

An analysis of temporal dynamics of various ecosystems in the district Hoshiarpur, Punjab (India)

Abstract

The diversity and extent of ecosystems in any geographical region are defined by its geography and climate of area. The district of Hoshiarpur in the state of Punjab (India), which covers 395312 hectares of land in the state of Punjab in India, encompasses various ecosystems, forest ecosystem, agricultural cropland, urban ecosystem, pasture land, orchards and wasteland. For the geographical location of district in the foothills of Shivalik range in Northern India, the district was at one of time known for the presence of distinct partial aquatic ecosystem, the seasonal Hilly Torrents, locally known as “Choes” that were used to run through the district during the rainy season. These seasonal drains were used to run from the hills down into the plains of the district Hoshiarpur during monsoon season carrying water and lots of sand, gravel and stones. However, with the increase in urbanization and construction of dams up in the hills, these trails of rainy water now remain almost dry even during the rainy season. However, the district is still considered to be the green belt of Punjab in the times of increasing desertification and urbanization all around in the state. The objective of this study was to analyze any significant change in its ecosystems mainly vegetative cover in the district that may have occurred until 2015-2016 taking 1975 as the base year. The data available from the year 1975 shows that the district had 65.21% of its geographical area as cultivated area and 9.305 % as forested land. However, the data available from the latest year of 2015-2016 shows the district having increase in its area under cultivation (72.68%) and forest cover (18.03%). It is concluded that district has observed an increase in the forest/vegetative and agricultural land ecosystems with aquatic ecosystems covering a geographical area of 2.133%.

Keywords: land ecosystems, aquatic ecosystems, geographical area, cultivated area, vegetative cover, indistinct boundaries

Volume 9 Issue 1 - 2025

Kirandeep K Dhani

Department of Botanical & Environmental Sciences, Guru Nanak Dev University, India

Correspondence: Kirandeep K Dhani, Department of Botanical & Environmental Sciences, Guru Nanak Dev University, 143005, India, Tel +89684717 23, Email kirandeepdhani@gmail.com

Received: December 20, 2024 | **Published:** January 22, 2025

Introduction

The distribution of various ecosystems that make this planet earth, is variable over space and time depending upon various natural or anthropogenic factors like earthquakes, urbanization, population expansion etc. These ecosystems have indistinct boundaries and physical area covered by each ecosystem in different regions over the time locally as well as globally. This variation in the extent of local ecosystems is observable by remote sensing in the terms of land use and land cover. Land use describe how the land is being used and land cover describes what covers the earth's surface. Land cover data documents how much area in a country, district is covered by forests, or water and Land use describes how the land is being used by people, either for building or conservation.

Land use and Land cover (LULC) estimates can be obtained using different methodologies. One, using the topographical maps created on the scale of 1:50,000, or 1:25,000 (available from Survey of India)¹ or soil survey organizations. However, the maps do not report the LULC changes that might have occurred in recent a few years. Two, using the remote sensing, which is being applied these days preferably. In India, DOS acquires such data using multi-temporal Resourcesat-2 terrain corrected Linear Imaging Self Scanning Sensor (LISS)-III under Natural Resources Census (NRC). This data uses a classification scheme as tabulated in Table 1 for various ecosystems in any region.² The satellite or aerial imagery provides the land cover estimate of that time or year, while land cover maps for different years provide for changes in ecosystem boundaries over the time. This type of data is then used to evaluate any kind of change in Land use land cover pattern over a period of time and provide a general overview of changes in the boundaries of local ecosystem over time

Hoshiarpur, is a district in the state of Punjab (India), which lies between the Sutlej and Beas rivers (between latitude 32°5 and 30° 58', and longitude 76° 4t' and 75° 31', Figure 1 & 2) and covers an area of 33900 Hectares. Two rivers, Beas and Sutlej, practically form the northern and southern boundaries of the District. The climate of the district is mild. Summer sets in April and ends in June every year. The season is followed by rainy season in July August and September. Winters begin in October and last up to March end. Summer season is hot when temperatures cross 45 Degrees centigrade. Winters are harsh, when temperatures may touch 0 degree centigrade or a few degrees below sometimes. Total average rain fall in the district is 1125 mm, out of which 75% rainfall is experienced in the period July to September, whereas 15% rainfall is experienced in the winter months of January and February. For its climate and geographical location in the foothills of small Shivalik ranges, the district of Hoshiarpur has remained renowned for mainly two ecosystems: One, the Seasonal Hill Torrents (known as “Choe” in its local language Punjabi) and secondly, the vegetation, specifically the mango trees. The hill torrents or “Choes” (Singular “Choe”) rise in the hills after a rainfall, and leave the hills in the form of a narrow outlet and widens on its way through the plains. Again, after traveling in the plains, these break up into a number of branches before drying up again on the land. Since, the district is located in the foothills of Shivalik ranges, it bears the rush of these seasonal torrents after every rainfall. The choes bring lots of stones, pebbles, sand into the plains plus it is a natural system of recharging the groundwater in the plains.

