theme/thematic/theme.php>) was used. The downloaded images were layer stacked in ERDAS imagine software. The satellite images were subset using Dindigul district administrative boundary. The Geodatabase (GDB) was created using ArcGIS software (Figure 2).

The False Colour Composite (FCC) was created for the identification of LU/LC classes. The LU/LC classification was attempted by visual interpretation method by the first level LU/LC categories of NRSC, which include 16 classes like urban built-up, mining, rural built-up, crop land, fallow land, plantation dense forest, deciduous forest, forest plantation, forest scrub, grazing land, wasteland, tank and river stream. The field verification has been carried out the changes in LU/LC have been detected using ArcGIS software to conform some of the LU/LC categories for 1990 -2009. The area covered under each LU/LC has been calculated and tabulated.

Results and Discussion

Land use/land cover-1990

The Map 2 portrays the major classes of LU/LC in 1990. The

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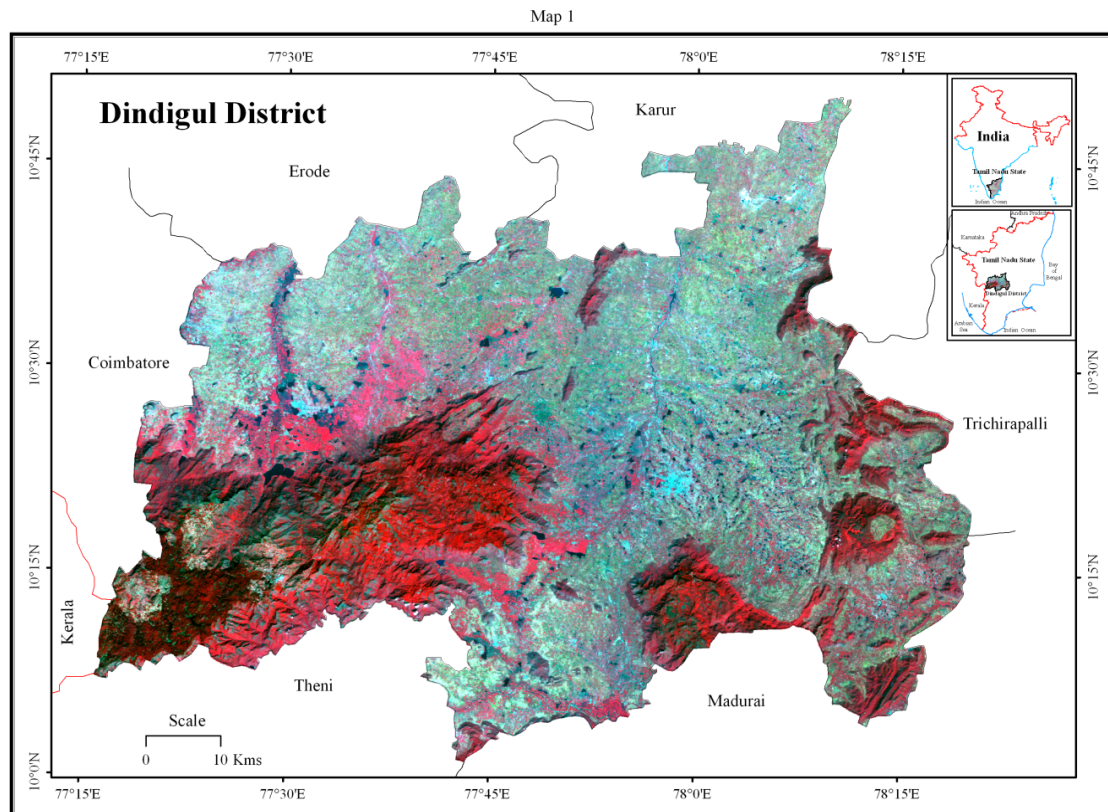


Figure 1: Study area in dindigul District.

