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Land Use Change under the Condition of High Population Pressure: A Geographical Study of Ayodhya District, Uttar Pradesh

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Abstract : *This paper aims to analyze the impact of population growth and density on land use change during 1991-2019 in Ayodhya district of Uttar Pradesh. Population density is considered as the main driving force of land use change; and apart from this, there are some other factors i.e. urbanization, industrial development etc., which also affect the land use of any region. In this paper Ayodhya district has been selected as the study area to understand impact of population growth on land use change. Data was collected from secondary sources, tabulated and calculated in MS Excel sheet. Map was prepared with the help of ArcGIS software. Changes in spatial land use in the district were also analyzed using regression and correlation techniques. The results showed that the area under cultivable waste land has decreased, and the area under forest, net sown area and non-agricultural use have increased. The area under forest has increased due to plantation in reserved forest areas. Area under cultivable waste land has decreased due to reclamation of the waste land for the agricultural and residential purposes.*

Keywords : *Land use change, population growth, population density, agriculture*

Introduction

Land is the platform which supports all the anthropogenic activities; it embodies all natural as well as cultural landscape over the earth surface. With the development of medical sciences and government initiatives to ensure the food security in 20th century, human population have registered a rapid increase and to meet the demand of food and shelter of this growing population, global land use pattern, especially agricultural land use pattern, have gone through some drastic changes. Land use is the surface utilization of all developed and vacant land on specific point at given time and space (Mandal, 1982).The area under forest, grassland and water bodies has been converted into cropland and built-up land all over the world. Land use can be defined as man's activities and various usages which are carried on land (Clawson and Stewart, 1965). The geographical interpretation and understanding of land use change and driving forces are important in order to assess the socio-economic and environmental processes taking place in a given area.The pattern of

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land use change is an important parameter to understand the land use planning, management and its sustainability. Historically, the most important driving force for most of the land use changes is population growth (Meyer and Turner, 1992). Pressure of population on land use is the biggest challenge in the present day scenario. Borah (2003) concluded that population pressure by increasing food demand intensifies agricultural land use. Depending upon social, cultural, political and economic activities the purpose of land use differs from one country to other. Developed and developing countries have different land use pattern. The changes in land use in developed countries are mainly driven by economic reasons: such as large scale farming, urban development and industrial establishments. But, in the developing countries poverty and rapid population growth are the major driving forces (Ramankutty and foley, 1999) in this regard. Countries, like India, face immense pressure on land. Although India recognized the problem of rapid population growth soon after the independence, it has limited success in controlling its growth rate (International Institute for Population Sciences and ORC Macro, 2000).

In this paper, an attempt has been made to highlight the nature of population pressure and its impact on land use change in Ayodhya district for the period from 1991 to 2019. The main objectives of the study are:

(i) To analyze the changing land use pattern in Ayodhya district, and

(ii) To assess the impact of population growth on land use pattern of the district.

The Study Area

Ayodhya district, is situated in the eastern part of the state of Uttar Pradesh. The official name of district was changed from Faizabad to Ayodhya in November 2018 by the Uttar Pradesh Government. It stretches from 26°24’ to 26°52’N of latitudes and in terms of longitude, it lies between 81°42’ and 82°28’E. The district has an area of 2764 sq. km. Ayodhya had a population of 2,470,996 persons (Census of India, 2011). The district is surrounded by Basti and Ambedkar Nagar in the east, district Barabanki in the west, district Gonda in the north, and Sultanpur in the south. It is part of the Middle Ganga Plain and covered by alluvial soil.

Data base and Methodology

The data for this study have been collected from various secondary sources such as Directorate of Economics and Statistics of Ayodhya district, and District Census Handbook, Ayodhya. Land use data of 1999-2000, 2009-10 and 2018-19 have been used for the analysis of changes in land use. However, the changes in population pressure are analyzed on the basis of 1991, 2001 and 2011 census data. GIS mapping and other cartographic techniques have been used for interpretation and analysis of data. The technical committee on Co-ordination of Agricultural Statistics, setup in 1948, by the Ministry of Food and Agriculture, recommended a nine fold land use i.e. (i) Forests (ii) Barren cultivable waste, (iii) Present fallow land, (iv) other fallow land, (v) Barren & uncultivable land, (vi) Land put to non-agriculture use, (vii) Pastures, (viii) Area under bush & garden, and (ix) Net Area sown. On account of general understanding and requirement of this study, land use has been classified only in four categories namely: (i) Forests (ii) area under non-agricultural use (Barren