Second most prevalent ecosystem in the District is its vegetation cover or forest cover. The natural vegetation and plantation, which is broadly related to its climate and geography, is quite diverse, and provide the district with its green belt. The district is specifically

famous for a large cultivation of its mango species (*Mangifera indica*). Other species predominantly found in the region include *Dalberaja sisoo* (Shisham), *Morusalba* (toot), *Azdirachtaindic* (neem) *Ficusspp* (pipal and bargad) as trees; *Zizyphusnummularia* (Jherberi), *Pongamea-glabra* (Aak), *Mimosa subicaulis* (Ral) as shrubs and *Saccharummunja* (Kana), *Saccharumspontaneum* (Kahi) as grasses. Vegetation encountered on the hills include the following species: *Acacia nilotica* (kikar), *Acacia catechu* (Khair), *Bombexcrioca* (semal) *Bivetiapaervis* (chamror) as tress; *Bauhinia Vahlli* (taur), *Dedoneaviscosa* (mander), *Indigofarasp* (Kathi) as shrubs as *Cenchrus - celearis* (chaman) *Buldiopisbinata* (bagger), *Chrangnites (nara)* as grasses. Some of the shrubs and trees found in the district include (shrubs. Halo, a smaller variety of ber: sannan (*Ougeinea Dalbergioides*): taur, Malghan (*Etauhinia Vahlii*): Bankar (*Premna Mucronata*): airs, Amaltas (*Cassia fistula*): aurzu (*Elmodendron Roxburghii*): hires: basuti, akkar (*Adhatoria Vasica*): sandhila : kirnits: Peidat (*Stereospermum suaveolens*). The bhet or willow (*Salim tetrasperma*) is a good tree for choe protection works as it has good spreading roots. Banna (*Vitex negundo*) is a deep-rooted shrub which grows to the height of a man. Shisham (*Dalbergia sissoo*) is quick growing and has long binding roots.³

These ecosystems in the district specifically the vegetation, and water bodies have their boundaries indistinct geographically and are variable temporally depending upon the population pressure, urbanization and developmental activities. The objective of this article is to understand the temporal dynamics of various ecosystems within the district and document the land use and land cover changes that have been observed since 1975 in the district of Hoshiarpur, Punjab (India) since 1975 (Administrative Office, Hoshiarpur).⁴

Materials and methods

The data used in this article for the purposes of its objectives was provided by ISRO geoportal. This data on land use and land cover has been generated on 1:50,000 scale using IRS LISS III satellite data for the years 2005-2006, 2011-2012 and 2016-2017 by ISRO and uses a classification system as described in Table 1.⁵ This system of classification has several categories of 27 classes for land use and land cover which are interpreted based on image parameters like tone, texture, pattern, size, and shape etc. Such a kind of data on Land use and land cover information is generated only once in 5 years at 1: 50000 scale. NRSC makes such kind of assessments for the country under Natural Resources Census (NRC) programme of ISRO since 2005 and prepares annual Land use and Land cover data for each state and district in India for land management practices in the country. This mapping of various ecosystem distribution was taken up using Kharif, Rabi and Zaid seasons of each year. This article analyses the compilation of LULC data from 2005-2006 until 2015-2016 for the district of Hoshiarpur in Punjab (India)⁶⁻⁸ and compares it to the land utilization area in the district as available from the records in 1975 (Figure 1&2, Table 1&2).

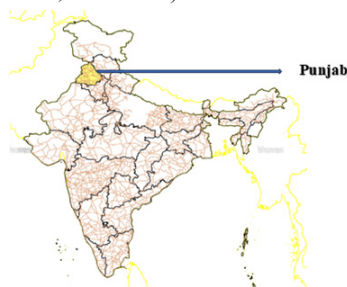


Figure 1 The state of Punjab is shown in yellow on the map of India with all the state boundaries in dark shade.



Figure 2 The district of Hoshiarpur in Punjab (India) is shown in yellow on the map of Punjab.

