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Non-inclusive tribal workforce participation in urban spaces: A case study of Jharkhand

Bipin Kumar¹ and Vijay Kumar Baraik²
¹Research Scholar, Discipline of Geography, School of Sciences, IGNOU, New Delhi,
²Associate Professor, Discipline of Geography, School of Sciences, IGNOU, New Delhi,
(Corresponding author's Email: bipin.kumar2801@gmail.com)

Abstract
Tribals, as indigenous communities, have always been subject to neglect and marginalisation. The non-inclusive economic mobility is the enduring legacy of ethnic segregations and discriminations. In the development framework, their inclusion into the fast-urbanizing urban spaces is considerably an unexplored question. In this backdrop, the paper looks at tribals' economic mobility in the urban spaces of Jharkhand through occupational classes. The paper is based on the 21-fold industrial classification provided in B-Series tables by Census of India, 2011. It uses a simple statistical method to analyse the occupational structure, sectoral participation and economic mobility. The paper portrays an assorted picture, inapt to the claim of an inclusive development model. The tribals have hardly been successful in catching the neo-liberal market-led economic opportunities, as the most developed urban centres are barely in tandem with the higher workforce participation in secondary and tertiary sectors; especially in the formal sectors. The other contrasting scenario is the least developed urban spaces have a higher level of tribal workforce participation in the tertiary sector than their most developed counterparts.

Keywords: Urban exclusion, urban tribal, tribal workforce participation, tribal economic mobility, segregated urban space

Introduction
The indigenous communities of India, popularly known as Tribals roughly coinciding with those who are Adivasis and legally as the Scheduled Tribes (STs) (Sarkar et al, 2006), have always faced exclusive inclusivity but in urban spaces, they have been facing inclusive exclusivity (Kumar, 2019). In urban centres, the in-situ encroachment of the tribal space-geographical, cultural, economic and most importantly the psychological- has pushed them from the principal to marginalised position in the same space as manual labourers, rickshaw pullers and other low level or menial jobs. The tribal populations are being marginalised and pushed away; many times, through the socially segregated urban spaces and the dynamics of market demand, where the livelihood options are defined by the uneven opportunities and constraints. In the development framework, their inclusion to
the fast-urbanizing urban spaces thus is a much concerned aspect. Consequently, it becomes necessary to bring the local social, economic and political context of the region in which the urban spaces function.

The traditional dependence of the tribals on natural resources—land, forest and water and the rural ethnic economic engagement also act as restraint force to their occupational transition in the urban areas. Moreover, these natural resources got reduced drastically in the urban areas, and whatever exist, hardly have open access.

The world has relocated itself from state-driven to the market-driven development model. India is no exception to it. In liberal policy regimes, where markets are the dominant mechanisms for allocating and controlling resources social development and poverty reduction is relatively modest compared to the experience in social democratic regimes where the state plays a much greater role in steering the economy (Nagaraj, 2012). The neo-liberal economic model, especially in the posts 1990s, principally driven by the market, had led to large scale occupational transformation in India's labour force participation. Such structural transformation has hardly been all-inclusive but absorbed differently by different sections of the society. The already divided socio-economic positions discriminatedally favoured some groups over others. A persistent gap between the relatively well-off and deprived ones along the line of social stratification and ethnicity too mirrored in their economic mobility. Here, economic mobility implies a shift of workforce to the higher income-generating category or formal sector. It has always been recognised as the most desired form of development, which secures both employment guarantee and social security.

Both sections are indeed finding opportunities in improving their socioeconomic conditions, but the later always lacks in grabbing it. Two possibilities run parallel to it; first, the market capability to compete with the relatively well-off (who already have acquired the better socio-economic foundations inherently) in the limited and much-exhausted resource, and second, the appropriation of the limited available resources favour least to the underprivileged. In the increasing penetration of the market economy into Adivasi territories, very often Adivasis/tribals are losers in every market exchange/transaction (Venkatanarayana, 2013). Such transitions are more significant in the urban areas as these urban spaces are being seen as the epitome of socio-economic development driven by industrialization, market economy and thereby, the employment opportunities.

One of the primary reasons behind the creation of the tribal state of Jharkhand was to respond to the right of self-determination of the tribals and to ensure equitable development of the tribal and non-tribal people alike (Rao, 2003). There are several micro studies, which have given sufficient focus on the loss of livelihood of the tribal communities linked to land rights, land alienation, securing a livelihood, development and displacement and tribal identity (Kumar et al, 2011, Sharan, 2005, Rao, 2003, Priyadarshi and Dutt, 2000). Such changes have been forced individually and institutionally through both legal and illegal means in Jharkhand. But it gets narrowed down to a limited few when tribal economic transitions in the urban spaces are specifically tried.

With the ever-penetrating forces of
economic proliferation, more and more numbers of settlements are increasingly being urbanised. In this backdrop, a case pertains to study the neo-liberal spatial unit keeping the perspective of a community positioned at last rung of development, which is indispensively the state of the indigenous communities inhabiting these urban spaces. Though it is another area of concern that the transformation of the economy from primary to secondary and thereby to services has been much faster than the concomitant workforce, whatever the transformations are, the main drivers to it are more visible in these urban spaces. The workforce transformation for the tribal in the urban spaces is one of the pertinent defining characteristics of modern economic development. Slow progress in expected change in the structure of employment towards non-agriculture in general and stagnation among STs for a long time is a cause of concern (Venkatanarayana, 2013). As a consequence, studying the tribal workforce transformation in the urban spaces gives fresh vantage to measuring their development parameters vis-à-vis their socio-economic transition. Their occupational distribution is highly skewed with very few from the ST population present in the socially elite occupations (Halder and Abraham, 2015).