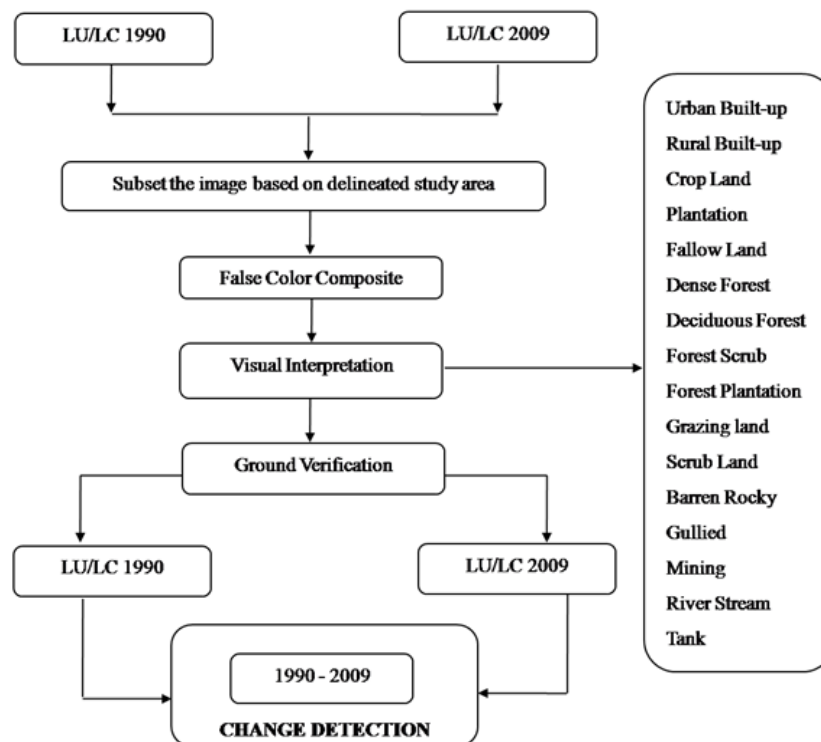


Figure 2: Approach for LU/LC and change detection 1990-2009.