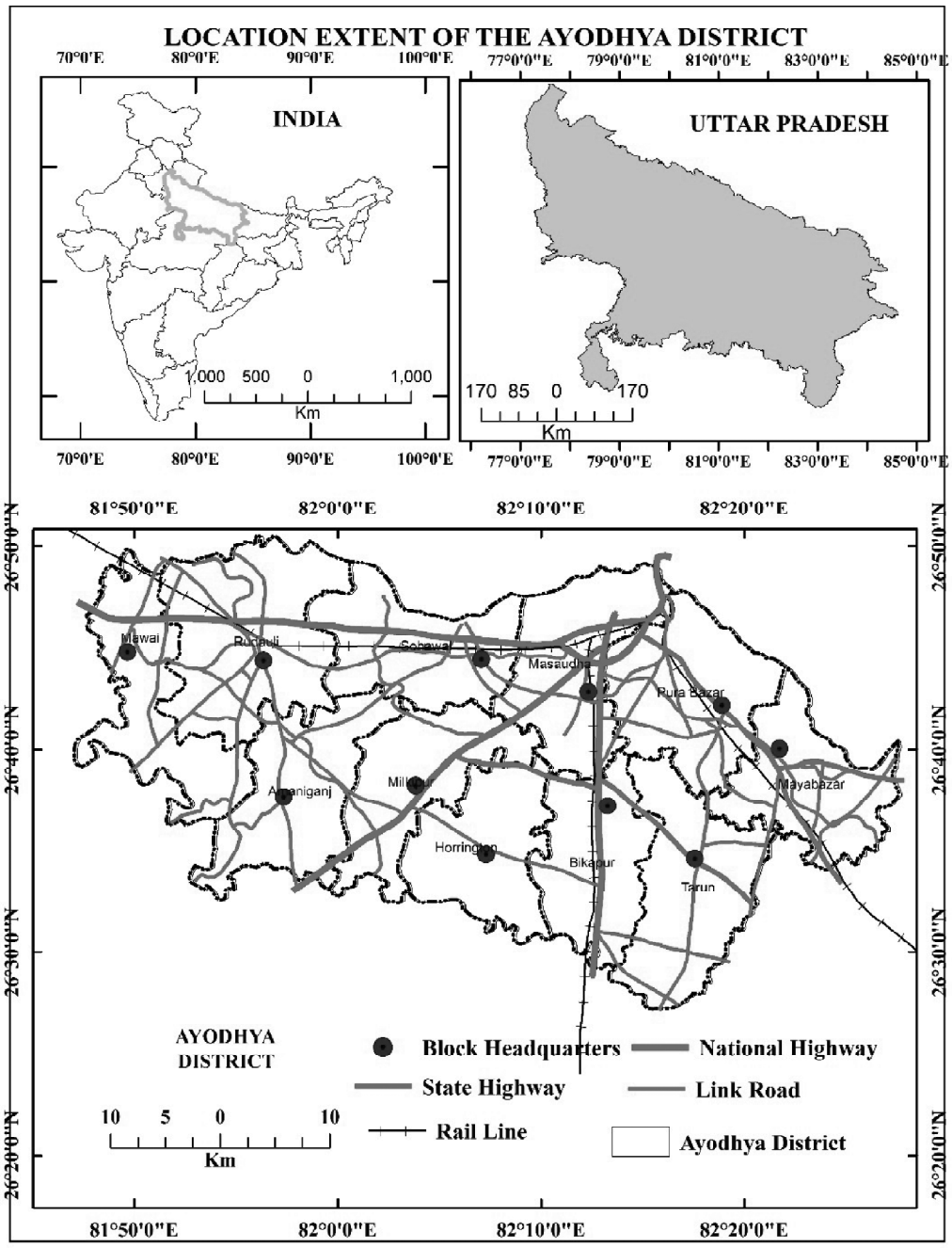

Fig. 1: **Location Map of the Study Area**

& uncultivable land and Land put to non-agriculture use) (iii) Cultivable waste land (Barren cultivable waste, present fallow land, other fallow land, Pastures and Area under bush & garden) (iv) Net Area sown. The area under non-agricultural use refers to the area not available for cultivation which includes all such lands which naturally or otherwise cannot be brought under cultivation. It comprises the land occupied by water bodies, human settlements, roads and streets and otherwise barren lands etc. (Chandel, 1991).

Result and discussions

Population growth of Ayodhya district has been analyzed with the help of the census data available from 1991 onwards. In 2001-2011, the population of Ayodhya district increased from 14,57,016 to 24,70,996 persons with 18.07% growth of population and the highest decadal growth was seen in the Rudauli (49.33%), Milkipur (18.56%) and Sohawal (16.85%) blocks and the lowest decadal growth was in Masaudha (9.76%) block. In 2001, the highest population density was found in Sohawal (986), Masaudha (920) and Purabajar (782) blocks while the lowest density was found in Mawai (578) block. In 2011, the highest density was recorded again in Sohawal (1186), Masaudha (1019) and Rudauli (980) blocks, while Rudauli registered the high density due to rapid population growth (49.33%) during 2001-11. The lowest density was found in Mawai (672) block (Table-1, Fig. 2&3).