To that end, this paper looks at the economic transitions of the tribal working-age population in the urban areas of Jharkhand through occupational classes. The objective of this paper is to identify the nature of tribal occupational structure through their work participation in the different occupational groups. Further, it explores the aspect of sectoral participation vis-à-vis economic mobility. Finally, it focuses on analyzing the gap like economic mobility between the urban spaces of the most developed and the least developed districts of Jharkhand. Though this paper is based on one of the highest classifications of workforce participation, it shows a limitation in analysing few vertical components like in tertiary sector, whether the workforce participation is in high skill or literacy jobs or the low paid jobs.

**Study area**

Jharkhand is a one of the suitable regions and fitting sample in India to undertake such a study among the Fifth Scheduled areas. It is located in the eastern part of India and comprises of the Chhotanagpur Plateau. It lies between 83°22 - 87°57 N latitude and 21°58 E - 25°18 E longitude. The state is known for its abundant natural resources and is a major producer of minerals in the country. However, the rocky terrain of the region limits the agricultural development. The geographical area of the state is 79,714 sq. km. The state has 24 districts with a total population of 3.29 crores (Census, 2011). It is also characterized with tribal population designated as the Scheduled Tribes with 26.21 percent share. Tribals constitute 9.8 percent of the total urban population of the state. In this backdorp, the study becomes imperative for Jharkhand as the tribals have long been asserting their socio-economic and political rights over the region; both pre-independence against the colonial rule and post-independence for the separate statehood. Within the state, the two sets of urban areas have been selected based on three parameters- the level of industrialization and urbanization, the share of tribal population and the inter-district development disparity reflected by the overall development index prepared by
the Institute of Human Development based on 17 indicators related with eight major dimensions of development, 2016-17. The details of the sample districts with urban spaces are given in Table 1.

Using the above conditions, the most urbanised districts with substantial urban tribal population and the least urbanised districts with the high urban tribal population have been matched with the condition of the most developed districts and the least developed districts. The map of the study area has been illustrated in Figure 1.

**Table 1: Selected urban spaces from the most developed and the least developed districts of Jharkhand, 2011**

| Districts (As per Overall Development Index, ranked in high to low order) | Percentage of Urban Population | Percentage of Urban ST Population | Urban ST Population |
|---|---|---|---|
| Dhanbad | 58.13 | 2.25 | 35040 |
| Ranchi | 43.14 | 20.06 | 252178 |
| PurbiSinghbhum (Jamshedpur) | 55.56 | 10.88 | 138709 |
| Gumla | 6.35 | 36.82 | 23965 |
| Simdega | 7.16 | 46.39 | 19920 |

Source: Primary Census Abstract, Census of India, 2011, calculated by authors.

The paper mainly hinges on quantitative methods and keeps it limited to understanding the occupational participation of the Scheduled Tribes. To analyse the nature of tribal occupational structure the percentages of main and marginal workers in each occupational group have been derived from their respective totals. The total worker's participation in the primary, secondary and tertiary sector has been calculated to

**Data sources and methodology**

This study is based on the B-Series data provided by the Census of India, which has given 21-fold occupational classification data for the main and marginal workers. The 21-fold industrial classification is an improvement over earlier data sets providing more in-depth inquiry of occupational engagements. The occupational data of the Scheduled Tribes (STs) in the urban areas have been extracted for the selected five districts' urban areas (most developed districts-Dhanbad, Ranchi and Purbi Singhbhum, and the least developed- Gumla and Simdega) from the following tables:

- B-4 ST: Main Workers Classified Industrial Category for Scheduled Tribes, 2011
- B-6 ST: Marginal Workers Classified Industrial Category for Scheduled Tribes, 2011

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understand the dynamics of economic mobility. The gap between the most developed and the least developed districts has been based on interpretation derived from data analysis. Simple statistical techniques have been used for deriving the meaningful tables from the provided data. Similarly, the general cartographic technique has been employed for visual presentation of data.

Findings and discussion

The transformation of the workforce from primary to secondary and thereby tertiary is regarded as positive; higher in the ladder signifies more income generation and better livelihood conditions. The assumption here is that the level of occupational engagement is synonymous to economic return and defines livelihood opportunities and living standards. Industries and mining are the two most important drivers of urbanisation in Jharkhand. A glance at the urban scenario of Jharkhand shows that most industrialised districts are also the most urbanised ones. Moreover, the distributions of tribal population in the urban areas of Jharkhand are highly uneven. The most urbanised districts, have the least urban tribal population while the least urbanised districts have the most tribal urban population.