Table 1 Land use Land cover Classification Scheme as used with brief description given in appendix (NRSC, 2012)

S. No	Basic description	Classes
1	Buitup Land	Urban
		Rural
		Mining
2	Agriculture	Rural
		Mining
		Crop Land
		Plantation
		Fallow
3	Forest	Shifting cultivation
		Evergreen
		Deciduous
		Forest
		Scrub
		Swamp/mangroves
		Grass/Grazing
4	Grass Grazing	Grass/Grazing
		Salt affected land
5	Barren/wasteland	Gullied/ravinous
		Scrub land
		Sandy area
		Barren Rocky
		Rann
		Inland wetland
		Coastal wetland
6	Wetlands/Waterbodies	River/Stream/Canals
		Waterbodies
7	Snow/Glaciers	

Results and discussion

This record (Table 2) from the year 1975 on land use and classification in the district of Hoshiarpur (as available from the district commissioner’s office) shows that the total geographical area of the district in those times amounted to 391253 hectares (3912 Sq Kms). Maximum area in the district was under crop cultivation which amounted to 65.21 % and the forested land was 8.6 %. Waste land in the district at that time was 11.9% of total geographical area of the district. The area under pasture and orchards also amounted to 0.58% of the total geographical area of the district. There is no data available on the area under waterbodies (Wetlands, canals, streams or rivers) as available in the current times.

Table 2 Land Utilization in the District Hoshiarpur, Punjab (India) in 1975

S.No	Classification	Area (Hectares)	Percentage
1	Geographical Area	391253	
2	Cultivated Land	255150	65.21356
3	Waste Land	46602	11.91096
4	Unculturable Waste Land	90.25	0.023067
5	Forest Land	29298	7.488249
6	Current Forest	4868	1.244208
7	Pasture	2185	0.558462
8	Orchard	137	0.035016
9	Area under paths, hill roads and habitations	33220	8.49067
10	Current low	1946	0.497376
11	Miscellaneous Land	8821	2.254551

The data from NRC-LULC in the year 2005-2006 shows that the area under cropland equalled almost 61.51% of total geographical region of the district and the plantation under agriculture amounted to 10.47%. The data do not record any presence of barren or rocky land or rann area in the district. While most of the land is under crop cultivation, forest area in the district in this year covered 18.028% of the total geographical region of the district. Among all the classification classes, it was observed that salt affected land has the minimal share (0.017%) among all the categories defined under classification scheme. Built-up land in rural or urban regions occupied 4.827% of the total in this year (Table 3, Figure 3a).

Table 3 Different ecosystems and their share of geographical coverage in Hoshiarpur (Punjab) Total geographical area of District 3310 Sq Kms. ⁶⁻⁸

	2005-06	Percent of total	2011-2012	Percent of total	2015-16	Percent of total
Agriculture (Sq Kms)						
Crop land	2036.06	61.51239	2015.53	60.89215	2329.49	70.37734
Fallow	4.53	0.136858	6.37	0.192447	13.36	0.403625
Plantation	346.58	10.47069	357.56	10.80242	62.95	1.901813
Barren/Waste lands			2.65	0.08006		
Barren rocky						
Gullied Ravinous land	2.75	0.083082	0	0	5.65	0.170695
Rann						
Salt affected land	0.59	0.017825	0.76	0.022961	0.02	0.000604
Sandy area	13.64	0.412085	6.03	0.182175	6.73	0.203323
Scrub land	69.88	2.111178	72.71	2.196677	44.31	1.338671
Builtup						
Mining	5.59	0.168882	7.78	0.235045	8.68	0.262236
Rural	100.99	3.051057	110.94	3.351662	113.89	3.440785
Urban	53.25	1.608761	57.96	1.751057	56.79	1.71571
Forest						
Deciduous	564.53	17.05529	564.64	17.05861	568.53	17.17613
Plantation	11.97	0.361631	10.91	0.329607	12.83	0.387613
Scrub forest	20.44	0.617523	20.02	0.604834	16.09	0.486103
Grass/grazing						
Wetlands/Waterbodies						
Inland wetland	9.87	0.298187	7.43	0.224471	2.83	0.085498
Rivers/streams/canals	66.08	1.996375	64.8	1.957704	63.55	1.91994
Waterbodies	3.23	0.097583	3.91	0.118127	4.3	0.129909