Table 1. Population density of the district

Blocks	Area (Sq.km.)	Population			Density			Decadal Growth Rate (%)	
		1991	2001	2011	1991	2001	2011	91-01	2001-11
Sohawal	178.62	143643	176179	211891	697	986	1186	22.65	16.85
Masaudha	206.13	137493	189536	210054	667	920	1019	37.85	9.76
Pura Bazar	203.59	127132	159271	188686	624	782	927	25.28	15.58
Mayabazar	214.59	126869	154666	183935	591	721	857	21.91	15.91
Amaniganj	247.50	126062	155532	183618	509	628	742	23.37	15.29
Milkipur	219.69	128526	156881	192651	585	714	877	22.06	18.56
Horrington	218.90	109151	134497	157544	499	614	720	23.22	14.62
Bikapur	195.14	123452	150353	173629	633	771	890	21.79	13.4
Tarun	271.03	145828	180101	207576	538	665	766	23.50	13.23
Mawai	238.60	146119	1,37,909	160332	612	578	672	-5.62	16.26
Rudauli	266.10	133193	1,74,661	260827	501	656	980	31.13	49.33
District	**2459.89**	**1447468**	**1457016**	**2470996**	**587**	**730**	**876**	**22.47**	**18.07**

Source: District Census Handbook of Faizabad, 1991-2011

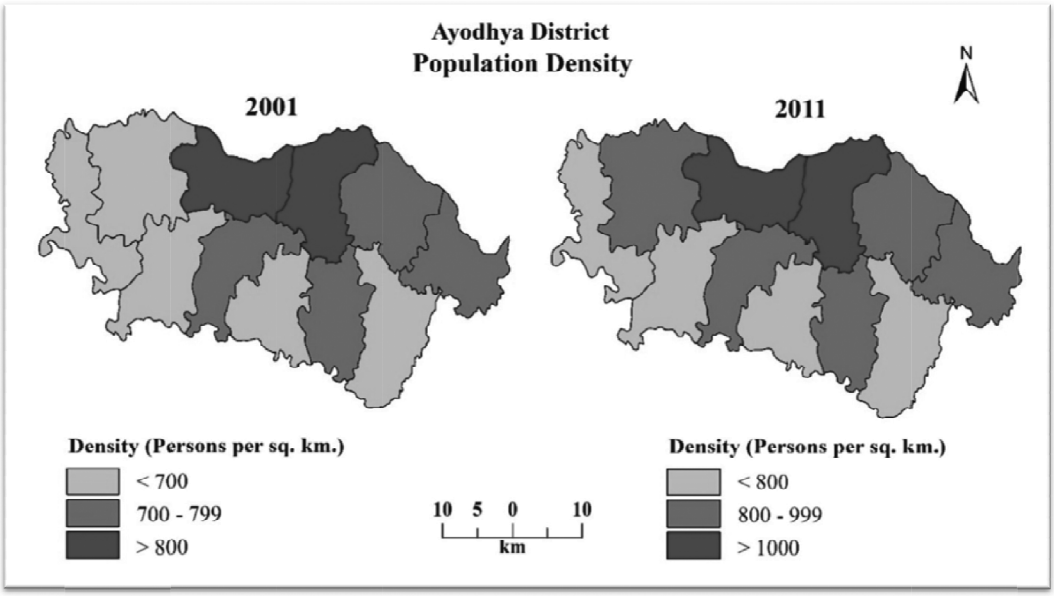

Fig. 2 Population Density of Ayodhya District

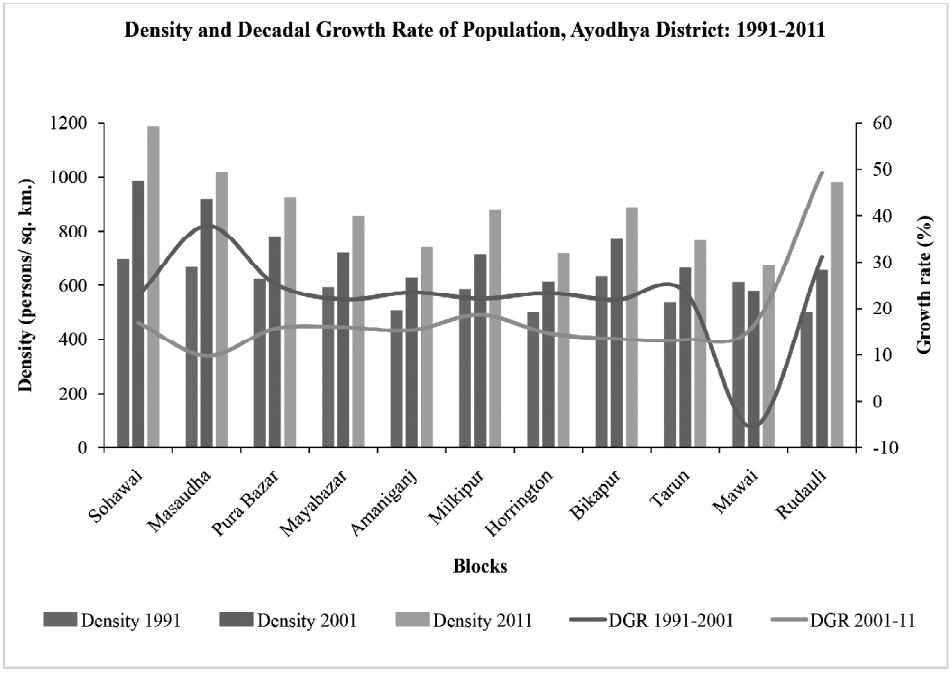

Fig.3 Population Density and Decadal Growth Rate of Population, Ayodhya District 2001-2011

Land Use Pattern

Land use is the management and modification of natural environment into built-up environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods (FAO, 1999). The area of which data on land use classification are available, is known as the 'reported area'.

Forest

According to the latest available data (2018-19) the total reported area of district is 2, 58,969 hectares which includes nearly 1.2% area under forest. In 1999-2000, 0.9 % of the total reported area of the district was under forests which were less than 33%, the targeted percentage area in the National Forest Policy, 1986. The area under forest in 2009-10 increased to 1.19% of the reported area due to expansion of forest into some barren land which further decreases to --1.16% of the reported area in 2018-19. The perusal of area under forest at block level in 2018-19 shows that Mawai block (26.01%) has the highest share of forest area followed by Rudauli (22.23%) and Maya Bazar (07.31%). Masaudha (4.57%), Bikapur (4.66%) and Sohawal (4.73%) blocks registered the lowest area in forest cover (Table-2, Fig.4).