Workforce participation

The composition of the working tribal population in Jharkhand shows a marked variation over the urban spaces, and also between the main and marginal categories (Table 2). Those workers who had worked for the major part of the reference period (i.e., 6 months or more) are termed as Main Workers while those who had not worked for the major part of the reference period
Table 2: Percentage of Scheduled Tribes as Main and Marginal Workers in the Urban Areas of the selected five districts of Jharkhand, 2011

| Occupational Category     | Main Workers | Marginal Workers |
|---------------------------|--------------|------------------|
|                           | Dhanbad      | Ranchi           | Purbi Singhbhum | Gumla | Simdega | Dhanbad | Ranchi | Purbi Singhbhum | Gumla | Simdega |
| Cultivators               | 1.0          | 2.9              | 0.8             | 14.0  | 19.6    | 3.9     | 6.0    | 4.0            | 17.2  | 27.7    |
| Agricultural Labourers    | 6.4          | 5.3              | 1.8             | 5.1   | 12.9    | 16.4    | 18.2   | 23.3           | 35    | 44.4    |
| Mining and Quarrying      | 28.3         | 3.7              | 3               | 2.6   | 1.7     | 6.1     | 1.8    | 2.1            | 0.8   | 0.9     |
| Manufacturing             | 7.5          | 7.1              | 27.6            | 4.6   | 4.5     | 10.1    | 4.8    | 13.9           | 5.6   | 3       |
| Electricity, Gas, etc.*   | 1.4          | 1.1              | 1.5             | 1.1   | 1.2     | 0.1     | 0.2    | 1.3            | 0.5   | 0       |
| Construction              | 18.2         | 20               | 34.9            | 6.8   | 9.7     | 36.2    | 29     | 32.1           | 11    | 12.2    |
| Wholesale and Retail Trade| 3.1          | 5.3              | 4.1             | 3.8   | 3.4     | 2.4     | 3.2    | 3.1            | 1.8   | 2.1     |
| Transportation and Storage| 9.5          | 8.5              | 6.6             | 5.7   | 5.4     | 6.4     | 4.2    | 4.4            | 2.5   | 1.5     |
| Accommodation & food services | 0.6        | 1.2              | 0.7             | 1.4   | 1.4     | 0.4     | 0.6    | 0.4            | 0.5   | 0.5     |
| Information and Communication | 0.3        | 0.9              | 0.5             | 0.4   | 0.4     | 0       | 0.2    | 0.1            | 0.1   | 0       |
| Financial, Professional, etc.# | 2.4        | 5.8              | 2.6             | 4.5   | 4       | 0.6     | 0.7    | 0.3            | 0.4   | 0.1     |
| Administrative, Defense, etc.$ | 4.7        | 9.1              | 3.6             | 16.5  | 8.9     | 0.6     | 1.5    | 1.1            | 1.4   | 0.5     |
| Education, Health, etc.@ | 6.5          | 14.2             | 6.2             | 20    | 20.7    | 1       | 2.5    | 1.8            | 1.8   | 1.3     |
| Arts, Entertainment, etc.^ | 10.1         | 14.9             | 6.1             | 13.4  | 6.2     | 15.8    | 27.1   | 12             | 21.4  | 5.8     |
| Total Workers (in Numbers) | 8301         | 66155            | 39487           | 4704  | 4295    | 2891    | 20606  | 8022           | 1461  | 2070    |

* Electricity, Gas, Steam and Air conditioning Supply; Water Supply; (Sewerage, Waste Management and remediation activities)

# Financial and Insurance activities; Real Estate activities; Professional, Scientific and Technical activities

$ Administrative and support service activities; Public Administration and Defence, Compulsory Social Security

@ Education; Human Health and Social Work activities

^ Arts, Entertainment and recreation; Other Service Activities; Activities of Households as Employers; Undifferentiated Goods and Services; Activities of Extra-Territorial Organizations and Bodies

Source: Calculated by authors from B-Series data set of Census of India, 2011.
(i.e., less than 6 months) are termed as Marginal Workers (Census, 2011). There are only a few categories where the concentration of tribal workforce is more prominent. The main and marginal workers do not display the direct division as the formal and informal sectors. Even in the main workers' category, many occupational groups are informal. But in the marginal sector, there is no formalisation, the work is intermittent and there is no job security or social security.

In the main worker's category, the picture for the tribals not only presents a murky scenario but it also doesn't go well with the levels of the development of the districts under study. Although the main workers have a maximum number of working days, not all are into the formal sectors as well. It is also true that the most developed districts barely correspond with the workforce transformation into higher or most income-generating sectors (Figure 2).

In Dhanbad district, the highest proportions of main workers (28.3 per cent) are engaged in the 'Mining and Quarrying' sector. Coal mining is the main economic activity of the district. After Mining and Quarrying, the construction sector forms the second largest employment category for the tribal population with 18.2 per cent main workers. It needs to be noted that both Mining-Quarrying and Construction engage the tribal main workers mostly in informal sectors of employment, where workers are hired either on a contractual or daily basis. Job security, health benefits or even a guarantee to long term employment is often unavailable for the workers engaged in these sectors. In Purbi

![Percentage of STs Main Workers, Jharkhand 2011](image.png)

Figure 2: Percentage of ST Main Workers in the selected urban spaces in Jharkhand, 2011
Singbhum, Construction and Manufacturing are the major sectors, where the tribal main workers are mostly employed comprising 62.5 per cent of the overall main workers. Unlike Dhanbad, in this district, the participation in Non-household Manufacturing sector is quite high (26.9 per cent) after the construction sector.