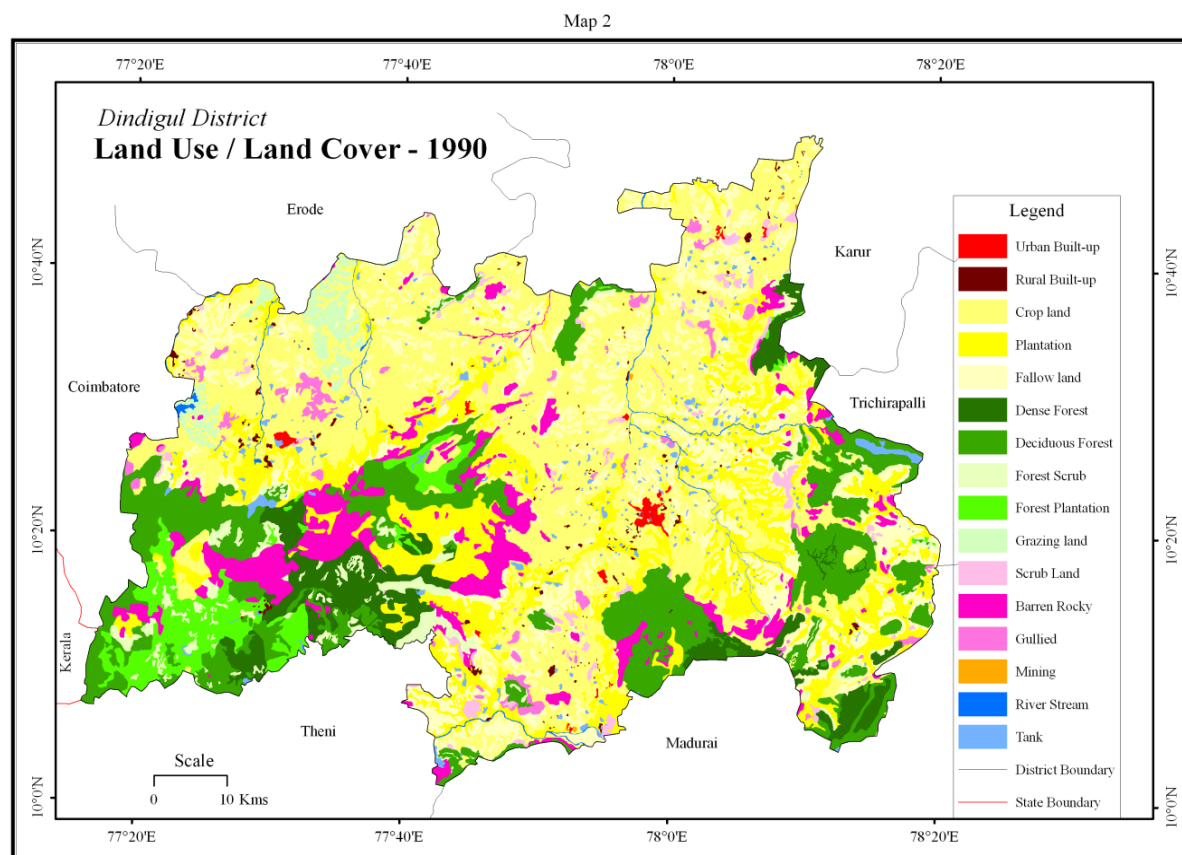


Figure 3: Land use/land cover-1990 in Dindigul District.

crop land can be seen along the foot hill region Palani hills. A small patch of fallow land is present in the Thoppampatti block as well as Mannavanur and Poomparai villages in Kodaikanal block. A big patch of fallow land is noticed in the south eastern part of Sanarpatti and Vadamadurai blocks. Similarly small patches of fallow land are detected in the Gujiliamparai block in the northern part of Dindigul District. The area under fallow has appeared in the central parts of Vadamadurai and Batlagundu blocks. The area under agriculture plantation is located in the Kodaikanal hills, especially Adalur, Periyur, Manalur, Thandigudi and Vadagouchi villages in the south eastern part of Dindigul District.

In plain regions, large area is under agriculture plantation; they are found in the eastern part of the district covering Natham block, Karanthamalai and Mundamalai area.

Some small patches of plantation can be seen in Athoor and Batlagundu blocks in Dindigul District. The area under dense forest is present in Kookal, Thonimalai, Erukkamalai and Karanthamalai. Big patches of deciduous forest can be found in the Kodaikanal hills, Sirumalai hills and Karanthamalai RF area. The forest scrub can be seen in lower region of Kodaikanal hills and Sirumalai hills. There are some big patches of forest plantation has showing in Poomparai, Poondi and in and around Kodaikanal town and Adukkam area.

Some big patches of scrub land are found in South-eastern part of the district and small patches in Nilakottai, Oddanchatram and Veda sandur blocks. The area under gullied land is found in the southern and western parts of the District.

Shanmuganathi, Shanmugavarthini and Kodavanar are dry. The Tanks are visible in Vagarai, Pungamuthur, Porulur and Kottathurai villages in Thoppampatti block during 1990.

The area under built-up land is found in and around Dindigul, Palani, Oddanchatram, Kodaikanal and Gujiliamparai towns. The area under mining can be seen only in Veda sandur block. The areal extent of rural built-up can be seen in and around Ayyampalayam, Batlagundu, Nilakottai, Pallapatti, Sevugampatti, Thottanuthu, Athoor and Chinnalappatti towns.

Land use/land cover-2009

The map 3 describes the main classes of LU/LC in 2009. The area under crop land is found in big patches in the northern parts of Thoppampatti, Oddanchatram, Veda sandur, Gujiliamparai, and Vadamadurai blocks, while some small patches of crop land can be seen in the southern part of Nilakottai and Batlagundu blocks.

Big patches of fallow land are noticed in the Shanarpatti and Dindigul blocks and some small patches in the western part of Oddanchatram, Central part of Nilakottai and Batlagundu blocks in Dindigul District.

The area under agricultural plantation has found in Athoor, Reddiyarhatram and Natham blocks and also found in southern part of Nilakottai, North western part of Batlagundu and western side of Thoppampatti and Palani blocks. The small blocks of plantation can be noticed in the foot hill region of Kodaikanal, Sirumalai, Karanthamalai, Methugumalai and Alagar hills RF region of the District (Figure 3).