Non-Agricultural Land Use

Area under non-agricultural use in the district was 6.73 percent area of the total reported area in 1999-2000 which increased to 16.23 % in 2009-10 and further decreased to 15.78 percent in 2018-19. Area under non-agricultural use was very high in Rudauli block (12.52%) in 2018-19 followed by Maya Bazar (10.69%) Sohawal (9.78 %) and Masaudha (9.54%) and it was lowest in the Mawai (7.80%) and Bikapur block (7.29%) (Table-2, Fig.4).

Cultivable Waste Land

Cultivable waste land includes that land which may be brought under cultivation. This category comprised 17.06 percent in 1999-2000 of the total reported area which slightly decreased to (15.86%) in 2009-10 and further declined to (12.48%) in 2018-19. The highest area under cultivable waste land was found in Tarun block (12.48%), Rudauli (9.83%) and Amaniganj (10.38%), whereas Horringtongunj block (6.51%) had the lowest area under cultivable waste land in 2018-19 (Table-2, Fig.4).

Net Area Sown

The land use pattern in Ayodhya district is dominated by net area sown because of better irrigation facilities. Net area sown represents to the total cultivated area which accounted for 67.25% of the total reported area in 1999-2000. This area decreases to 66.73% in 2009-10, but again increases to 69.19 % in 2018-19. There is variation in distribution of net sown area at block level. In 1999-2000, it was the highest in Rudauli block (13.50 %) followed by Tarun (10.50 %), Horringtongunj (09.70%) and Amaniganj (09.38 %) blocks, whereas the lowest net area sown was in Pura Bazar block (07.39 %). In 2018-19, land under this category was the highest in Rudauli block (13.27%) followed by Tarun (09.42 %) and Milkipur block (09.41%) whereas the lowest net area sown was registered in Pura Bazar block (07.62 %) (Table-2, Fig.4).