The ST main workers of Ranchi are mostly engaged in the construction sector for employment comprising 20.0 per cent of the total main workers. Two other sectors of employment where the Singbhum tribals are mainly engaged in are a) Education; Human Health and Social Work activities and b) Non-household Arts, Entertainment and Recreation; Other Service Activities; Activities of Households as Employers; Undifferentiated Goods and Services; Activities of Extra-Territorial Organisations and Bodies. Each of these sectors accounts for about 15 percent of employment of the ST main workers. The first in most cases provide formal employment, while the second is completely informal. According to NSSO 68th round, 2011-12, 100 per cent employees in arts, entertainment and recreation in Jharkhand are informal (Jharkhand Economic Survey, 2017-18). Although it is informal, the emergence of Ranchi as a hub for tribal arts, entertainment and recreation is a remarkable achievement of tribals' socio-cultural recognition. Almost 10 per cent of the working populations are engaged in the administrative and support service activities; public administration and defence and compulsory social security sectors. Overall, the services sector and the construction sector are other main sources of employment for the ST population of this district. In Ranchi, the ST main workers have greater access to the formal sectors of employment, compared to Dhanbad and Purbi Singbhum. However, these districts have much lesser urban tribal population than Ranchi. Ranchi, being the seat of tribal socio-cultural and political rights assertion for the region, has created a better complementary space to attain education and vocational training, which is also reflected in their greater access to the services sector.

In Gumla and Simdega, the Education; Human Health and Social Work activities sectors together employ 20.0 and 20.7 per cent of the ST main workers respectively, a contrary scenario than the developed districts, where these sectors are mainly occupied by non-tribals. The Administrative and support service activities, Public Administration and Defence, Compulsory Social Security sectors also employ 16.5 and 8.9 per cent of the ST workers in Gumla and Simdega districts respectively. These two service sectors mostly fall in the formal employment category. The Agriculture sector (comprising both cultivators and agricultural labourers) engage 19.04 and 32.47 per cent of the urban ST workers in Gumla and Simdega respectively. It is worth noting that in the districts like Gumla and Simdega, where the tribal populations are present in higher percentages and are least urbanised, a high proportion of occupation/livelihood option is predominantly provided by the agrarian and the service sectors. This is contrary to those urban areas where lesser proportions of tribal populations are present the ST main workers are mainly employed in the informal sector, mostly construction.

The vulnerability of the tribal workers
is reflected through their major concentration in the marginal sector. As per Table 2, the percentages of marginal tribal workers to the total tribal workers are 25.8, 23.75, 16.88, 23.69, and 32.52 in the urban areas of Dhanbad, Ranchi, Purbi Singhbhum, Gumla and Simdega respectively; almost on an average one-fourth are engaged as marginal workers. This is directly an informal workforce, where even the work is irregular and wages could hardly support their livelihood.

Even in marginal workers category, the highest clustering is of the cultivators and agricultural labourers. It also shows a variation as per the development levels of the districts. The districts of Gumla and Simdega have more than half of their marginal workers as cultivators and agricultural labourers, while in Dhanbad, Ranchi, and East Singhbhum, it is around 20.3, 24.2 and 27.3 per cent respectively (Figure 3). The high dependence on agriculture sectors indicates that the livelihood options of the tribal population are still predominantly ruralised in the urban centres. It also shows the prevalence of subsistence economy around the agrarian sector, a contrarian claims to inclusive urban development.

After agriculture, the construction sector absorbs the second largest proportion of marginal workers. It forms the next major group for Gumla and Simdega with about 11.0 and 12.2 percent of the total STs marginal workers respectively. This is significant because both the districts have large proportions of the urban tribal population.

In the Dhanbad district, the

![Figure 3: Percentage of ST Marginal Workers in the selected urban spaces in Jharkhand, 2011](image-url)
construction sector alone employs 36.2 percent of the ST marginal workers. Such jobs are often limited and contractual where the labourers are employed to complete certain targeted tasks. Whenever the job is finalised, the contract is terminated and labourers are laid off. In Purbi Singhbhum too, these two sectors provide occupation to the majority of the ST marginal workers—32.1 percent ST marginal workers engaged in the construction sector and 27.3 percent engaged in agriculture, forestry and fishing. These two sectors together employ almost about 60 percent of the ST marginal workers. This is different from the scenario of workers engaged in the category of main workers, where the maximum employment

Figure 4: Occupational participation of ST in the selected urban spaces in Jharkhand, 2011
was in the manufacturing sectors.

In Ranchi, the construction sectors employ a vast majority of marginal workers (29.0 percent). Another 27.1 percent is employed in the non-household arts, entertainment and recreation; other service activities; activities of households as employers: undifferentiated goods and services; activities of extraterritorial organisations and bodies sectors. Being the capital city, this occupational group prevails, as many occasional opportunities emerge to find themselves engaged, but these are temporary, mostly available in festive seasons or other socio-cultural events. These figures present a dismal employment scenario for tribals in such a developed urban space of Jharkhand.

Sector-wise occupational structure

The urban spaces being the seat of industry and rapid economic development have fast shifted positions in sectoral participation of the workforce. More and more workforces are moving towards the non-primary sectors of the economy - secondary and tertiary. But the similar trends are hardly synchronous as far as the tribal communities go. It could be well analysed by looking at their sectoral participation in urban spaces (Figure 4). In the scenario of total workers (includes both main and marginal workers), the picture is not quite different as seen in individual cases. The main sources of occupation for the tribals in urban areas of Jharkhand are driven by the primary sector in both the most and the least developed districts. In developed districts, there is some occupational diversification but it primarily goes to the other informal sectors such as the construction sector.