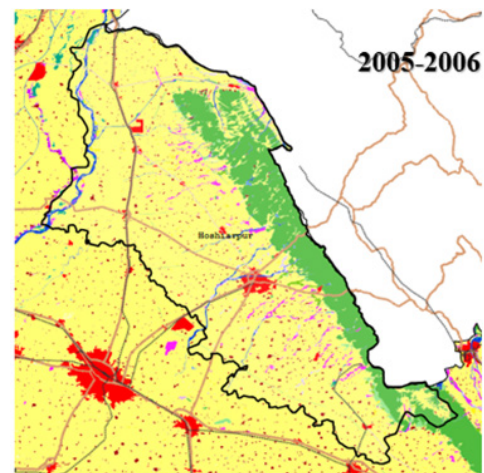


Figure 3a The distribution of ecosystems in Hoshiarpur district in 2005-2006. The color schematic for various ecosystems has been provided.

In year of 2011-2012, the data from NRC-LULC shows that there was a minor change in the ecosystem coverage areas from 2005-2006. While the area under cropland in the district decreased by 0.62% in five years and plantation under agriculture amounted to 10.80% that was an increase of 0.33%. Barren land in the district was reported for the first time at 0.08% of the total area in the district. There was no barren or rocky land/ Gullied Ravinous land in the district as per the records. Total Forest cover amounted to 17.99% of the total geographical region, while the area under waterbodies (wetlands/ rivers/streams/canals and other waterbodies) amounted to 2.299% of the total geographical area of the district. Area under Built-up category was only 5.337% of the total geographical area. Again, the salt affected land was observed to the minimal of 0.022% of total geographic region (Table 3, Figure 3b).

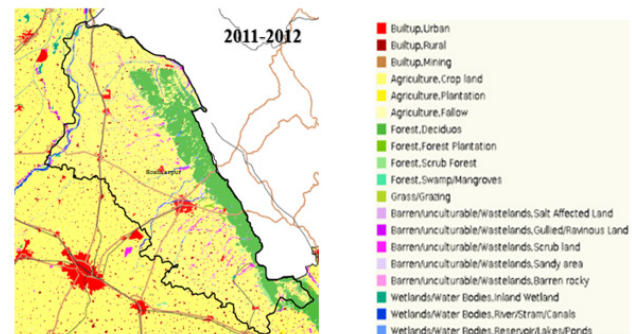


Figure 3b The distribution of ecosystems in Hoshiarpur district in 2011-2012.

The data for the year 2015-2016 shows that the area under crop cultivation was observed to be the maximum of all the years (70.337%). No barren and rocky land is reported even this year. The salt affected land furthermore decreased to 0.000604% of the total geographical region. Total area under forest cover amounted to 18.049% and area under wetlands and waterbodies amounted to 2.133% of the total geographical region in the district (Table 3, Figure 3c).

Overall, it was found that the district observed an increase in crop cultivated region since 1975 which has seen an increase of about 5%. The overall forest cover increased by 10% in 2015-2016 and the barren rocky land stayed at nil while the salt affected land also stayed at the bare minimal. This analysis of distribution of green belt and water

bodies in the district is based upon the available data. There is a small variability in the exact geographical area of the district. The 1975 record estimates it as 3912.53 Sq Kms while the district administration data records displays the area as 3390 Sq Kms. However, the NRC-LULC estimates it as 3310 Sq Kms. For the purposes of calculation, NRC-LULC estimates have been used as the base for the years 2005-06, 2011-2012 and 2015-2016. It was also observed that the land utilization classification and categories specified in 1975 record are not as elaborative as NRC Land use Land cover data for the years 2005-06, 2011-12 and 2015-16. The old record has been compiled and placed in record for administrative purposes. While the data on current times is uniform in its classification scheme, the data available from the year 1975 is not as extensive as that of today as available under NRC program. There is no record on how the geographic distribution of various ecosystems might have been assessed in 1975. However, it is assumed that data collection in the past must have been carried out manually in those times.

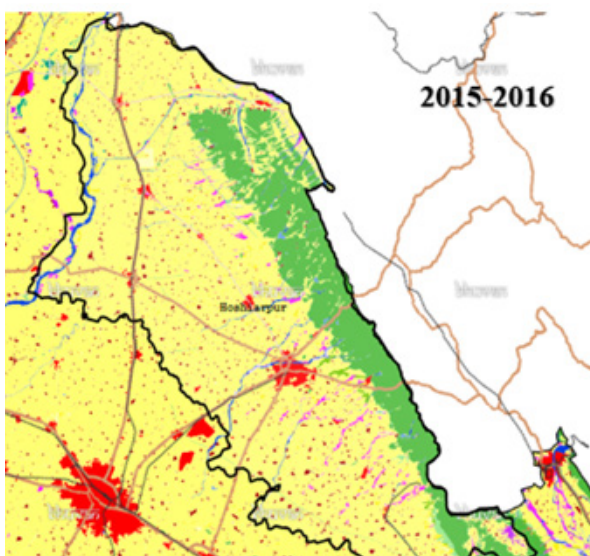


Figure 3c The distribution of ecosystems in Hoshiarpur district in 2015-2016.