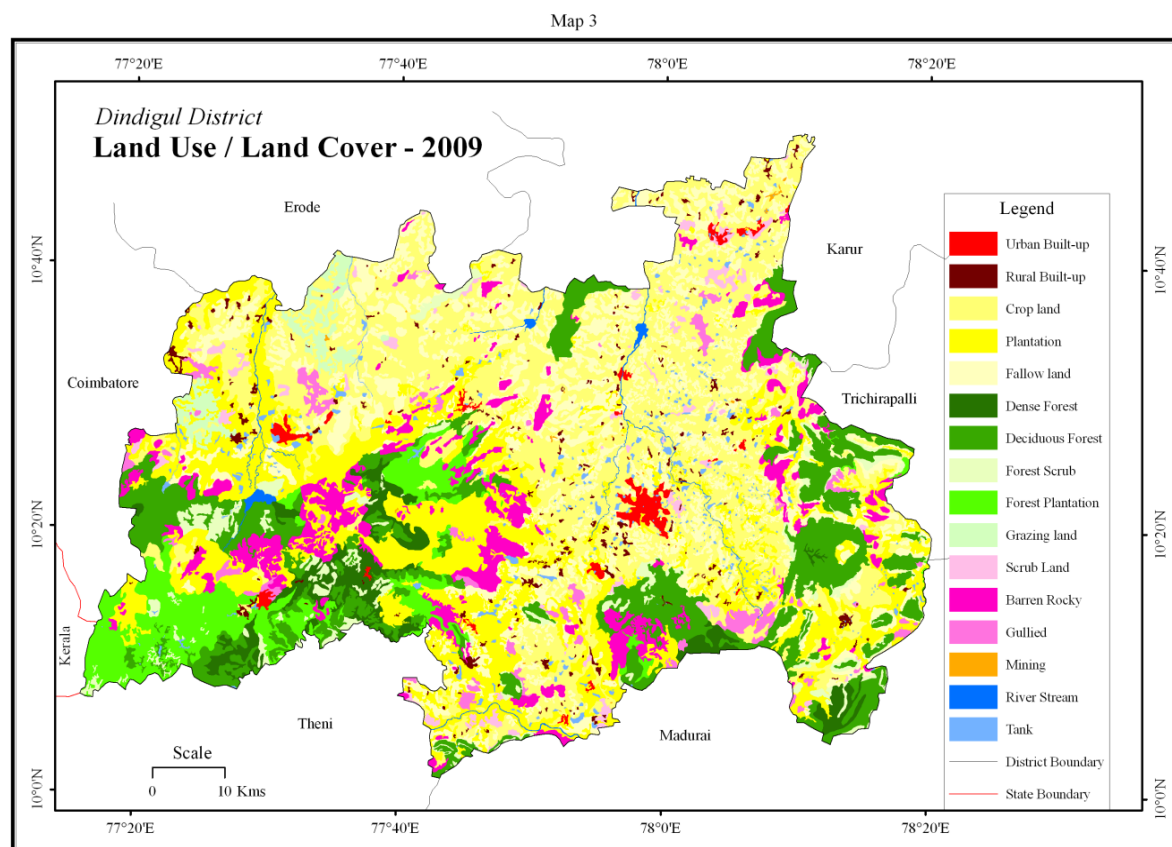


Figure 4: Land use/land cover-2009 in Dindigul District.

Dense forest are present in small patches in Vellagavi, central part of Pannaikadu, south eastern part of Pachalur in Kodaikanal blocks and also can be seen in South-eastern part of Sirumalai and South-western part of Alagar Hills in the District.

The deciduous forest can be noticed in North-western part of Kodaikanal hill, northern part of Sirumalai and eastern part of Alagar hills, and also it is found in Karanthamalai, Methugumalai and Kombaipatti forest regions in the district. The Areal extent of forest scrub can be seen in big patches near Kookkal and Pannaikadu in Kodaikanal block and also in the higher reaches of Sirumalai hill and northern part of Kondarangi hills area in the district.

The area under forest plantation can be seen in the South-western part of Kodaikanal block especially Poondi and Mannavanur areas and in big patches in Vadagadu, Adalur and Adukkam villages in Kodaikanal block. Some small patches of forest plantation can be noticed in the lower reaches of Sirumalai RF (Figure 4).

The grazing land is present only in western and North-western part of Palani and Thoppampatti blocks in Dindigul District. The area under barren/rocky land cover are located in some big patches in central and eastern parts of Kodaikanal hill, western part of Sirumalai hill, and also noticed in small patches in the eastern part of District. The spatial distribution of gullied land can be seen in Kombaipatti, Sengattampatti, Kunnuvarankottai, Sekkapatti and Amarapoondi villages in Dindigul District.