Table. 2: Block Wise Land Use Pattern

CD Block	Land Use Classes (Area in ha and percent)											
	Forest			Net Sown Area			Cultivable Waste Land			Area under non-agricultural use		
	1999-2000	2009-2010	2018-2019	1999-2000	2009-2010	2018-2019	1999-2000	2009-2010	18-19 2019	1999-2000	2009 2010	2018 2019
Sohawal	5	143	143	13566	14151	14691	3091	2791	2370	3340	3956	4342
	0.21	4.72	4.73	7.91	8.19	8.20	7.10	6.79	7.33	8.87	9.41	9.78
Masaudha	3	138	138	13899	14402	14623	3379	3078	2690	3736	4178	4237
	0.13	4.56	4.57	8.10	8.33	8.16	7.76	7.49	8.32	9.92	9.93	9.54
PuraBajar	4	178	178	12691	13158	13667	5274	3959	3111	3173	3838	3980
	0.17	5.88	5.89	7.40	7.61	7.63	12.11	9.64	9.62	8.43	9.13	8.96
Mayabajar	5	221	221	14949	14711	15279	3008	2942	2537	3980	4590	4749
	0.21	7.30	7.31	8.71	8.51	8.53	6.91	7.16	7.85	10.57	10.91	10.69
Amaniganj	524	188	188	16101	16248	16878	4606	4656	3355	3151	4067	4137
	22.35	6.21	6.22	9.38	9.40	9.42	10.58	11.33	10.38	8.37	9.67	9.31
Milkipur	10	204	204	15274	15496	16095	3538	3528	2770	2722	3151	3572
	0.43	6.73	6.75	8.90	8.96	8.98	8.12	8.59	8.57	7.23	7.49	8.04
Horrington	26	189	189	16647	15783	16395	2835	3897	2970	2615	3200	3468
	1.11	6.24	6.25	9.70	9.13	9.15	6.51	9.49	9.19	6.94	7.61	7.81
Bikapur	5	141	141	13351	16255	16886	4126	3566	2657	2315	2965	3239
	0.21	4.66	4.66	7.78	9.40	9.42	9.47	8.68	8.22	6.15	7.05	7.29
Tarun	14	164	164	18031	15629	16234	5287	5017	4034	2834	3598	3669
	0.60	5.41	5.43	10.51	9.04	9.06	12.14	12.21	12.48	7.53	8.56	8.26
Mawai	1581	788	788	13904	14120	14660	4026	3811	2654	3856	2858	3464
	67.42	26.02	26.07	8.10	8.17	8.18	9.24	9.28	8.21	10.24	6.80	7.80
Rudauli	168	675	669	23174	22898	23794	4380	3837	3178	5939	5640	5561
	7.16	22.28	22.13	13.51	13.25	13.28	10.06	9.34	9.83	15.77	13.41	12.52
District	2345	3029	3023	171587	172851	179202	43550	41082	32326	37661	42055	44418
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Based on district statistical dairy (Economics & Statistical department, Ayodhya) 1999, 2009, 2019

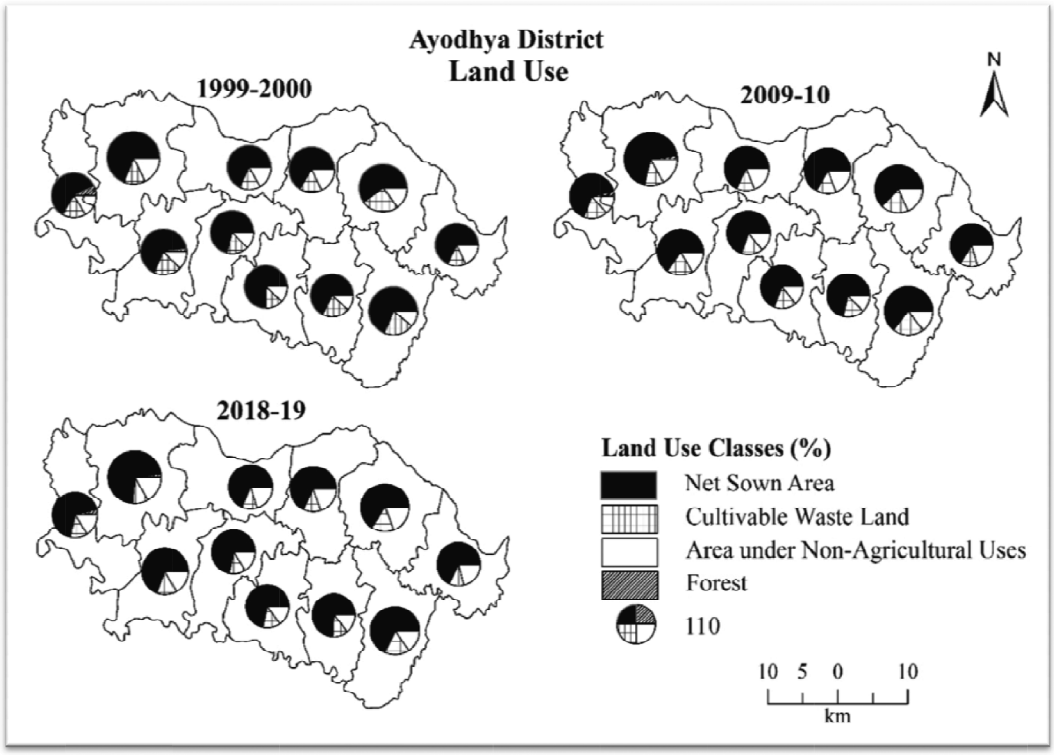

Fig. 4: General Land Use Pattern in the District.