Image Data Source: IRS P6 LISS III satellite data of Kharif (October/November), Rabi (January/February/March) and Zaid (April/May) of following year. Land Use/ Land Cover Mapping on 1:50,000 scale using multi-temporal Resourcesat-2 terrain corrected Linear Imaging Self Scanning Sensor (LISS) -III data was taken up by DOS, under Natural Resources Census (NRC) Project of National Natural Resources Repository (NRR) Program

Conclusion

It can be concluded the district has observed an overall increase in geographical area for crop cultivated ecosystem and forest ecosystem since 1975. While the district had 65.21% of its geographical area as cultivated area and 9.305 % as forested land in 1975, these ecosystems observed an increase to 72.68% and 18.03% in its geographical range in the district in 2015-2016. Since, no data on the land use by various waterbodies was available for year 1975, the assessment on the expansion or contraction in aquatic ecosystems within the district is incomplete. The latest data available suggests that only 2.13% of the geographical area in the district is covered by aquatic ecosystems, which can be attributed to reduced rainfall in the state, disappearance of “choes” or Hill torrents in the recent past and construction of

various dams in the uphill regions of adjoining state of Himachal Pradesh in India. It is concluded that district has observed an increase in the forest/vegetative and agricultural land ecosystems with aquatic ecosystems covering a geographical area of 2.133 % (Appendix).

Acknowledgements

Thanks to National Remote Sensing Centre (NRSC), ISRO, Hyderabad, India for providing Land Use/ Land Cover information for this work from Natural Resources Census Project.

Conflicts of interest

The author the declares there is no conflict of interest.

References

1. Soil Resource Based Land Use of Hoshiarpur & Nawanshahr District (Punjab) National Bureau of Soil Survey & Land Use Planning. *Indian Council of Agricultural Research*. 2017;1–110.
2. Pallavi S, Dattatray GR. ISRO, NRSC, (2012), Manual of National Land Use/Land Cover Mapping (Second Cycle) Using Multi-temporal Satellite Data, Department of Space, Hyderabad. *JGIS*. 2024;16(1):21–31.
3. Forest Survey of India. *Report on Inventory of Trees Outside forests in Punjab*. 2006.
4. Manhas RK, Singh L, Vasistha et al. HB Floristic Diversity of Protected Ecosystems of Kandi Region of Punjab, India. *New York Science Journal*. 2010;3(4):96–103.
5. NRSC. *Land Use Land Cover Atlas of India (Based on Multi-temporal Satellite Data of 2005-2006)*, Department of Space, ISRO, GOI, Hyderabad. 2011.
6. NRSC. Land Use / Land Cover database on 1:50,000 scale, Natural Resources Census, Project, LUCMD, LRUMG, RSAA, National Remote Sensing Centre, ISRO, Hyderabad. 2019.
7. NRSC. Land Use / Land Cover database on 1:50,000 scale, Natural Resources Census Project, LUCMD, LRUMG, RSAA, National Remote Sensing Centre, ISRO, Hyderabad. 2014.
8. NRSC. Land Use / Land Cover database on 1:50,000 scale, Natural Resources Census Project, LUCMD, LRUMG, RS & GIS AA, National Remote Sensing Centre, ISRO, Hyderabad. 2006.

Appendix

DESCRIPTIONS OF LAND USE AND LAND COVER CLASSES		
LULC classification scheme and brief description of classes are as given hereunder:		
Sl.	Description-1	Description-2
1	Builtup	Urban
		Rural
		Mining
2	Agriculture	Crop land
		Plantation
		Fallow
3	Forest	Current Shifting cultivation
		Evergreen / Semi evergreen
		Deciduous
		Forest Plantation
4	Grass/ Grazing	Swamp / Mangroves
		Grass/ Grazing
		Salt Affected Land
		Gullied / Ravinous Land
		Scrub land
5	Barren/unculturable/Watlands	Sandy area
		Barren rocky
		Rann
		Inland Wetland
		Coastal Wetland
		River / Stream / canals
		Water bodies
7	Snow and Glacier	Seasonal and Permanent snow