The area under scrub land is mainly noticed in the Puliampatti,

Akkaraipatti, Kulathupatti, Thennampatti, Periakottai, Pannaipatti and Sandaiyur villages in the Dindigul District.

The spatial distribution of river/stream can be seen in northern part and southern part of Dindigul District. The water bodies are more in number in Dindigul and Vadamadurai blocks. Small sized water bodies are also present in Reddiyarchatram, Athoor, Nilakottai and Palani blocks of the district.

The areal extent of built-up area showing strong increasing tendency, it can be seen in and around Dindigul, Palani, Oddanchatram, Nilakottai, Batlagundu, Vadamadurai, Vadasandur, Gujiliamparai and Kodaikanal towns. Pallapatti, Chinnalappatti, Ayyampalayam and Reddiyarchatram settlements are rapidly growing towns in the district.

The area under “rural built-up” are mainly restricted to Palani, Reddiyarchatram, Vadamadurai and Gujiliamparai blocks and small patches can be seen in Thoppampatti, Vadasandur, Dindigul, Athoor, Gujiliamparai and Nilakottai blocks of the District.

Change Detection

Change Detection 1990-2009

Table 1 furnishes data on changes in LU/LC between 1990 and 2009. The area under “built-up” land has increased from 0.37 percent to 1.01 percent. This includes 0.35 percent of crop land and 0.08 percent of fallow land; and 0.32 percent of area has not changed. There is a marginal changes has occurred in mining area. The areal extent of “rural built-up” has increased thrice from 0.43 percent to 1.14 percent.

Year	1990 Area in percent																	
	LU/LC Categories	Urban Built-up	Mining	Rural Built-up	Crop Land	Fallow Land	Plantation	Dense Forest	Deciduous Forest	Forest Scrub	Forest Plantation	Grazing Land	Barren Rocky	Scrub Land	Gullied	River Stream	Tank	Total
2009	Urban Built-up	0.32	0.01	0.06	0.35	0.08	0.06	0.04	0.00	0.00	0.02	0.00	0.01	0.06	0.00	0.00	0.01	1.01
	Mining	0.00	0.01	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
	Rural Built-up	0.00	0.00	0.20	0.48	0.18	0.21	0.01	0.02	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.01	1.14
	Crop Land	0.01	0.01	0.08	17.22	4.48	4.09	0.01	0.07	0.02	0.05	0.43	0.32	0.17	0.21	0.09	0.28	27.55
	Fallow Land	0.01	0.00	0.03	7.19	6.10	0.83	0.01	0.10	0.04	0.00	0.16	0.13	0.14	0.16	0.02	0.10	15.04
	Plantation	0.01	0.00	0.04	5.21	1.71	8.92	0.31	0.68	0.10	0.15	0.06	1.04	0.09	0.11	0.14	0.18	18.75
	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.08	1.89	0.70	0.12	0.03	0.00	0.04	0.00	0.00	0.00	0.01	2.86
	Deciduous Forest	0.00	0.00	0.00	0.15	0.16	0.08	2.07	8.32	0.55	0.62	0.00	0.39	0.04	0.02	0.00	0.02	12.43
	Forest Scrub	0.00	0.00	0.00	0.11	0.07	0.02	0.35	1.41	0.53	0.13	0.00	0.06	0.05	0.01	0.00	0.02	2.77
	Forest Plantation	0.00	0.00	0.00	0.02	0.01	0.06	0.40	1.69	0.67	2.65	0.00	0.12	0.00	0.00	0.00	0.02	5.65
	Grazing Land	0.00	0.00	0.00	0.47	0.05	0.00	0.00	0.00	0.00	0.00	0.78	0.01	0.00	0.01	0.02	0.00	1.34
	Barren Rocky	0.00	0.00	0.00	0.28	0.30	0.25	0.14	0.90	0.18	0.04	0.00	3.67	0.22	0.22	0.00	0.01	6.21
	Scrub Land	0.00	0.00	0.00	0.31	0.44	0.05	0.01	0.01	0.00	0.00	0.00	0.05	0.37	0.15	0.00	0.02	1.43
	Gullied	0.00	0.00	0.00	0.31	0.25	0.08	0.03	0.05	0.01	0.03	0.01	0.49	0.17	0.49	0.00	0.01	1.92
	River Stream	0.00	0.00	0.00	0.12	0.04	0.09	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.08	0.10	0.47
	Tank	0.01	0.00	0.00	0.33	0.06	0.30	0.00	0.01	0.01	0.02	0.00	0.00	0.01	0.00	0.01	0.58	1.35
	Total	0.37	0.04	0.43	32.61	13.96	15.12	5.27	13.98	2.23	3.75	1.43	6.35	1.34	1.38	0.37	1.36	100.00