In the primary sector, most of the tribal workforce engagement is observed in the districts of Simdega, Dhanbad and Gumla. This structure shows that even though these are urban spaces, the engagement of tribals in the agriculture sector drives their economy. Dhanbad's high engagement in the primary sector mainly goes to the high level of tribals' participation in mining and quarrying activities. Ranchi being the capital district should have the least engagement in the primary sector among the developed urban spaces, but it is in the Purbi Singhbhum district.

The secondary sector employment has a direct relation to the level of industrialization. The most industrialised districts are showing the maximum engagement of tribals as reflected in Purbi Singhbhum followed by Dhanbad and Ranchi. But in the secondary sector too, most of the tribal populations are engaged in the construction sector except in Purbi Singhbhum. Gumla and Simdega, the least urbanised districts show that very less proportion of ST working populations are engaged in the secondary sector. The tertiary sector's picture clarifies the position of tribals when it is linked with the primary and secondary sector. The maximum participation of the tribal workforce in the tertiary sector is not in the urban spaces of the most developed districts like Dhanbad or Purbi Singhbhum but in the district of Gumla, followed by Ranchi and Simdega.

This could be summarised as follows:

- **Gumla is showing high participation in the tertiary sector mainly in administration and education and health.** It is because of the high tribal urban population (36.8 per cent), where urban tribal spaces are least captured by other communities, unlike the other
urban spaces. Similar is the case of Simdega with the urban tribal population of 46.39 percent.

- Ranchi being the capital district provides a wide range of opportunities, thus the workforce participation in tertiary sector for the tribals is high.
- Dhanbad and Purbi Singhbhum with low urban tribal populations show a low level of tribal workforce participation in the tertiary sector.

**Conclusion**

The assessment of workforce participation of the ST population in the urban spaces of Jharkhand reflects that the informal sector employment is mostly prevalent among the ST workers even in the urban spheres. The construction sector after agrarian is the most dominant sector providing informal occupation. In those districts where the tribal population is present in large proportions, the participation in the tertiary sector is high. The analysis clearly shows that the tribals are engaged in the vulnerable sectors of employment even in the urban areas. They have not been so successful in catching the neo-liberal market-led economic opportunities as the most developed regions hardly overlap with the most workforce participation in secondary and tertiary sectors, especially the formal sectors. The condition of the more developed district does not necessarily mean added occupational opportunities for the tribals in higher, better and secured jobs and similar economic mobility. The process of economic transition hardly looks uplifting the tribal population. Although, the economic mobility is restricted in most urban spaces, here the shifting from primary to secondary and then to tertiary is maximally appropriated by the non-tribals. More developed districts attracted the immigrants more to their urban spaces, mostly non-tribals; competing with them with low education and skills looks restricted for the tribals. The high participation of urban tribal workforce in some formal tertiary sector in the least developed districts and the informal, mainly agriculture and construction sector in most developed districts the prominent testimonies.

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Role of agricultural technology on socio-economic development in Hathras district, Uttar Pradesh

Mumtaj Ahmad¹, Pasarul Islam² and Shamsul Haque Siddiqui³
¹Assistant Professor, Department of Geography, AMU, Aligarh
²Research Scholar, Department of Geography, AMU, Aligarh
³Former DSW & Chairperson, Department of Geography, AMU, Aligarh
(Corresponding author's email: mumtazgeog@gmail.com)

Abstract
Agriculture in India has experienced a significant transformation in the past fifty years, with agriculture being more and more oriented to a productivist form of socio-economic production. Introduction of new agricultural technologies, high yielding varieties of seeds, improve access to irrigation, education, efficient use of fertilizers and extension services are capable of enhanced productivity per unit of land. Increased production further reflects on socio-economic transformation in rural communities. The study uses secondary data from various sources published by the Government of India and the Government of Uttar Pradesh. The study covers the period between 2000-01 and 2014-15 to analyze the role of agricultural technologies on socio-economic transformation in Hathras district. The methodology adopted for the present study are Data Interpolation or Extrapolation, Yang's Crop Yield Index, Dayal’s Labour Productivity, Data Standardisation technique Z-score, and Composite Z score. The study concludes that the district has experienced tremendous technological changes in agricultural practices, agriculture induced better productivity and productivity further leads to overall socio-economic transformation.

Keywords: Agriculture, technology, productivity, socio-economic development

Introduction
The agriculture sector is the single largest employer in the world (Seidel et al., 2017). Even in India, the agriculture sector employs more than 50 per cent people. The application of high yielding varieties of (HYV) seeds (1966-67) and technological development have given a quick response in the form of farm production and productivity. The country like India has two sources to increase in agricultural output viz. area and productivity. Due to the rising demand for land for non-agricultural uses and the already high share of arable land in the total geographical area of the country, further expansion in area under cultivation is not feasible. Hence to ensure the economic well being of the farmers, the only viable option is to continue to enhance productivity per unit of land through the modern means of agriculture (Chand, 2017; Singh, 2019).