Land Use Changes

Forest

Deforestation is an important process of land use/ land cover change(Lambin, 2001), but in study area the change in land use structure during past 18 years (1999-2019) depicts that forest land increased in 9 blocks namely in Sohawal (2760%), Masaudha (4500%), Pura Bazar (4350%), Maya Bazar (4320%), Milkipur (1940%), Horringtongunj (626%), Bikapur (2720%), Tarun (1071%), and Rudauli (298.21%) but forest land in Amaniganj (-64.12%), Mawai (50.16%) declined due to increase in agricultural and non-agriculture utilization of forests i.e. road and building construction, urbanization, industrial development and use of wood as industrial and domestic fuel etc. The International Panel on Climate Change (IPCC) emphasized that the conversion between forest and other land-use types (e.g., forest to cropland, grassland, or other land-use types) is frequently referred as deforestation. In contrast, afforestation "occurs when forest cover expands with the plantation of trees on lands without trees" (Rudel, 2005). In the district 28.91% increase has been registered during recorded period due to afforestation programs (Table-3)

Table-3: Block Wise Land Use Changes (area in ha)

Block	Forest			Net Sown Area			Cultivable Waste Land			Area under non-agricultural use		
	1999-2000	2018-2019	Percent Change	1999-2000	2018-2019	Percent Change	1999-2000	2018-2019	Percent Change	1999-2000	2018-2019	Percent Change
Sohawal	5	143	2760.00	13566	14691	8.29	3091	2370	-23.33	3340	4342	30.00
Masaudha	3	138	4500.00	13899	14623	5.21	3379	2690	-20.39	3736	4237	13.41
Pura Bazar	4	178	4350.00	12691	13667	7.69	5274	3111	-41.01	3173	3980	25.43
MayaBazar	5	221	4320.00	14949	15279	2.21	3008	2537	-15.66	3980	4749	19.32
Amaniganj	524	188	-64.12	16101	16878	4.83	4606	3355	-27.16	3151	4137	31.29
Milkipur	10	204	1940.00	15274	16095	5.38	3538	2770	-21.71	2722	3572	31.23
Horringtongunj	26	189	626.92	16647	16395	-1.51	2835	2970	4.76	2615	3468	32.62
Bikapur	5	141	2720.00	13351	16886	26.48	4126	2657	-35.60	2315	3239	39.91
Tarun	14	164	1071.43	18031	16234	-9.97	5287	4034	-23.70	2834	3669	29.46
Mawai	1581	788	-50.16	13904	14660	5.44	4026	2654	-34.08	3856	3464	-10.17
Rudauli	168	669	298.21	23174	23794	2.68	4380	3178	-27.44	5939	5561	-6.36
Total	**2345**	**3023**	**28.91**	**171587**	**179202**	**4.44**	**43550**	**32326**	**-25.77**	**37661**	**44418**	**17.94**

Source: Computed by Authors based on Land Use data, 1999-2019

Area under Non Agricultural use

From 1999-2019, area under non-agricultural use registered 17.94% increase in the district. Highest increase observed in Bikapur (39.91%) block, other blocks such as Horringtongunj (32.62%), Amaniganj (31.29%), Milkipur (31.23%), Sohawal (30.00%), Tarun (29.46%), Pura Bazar (25.43%), MayaBazar (19.32%) and Masaudha (13.41%) also witnessed positive change in area under non-agricultural use due to economic activities as well as increase in built-up area however lowest area under non-agricultural use was found in Mawai (-10.17%) and Rudauli (-6.36%) blocks (Table-3).

Cultivable Waste Land

A cultivable wasteland is a degraded land with minimum or no vegetation. Waste lands can be brought under vegetation with appropriate effort (Balasubramanian, 2015). Cultivable waste land registered a decrease of about 25.77 % in the district during 1999-2000 to 2018-19. This has been possible due to application of scientific techniques to an impressive enhancement in current fallow. Cultivable waste land registered an increased between 1999-2010, but declined in 2018-19 in most of the blocks because of significant increase in area under bushes, garden/horticulture and plantation along with increase in current fallow. Horringtongunj (4.76%) is the only block where slight increase of cultivable waste land was seen (Table-3).