Table 1: Change Detection 1990-2009.

Land Use/Land Cover Area in percent		
Name	1990	2009
Urban Built-up	0.37	1.01
Rural Built-up	0.43	1.15
Crop Land	32.59	27.54
Plantation	15.11	18.75
Fallow Land	13.97	15.04
Dense Forest	5.27	2.86
Deciduous Forest	13.98	12.43
Forest Scrub	2.23	2.77
Forest Plantation	3.75	5.65
Grazing land	1.43	1.34
Barren Rocky	6.36	6.21
Scrub Land	1.34	1.43
Gullied	1.38	1.93
Mining	0.04	0.07
River Stream	0.37	0.47
Tank	1.37	1.36
Total Area	100.00	100.00

Table 2: Dindigul District.

This covers 0.48 percent of crop land, 0.18 percent of fallow and 0.21 percent of plantation. Less than one percent of “rural built-up” area has remained unchanged.

The spatial distribution of crop land has decreased from 32.61 percent to 27.55 percent. It contains 4.48 percent of fallow land, 4.09 percent of plantation, 0.43 percent of grazing land and 0.28 percent of area under water bodies in Dindigul District. There is 17.22 percent of crop land unchanged. The area under fallow land has increased from 13.96 percent to 15.04 percent. It consists of 7.19 percent crop land and 0.83 percent plantation. The remaining 6.10 percent of area is unchanged. The areal extent of plantation has increased from 15.12 percent to 18.75 percent. Here, 5.21 percent of crop land, 1.71 percent of fallow land, 1.04 percent of barren rocky and 0.18 percent of water bodies area are converted into plantation only 8.92 percent of area has remained unchanged.

The area under dense forest has decreased two times from 5.27 percent to 2.86 percent. The 0.70 percent of area under deciduous forest and 0.12 percent of forest scrub have been converted into dense forest and 1.89 percent of area has remained as dense forest. The distribution of deciduous forest has decreased from 13.98 to 12.43. It contains 2.07 percent of dense forest, 0.55 percent of forest scrub and 0.61 percent of forest plantation. The 8.32 percent of area has remained unchanged. The areal extent of forest scrub has marginally increased from 2.23 percent in 1990 to 2.77 percent in 2009. It includes 0.35 percent of dense forest, 1.41 percent of deciduous forest and 0.13 percent of forest plantation. The remaining 0.53 percent of forest scrub area is unchanged. The area under forest plantation has increased from 3.75 percent in 1990 to 5.65 percent in 2009. It contains 0.40 percent of dense forest, 1.69 percent of deciduous forest. The 2.65 percent of area has remained unchanged.

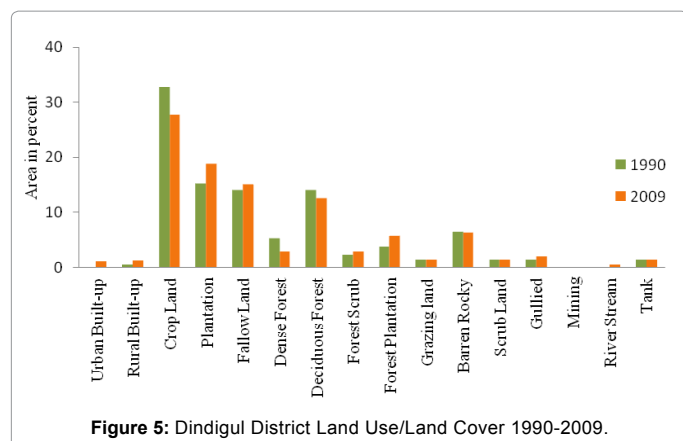


Figure 5: Dindigul District Land Use/Land Cover 1990-2009.