Despite the diminishing share of GDP from agriculture over the decades, the economy as a whole continues to depend on
Indian agriculture employs 43.4 per cent of the economically active population, which is higher by 15.4 per cent than the world average of 28.0 per cent. India shares 2.4 per cent of the world's total area (seventh rank) and 2.3 per cent of the world's land area, 1.8 per cent of the world's arable land and 36.8 per cent of the world's irrigation area. With these resources, the country is to support 17.7 per cent of the world's population and 15 per cent of the world population who depend on agriculture (FAO, 2016). India has the second-largest arable land in the world, next to the USA only. The country is in proud possession of the third largest reservoir of scientific and technical manpower in the world (Mahalingam, 2002). As agriculture is the mainstay of the rural Indian economy, the entire socio-economic conditions revolve around it (Kuppuswamy, 1990). The introduction of new agricultural technologies, high yielding varieties of seeds, improve access to irrigation, education, efficient use of fertilizers and extension services plays a crucial role in socio-economic development (Kanwar, 1970). These modern agricultural implements are the most powerful weapons for bringing the transformation in the socio-economic sectors, as these innovations generally help to increase output, decreasing costs, or both (Mirchandani, 1973). Therefore, practising techno-agriculture is the only way to improve the economic position of all categories of farmers by increasing productivity and per hectare income (Mohanty, 2001; Siddiqui, Nooruzzaman and Rahman, 2008). The intensification of agricultural productivity through technological innovation has often been reported to induce considerable social and economic transformation in rural communities (Bene and Opareh, 2009; Ahmad and Islam, 2018). The objectives of the present study are to find out the levels of use of agricultural technology and its impact on socio-economic development in Hathras district. For that, the following variables (table 1 and 2) were selected for 2000-01 and 2014-15.

| Variables | Description |
|-----------|-------------|
| X1 | Number of tractors per 1000 hectares of gross cropped area |
| X2 | Number of advance harrow and cultivator per 1000 hectares of gross cropped area |
| X3 | Number of sprayers per 1000 hectares of gross cropped area |
| X4 | Number of advance sowing instrument per 1000 hectares of gross cropped area |
| X5 | Number of iron plough per 1000 hectares of gross cropped area |
| X6 | Consumption of chemical fertilizers kg per hectare of gross cropped area |
| X7 | The area under net irrigation in thousand hectares |
| X8 | Road density per sq.km |

Source: District Statistical Bulletin and District Census Handbook, Hathras (2000-01 and 204-15)
The study uses secondary data from various sources published by the Government of India and the Government of Uttar Pradesh. The study covers the period between 2000-01 and 2014-15 to analyze the role of agricultural technology on socio-economic development in Hathras district. The main sources of data are the websites of the Census of India, Directorate of Economics and Statistics (DES) of the Government of Uttar Pradesh, National Sample Survey Organisation (NSSO), Ministry of Agriculture and Farmers Welfare, Agriculture Census of India and so on. The data extrapolation/interpolation technique has been applied to acquire useful and usable information for decision making. The extrapolation/interpolation formula has been used as follows:

\[
PP = \frac{P_1 + P_2 + N^{n}}{2n + 1} \\
T = \text{Grand Total in the respective field}
\]

Note: \(T\) = Grand Total in the respective field

\(P_1\) = Figure of the previous year
\(P_2\) = Figure of the succeeding year
\(N\) = Number of years between periods
\(n\) = Number of years between the previous years and the year for which data or figure would be projected.

Table 3 represents Yang’s crop yield index which is used to measure the agricultural productivity in the study area. The formula for calculating the crop yield index is:

\[
\text{Crop Yield Index} = \frac{\text{Average Yield in District}}{\text{Average Yield in Block}} \times 100
\]

Table 2: These are variables of socio-economic development in Hathras district (2000-01 and 2014-15)

| Variables | Descriptions |
|-----------|--------------|
| \(Y_1\)  | Agricultural productivity-based Yang’s yield index method |
| \(Y_2\)  | Labour productivity based on current price (2014-15) |
| \(Y_3\)  | Number of rural banks per 100,000 of the rural population |
| \(Y_4\)  | Number of regulated markets per 100,000 of the rural population |
| \(Y_5\)  | Total literacy rate |
| \(Y_6\)  | Female literacy rate |
| \(Y_7\)  | The literacy rate among SCs |

Source: District Statistical Bulletin and District Census Handbook, Hathras (2000-01 and 2014-15)

Table 3: Yang’s crop yield index to calculate productivity indices

| Name of Crops | Area of Crops | Yield | Crop Yield in the block as % to the district | % age multiplied by Area | Crop Yield Index |
|---------------|---------------|-------|--------------------------------------------|-------------------------|------------------|
|               |               |       |                                            |                         |                  |
| 1             | 2             | 3     | 4                                          | 5=(Col. 3/(Col. 4))*100 | 6= Col. 5* Col. 2 | 7=T6/T2#        |

Note: \(T\) = Grand Total in the respective field
Labour Productivity has been calculated based on the method applied by Dayal (1984). The following equation is considered:

The study area

The Hathras district situated between 27°20'0" north and 27°50'0" north latitudes and 77°40'0" east and 78°40'0" east longitudes have been selected for the present study. It is one of the newly created district (1997) of Uttar Pradesh curved out from Aligarh, Agra, Mathura and Etah are located in the western part of the state. It has a total geographical area of 1840 sq.km. (0.72 percent of the state) and about 90 percent of it's devoted to agriculture. About 21.3 percent of people live in an urban area which signifies that 78.7 percent of rural people dependent on agriculture as a means of livelihood. But the climatic character of hot summer and dry winter with unpredictable rainfall in monsoon season creates a major hurdle to the farmers. This district of western Uttar Pradesh comes under the influence of the green revolution since the 1960s. Fertile alluvial soil, assured irrigation, fertilizers, high application of mechanical tools and high rural literacy make this district agriculturally develop.