Net Sown Area

Net Area Sown represents the total cultivated area during the reference year without considering the number of times it has been cultivated in a year (Agricultural Census Division). This is the most important category of land use, and is directly related to the crop cultivation and production of food for the human consumption. Net sown area registered an increase of 04.44 % during 1999-00 to 2018-19 in the district. But at block level there are significant variations in net area sown during this period as in Tarun (-9.97%) and Horringtongunj (-1.51%) blocks registered decrease in net sown area and remaining nine blocks i.e. Bikapur (26.48%), Sohawal (8.29%), PuraBazar (7.69%), Mawai (5.44%), Milkipur (5.38%), Masaudha (5.21%), Amaniganj (4.38%), Rudauli (2.68%) and Mayabazar registered positive change in net area sown in Ayodhya (Table-3)

Per Capita Land Availability

High population growth results into high population pressure on land due to reduction in the per capita availability of the land. Table-4 shows the per capita land availability under major four categories in the district. The per capita forest land availability was negligible (0.00 ha) in 1999-2000 which remained unchanged in 2018-19. This clearly indicates the pressure of population on the forest resource. The highest per capita forest land availability is recorded in Mawai block (0.01 ha), followed by Rudauli (0.00 ha) in 2018-19. The other blocks have very poor forest cover due to huge population pressure and poor forest policy. Area under non-agricultural use decreased from 0.03 ha in 1999-2000 to 0.02 ha per person in 2018-19 due to urban infrastructure development which is not a good sign from agricultural point of view. Almost all the blocks depicted a shift towards conversion

of agricultural land for urban activities.Per capita availability of cultivable waste land in the district decreased from 0.03 ha in 1999-00 to 0.01 ha in 2018-19 which may be considered as a positive change, because farmers started using fertilizers, pesticides and other technological innovations to reclaim the waste land for agricultural purposes. The real population pressure is noticed on per capita availability of arable land which was 0.12 ha in 1999-00, but continuously it shrank to 0.07 ha in 2018-19. Block wise analysis shows that the highest per capita availability of arable land was noticed in Horringtonganj block (0.10 ha) in 2018-19 followed by Bikapur (0.10 ha), Amaniganj (0.09 ha), Mawai (0.09 ha) and Rudauli (0.09 ha) blocks where per capita area was higher than other blocks.

Table-4 : Per Capita Land Availability (in ha)

Block	Forest		Net Area Sown		Cultivable Waste Land		Area Under Non Agricultural Use	
	1999	2019	1999	2019	1999	2019	1999	2019
Sohawal	0.00	0.00	0.09	0.07	0.02	0.01	0.02	0.02
Masaudha	0.00	0.00	0.10	0.07	0.02	0.01	0.03	0.02
Pura Bazar	0.00	0.00	0.10	0.07	0.04	0.02	0.02	0.02
MayaBazar	0.00	0.00	0.12	0.08	0.02	0.01	0.03	0.03
Amaniganj	0.00	0.00	0.13	0.09	0.04	0.02	0.02	0.02
Milkipur	0.00	0.00	0.12	0.08	0.03	0.01	0.02	0.02
Horringtonganj	0.00	0.00	0.15	0.10	0.03	0.02	0.02	0.02
Bikapur	0.00	0.00	0.11	0.10	0.03	0.02	0.02	0.02
Tarun	0.00	0.00	0.12	0.08	0.04	0.02	0.02	0.02
Mawai	0.01	0.00	0.10	0.09	0.03	0.02	0.03	0.02
Rudauli	0.00	0.00	0.17	0.09	0.03	0.01	0.04	0.02
Total	**0.01**	**0.00**	**0.12**	**0.07**	**0.03**	**0.01**	**0.03**	**0.02**

Source: Computed by Authors based on Census of India 1991, 2011 & District Statistical Hand Book, 1999 and 2019

Correlation between Population Density and Different Land Uses

If we see correlation between forest area and population density (Fig. 5A) then the equation of the regression line is y = -0.4095x + 633.56, whose coefficient of correlation is 0.271, which indicates that the forest area is decreasing with increasing population density. The coefficient of determination R^2 is 0.0735, indicating that the figure is determined by 49.47 percent of the regression line of diversity. Similarly, Fig. 5B, 5C and 5D which are showing correlation of population density

with area under non Agricultural use, cultivable waste land and net area sown, whose correlation coefficient is 0.47, 0.42 and 0.44 respectively. On the basis of the Fig. 5C & 5D we can say that as the population density increased in Ayodhya district cultivable waste land and net area sown also increased.