The areal extent of grazing land has marginally decreased from 1.43 percent in 1990 to 1.34 percent in 2009. It contains 0.47 percent of crop land and 0.78 percent of area has remained unchanged. The area under barren land has slightly decreased from 6.35 percent to 6.21 percent. It includes 0.28 percent of crop land, 0.30 percent of fallow land, 0.25 percent of plantation and 0.90 percent of deciduous forest. The 3.67 percent of area has remained unchanged. The areal extent of scrub land has marginally decreased from 1.34 percent in 1990 to 1.43 percent in 2009. It occupies 0.31 percent crop land and 0.44 percent of fallow land. The 0.37 percent of barren land has unchanged. The spatial distribution of gullied land has marginally increased from 1.38 percent in 1990 to 1.92 percent in 2009. It contains 0.31 percent of crop land and 0.25 percent of fallow land. The 0.49 percent of gullied land has remained unchanged.

The area under river/stream has marginally increased from 0.37 percent in 1990 to 0.47 percent in 2009. The areal extent of water tank has decreased from 1.36 percent in 1990 to 1.35 percent in 2009. It includes 0.33 percent of crop land and 0.30 percent of agriculture plantation. The 0.58 percent of area has remained unchanged.

Statistical Comparison 1990 and 2009

The total geographical area of Dindigul District is 6083 sq.kms. For the study, LU/LC has been mapped for two different years viz., 1990 and 2009. The area under LU/LC has been calculated into the 16 classes for the study years. The percentage of each class has been calculated and furnished in Table 2.

The area under urban built-up has increased from 0.37 percent in 1990 and 1.01 percent in 2009. There is a marginal increase in mining area from 0.04 percent in 1973 to 0.07 percent in 2009. The areal extent of rural built-up has increased thrice from 0.43 percent to 1.14 percent.

The area under crop land has decreased from 32.59 percent in 1990 to 27.54 percent in 2009. The area under fallow land has increased from 13.97 percent in 1990 to 15.04 percent in 2009. Area under plantation as increased from 15.11 percent in 1990 to 18.75 percent in 2009.

The area under dense forest has decreased twice from 5.27 percent in 1990 to 2.86 percent in 2009. The deciduous forest increased from 13.98 percent in 1990 to 12.43 percent in 2009. The forest scrub land has decreased from 2.23 percent in 1990 to 2.77 percent in 2009. The area under forest plantation has steadily increased from 3.75 percent in 1990 to 5.65 percent in 2009. The grazing land has decreased from 1.43 percent in 1990 to 1.34 percent in 2009 (Figure 5).

The area under barren rocky has marginally decreased from 6.36

percent in 1990 to 6.21 percent in 2009. The scrub land has increased from 1.34 percent in 1990 to 1.43 percent in 2009. The gullied land has increased from 1.38 percent in 1990 to 1.93 percent in 2009 of the total geographical area of the district.

The areal extent of river/stream has increased from 0.37 percent in 1990 to 0.47 percent in 2009. But, the area under tank as steadily decreased 1.37 percent in 1990. In 2009 it has got reduced to 1.36 percent.

The Table 2 and Figure 5 reveal that there is an increasing trend in built-up area, especially in urban and rural built-up shows the increasing trend. The areal extend of agricultural land has increased particularly plantation and fallow land have got more development then the crop land. The area under forest plantation and gullied land are also showing increasing tendency. While the areal extent of crop land, dense forest, deciduous forest, grazing land, barren rocky and tank shows decreasing tendency in Dindigul District.

Conclusion

It is evident from the analysis of satellite images that the area under crop land has been utilized for urban built-up and rural built-up. The area under crop land and fallow land has been converted into plantation. The spatial distribution of dense forest has showing decreasing tendency and the area under forest plantation revealing increasing trend. While the areal extent of crop land, fallow land, dense forest, forest scrub, deciduous forest, grazing land, barren rocky, scrub land, river/stream and tank is decreased. Especially, the dense forest has lost 2.47 percent in Dindigul district between 1990 and 2009.

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