Result and discussion

Levels of use of agricultural technology (2000-01 and 2014-15)

The introduction of modern technology in agricultural practices is cheaper than labour which also becomes the source of raising agricultural productivity in developing countries. It covered all aspects
of agricultural technology such as the application of machinery, chemical fertilizers, water management and irrigation, other improved implements and institutional equipment, research extension and services, finance, and agricultural credit. This new strategy did succeed in boosting productivity and production in agriculture (WHO, 1968). The composite score of levels of use of agricultural technology is depicted in figure 1 and 2 for the years of 2000-01 and 2014-15. It reveals that in 2000-01, three blocks i.e., Sasni, Hathras and Sahapao have been recorded greater use of agricultural technology with an index value of more than 0.24.

A moderate level of use of agricultural technology varies between -0.26 to 0.24 includes the block of Mursan and Sadabad. The remaining block of Hasayan and SikandraRao lies under the low category. During 2014-15, Sahapao block remains at the top position having an index value of more than 0.38, whereas, Sasni, Mursan and Sadabad blocks registered a moderate use of agricultural technology in the study region. The remaining three blocks i.e. Hathras, Hasayan and Sikandra Rao appears under the lower category of use of agricultural technology with an index value of less than 0.22.

The study shows that the number of blocks under a higher category of agricultural technologies has declined from three (3) to one (1), while medium and low category reports increased from two (2) to three (3) during the period from 2000-01 to

![Figure 2: Levels of use of agricultural technology in Hathras district](image)
Table 4: Use of Agricultural Technology in Hathras district (2000-01 and 2014-15)

| Blocks       | X1 2000-01 | X2 2000-01 | X3 2000-01 | X4 2000-01 | X5 2000-01 | X6 2000-01 | X7 2000-01 | X8 2000-01 | X1 2014-15 | X2 2014-15 | X3 2014-15 | X4 2014-15 | X5 2014-15 | X6 2014-15 | X7 2014-15 | X8 2014-15 |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Sasni        | 20.69      | 37.85      | 33.78      | 49.08      | 13.83      | 24.82      | 13.53      | 28.79      | 16.86      | 23.91      | 114.2      | 175.6      | 22.10      | 22.43      | 0.82       | 1.15       |
| Hathras      | 24.61      | 35.48      | 81.22      | 131.9      | 10.65      | 23.59      | 18.38      | 17.14      | 37.01      | 21.66      | 125.1      | 190.8      | 21.07      | 21.08      | 0.51       | 0.90       |
| Mursan       | 23.24      | 45.14      | 27.30      | 49.16      | 13.94      | 14.98      | 13.51      | 19.90      | 10.02      | 26.70      | 118.1      | 207.3      | 19.70      | 19.77      | 0.74       | 1.10       |
| Sadabad      | 28.02      | 50.41      | 39.43      | 80.57      | 7.91       | 29.03      | 14.71      | 16.45      | 11.91      | 19.77      | 102.8      | 188.4      | 23.63      | 24.55      | 0.67       | 1.00       |
| Sahapao      | 17.60      | 49.67      | 41.18      | 70.39      | 13.62      | 33.99      | 16.43      | 29.31      | 16.20      | 28.80      | 150.7      | 255.8      | 14.72      | 15.12      | 0.77       | 1.21       |
| Sikantra Rao | 10.79      | 28.80      | 14.36      | 38.30      | 4.75       | 21.45      | 6.64       | 18.90      | 7.38       | 17.83      | 120.9      | 160.0      | 20.44      | 22.04      | 0.59       | 0.89       |
| Hasayan      | 8.46       | 22.84      | 13.41      | 33.23      | 4.25       | 18.40      | 6.21       | 15.75      | 7.68       | 15.76      | 100.9      | 138.1      | 22.74      | 24.29      | 0.59       | 0.86       |
| Total        | 19.13      | 37.08      | 34.98      | 62.23      | 9.52       | 23.01      | 12.51      | 20.38      | 14.88      | 21.42      | 118.7      | 188.0      | 144.3      | 149.2      | 0.65       | 0.98       |

Source: District Statistical Bulletin and District Census Handbook, Hathras (2000-01 and 2014-15)
Table 6: Standardised Z-scores of Use of Agricultural Technology in Hathras district (2000-01 and 2014-15)

| Blocks      | X1 2000-01 | X2 2014-15 | X3 2000-01 | X4 2014-15 | X5 2000-01 | X6 2014-15 | X7 2000-01 | X8 2014-15 | Composite Index 2000-01 | Composite Index 2014-15 |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------------------|-------------------------|
| Sasni        | 0.225      | -0.071     | -0.089     | -0.457     | 0.936      | 0.167      | 0.162      | 1.374      | 0.152                   | 0.392                   |
| Hathras      | 0.767      | -0.298     | 0.984      | 1.973      | 0.188      | -0.025     | 1.203      | -0.652     | 0.111                   | -0.085                  |
| Marsan       | 0.578      | 0.624      | -0.372     | -0.455     | 0.961      | 1.373      | 0.158      | -0.513     | 0.984                   | -0.052                  |
| Sadabad      | 1.239      | 1.127      | 0.158      | 0.466      | -0.456     | 0.827      | 0.416      | -0.513     | 0.984                   | -0.052                  |
| Sahapao      | -0.202     | 1.056      | 0.235      | 0.168      | 0.886      | 1.603      | 0.785      | 1.464      | 0.088                   | 1.429                   |
| Sikandra Rao | -1.143     | -0.935     | -0.937     | -0.773     | -1.199     | -0.360     | -1.316     | -0.346     | -0.769                   | -0.897                  |
| Hasayan      | -1.465     | -1.503     | -0.979     | -0.922     | -1.316     | -0.838     | -1.408     | -0.894     | -0.740                   | -1.336                  |