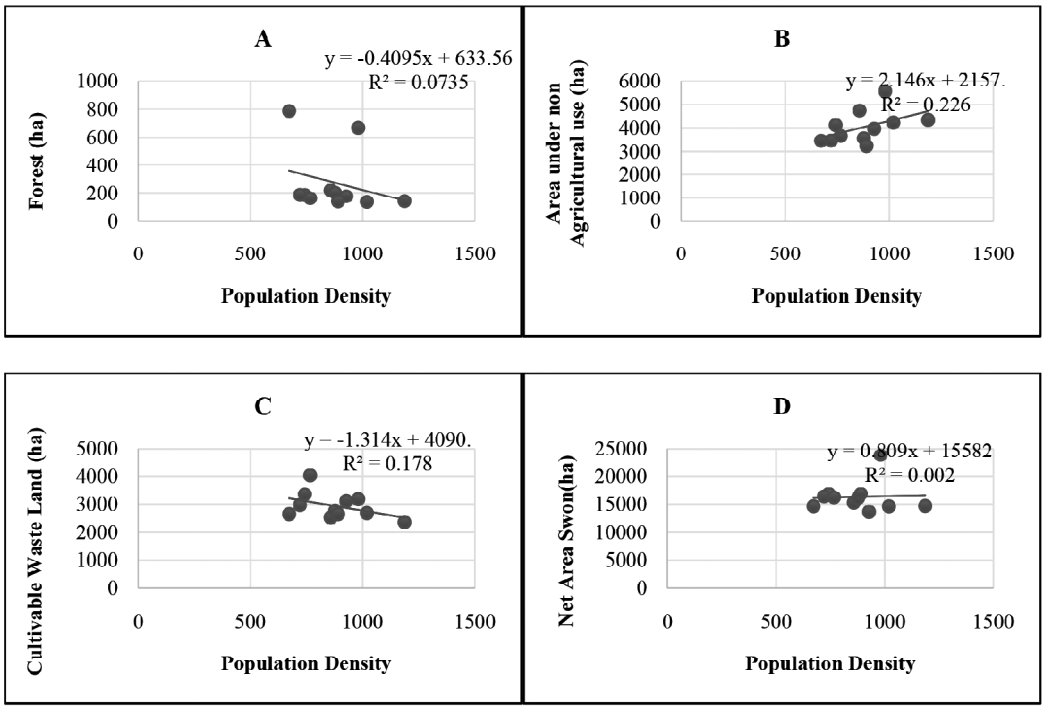

Fig 5: correlation between population densities with different land uses

Fig. A	**Fig. B**	**Fig. C**	**Fig. D**
Forest Area Vs Population Density	Area under non Agricultural use Vs Population Density	Cultivable Waste land Vs Population Density	Net Area Sown Vs. Population Density
y = -0.4095x + 633.56	y = 2.1468x + 2157.4	y = -1.3143x + 4090.1	y = 0.8098x + 15582
R^2 = 0.0735	R^2 = 0.2262	R^2 = 0.1782	R^2 = 0.002

Summary and Conclusion

Population pressure caused by rapid population growth is the key to all changes i.e. land use system, pattern, structure and demand etc. On the basis of the present study the following conclusions have drawn.

In 2018-19, forest cover was the maximum in Mawai block followed by Rudauli and Bikapur block. Sohawal, and Masaudha had very poor forest cover. The share of net area sown was found

the highest in Rudauli followed by Amanigunj block, while the lowest in Pura bazar block. Cultivable waste land was the highest in Tarun and Amanigunj the lowest in Maya bazar. In terms of land availability (ha/person), block wise analysis shows that the highest availability was noticed in Horringtonganj block (0.10 ha) followed by Bikapur (0.09 ha), Amaniganj (0.09 ha), Mawai (0.09 ha) and Rudauli (0.09 ha) blocks, where percentage of per capita area was higher than other blocks. Forest availability found the maximum in Mawai, followed by Amanigunj. The availability of cultivable waste land was found the highest in Horringtonganj and Tarun block followed by Amanigunj and Mawai and it was the lowest in Sohwal block. Availability of area under non-agricultural use was found the highest in Mayabazar, while it was the lowest in Tarun Block.

The above analysis clearly reveal that population pressure had been increasing at considerable rate which resulted into decline of per capita land availability i.e. land available for cultivation from 0.12 to 0.07 ha/person during the mentioned periods. To maintain the carrying capacity of land under cultivation, cultivable waste land can be used with suitable land reclamation technique and expansion of irrigation facilities. In this regard, Horringtonganj and Tarun block should be given priority, since these blocks have the highest share of cultivable waste land. There is also need to curb the high growth of population, so that fast decline in per capita land availability could be checked.

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