Source: District Statistical Bulletin and District Census Handbook, Hathras (2000-01 and 2014-15)
2014-15. But the index of the blocks particularly, Sahapao, Sadabad and Mursan have significantly increased by 5.5, 1.20 and 0.25 folds respectively in the region. Therefore, it evident that the study area has experienced tremendous transformation in agricultural practices during the period of investigation.

**Levels of socio-economic development (2000-01 and 2014-15)**

Agriculture has an immense role in the transformation of socio-economic conditions, especially in the developing nations of the world (Anriquez and Stamoulis, 2007). In India, the new agricultural technologies had started to play a key role in improving the status of people from 1966-67 (Fujita, 2010). Since then, agriculture becomes both forward and backward connections to other sectors of economic activities and becomes the prerequisite for the overall development in India. Thus, there is a mutual relationship between modern technological inputs and socio-economic development (Sharma, 2014). Figure 3 and 4 illustrates the levels of socio-economic development in the chosen study area for the years 2000-01 and 2014-15. It depicts that during 2000-01, the highest level of socio-economic development has been observed in the block of Sasni, Hathras and Mursan with an index value of above 0.22, whereas Hasayan and Sikandra Rao block lies under the low category of socio-economic development. A medium level of socio-economic development has been found in the Sadabad and Sahapao block whose

Figure 3: Levels of socio-economic development in Hathras district
Table 5: Socio-Economic Development in Hathras district (2000-01 and 2014-15)

| Blocks      | Y1 000-01 | Y2 2014-15 | Y3 2000-01 | Y4 2014-15 | Y5 2000-01 | Y6 2014-15 | Y7 2000-01 | Y7 2014-15 |
|-------------|-----------|------------|------------|------------|------------|------------|------------|------------|
| Sasni       | 92.92     | 94.87      | 46.44      | 67.41      | 4.42       | 2.84       | 3.87       | 3.32       | 64.02      | 72.49      | 47.71      | 59.77      | 57.3       | 67.51      |
| Hathras     | 97.32     | 99.52      | 52.15      | 62.33      | 1.89       | 2.87       | 1.89       | 2.30       | 63.64      | 72.52      | 47.46      | 59.90      | 56.7       | 66.51      |
| Mursan      | 99.44     | 101.68     | 59.95      | 91.09      | 3.84       | 3.84       | 1.28       | 1.10       | 62.51      | 73.65      | 43.86      | 59.88      | 53.9       | 67.36      |
| Sadabad     | 101.13    | 105.38     | 54.98      | 90.56      | 0.00       | 0.96       | 3.78       | 3.37       | 64.1       | 73.44      | 43.25      | 58.20      | 53.2       | 64.87      |
| Sahapad     | 102.07    | 104.63     | 56.85      | 90.45      | 0.00       | 0.00       | 0.00       | 1.58       | 62.18      | 71.88      | 43.26      | 57.58      | 53.5       | 65.22      |
| Sikandara Rao| 98.14    | 100.07     | 40.92      | 42.79      | 2.20       | 2.53       | 6.59       | 5.68       | 57.95      | 68.09      | 41.05      | 54.40      | 51.3       | 62.25      |
| Hasayan     | 100.37    | 100.62     | 40.95      | 56.64      | 2.05       | 1.75       | 2.05       | 4.08       | 56.34      | 67.57      | 39.11      | 53.40      | 50.7       | 63.03      |
| Total       | 98.77     | 100.97     | 50.32      | 71.61      | 2.06       | 2.11       | 2.78       | 3.06       | 61.53      | 71.38      | 43.67      | 57.59      | 53.80      | 65.25      |

Source: District Statistical Bulletin and District Census Handbook, Hathras (2000-01 and 2014-15)
Table 7: Standardised Z-scores of Socio-Economic Development in Hathras district (2000-01 and 2014-15)

| Block(s)       | Y1 2000-01 | Y1 2014-15 | Y2 2000-01 | Y2 2014-15 | Y3 2000-01 | Y3 2014-15 | Y4 2000-01 | Y4 2014-15 | Y5 2000-01 | Y5 2014-15 | Y6 2000-01 | Y6 2014-15 | Y7 2000-01 | Y7 2014-15 | Composite Index |
|----------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|----------------|
| Sasni          | 1.912      | -1.741     | -0.507     | -0.217     | 1.392      | 0.564      | 0.204      | 0.165      | 0.798      | 0.544      | 1.016      | 1.102      | 1.410      | 1.102      | 0.343 0.217    |
| Hathras        | -0.474     | 0.413      | 0.239      | 0.479      | -1.000     | 0.586      | -0.412     | -0.486     | 0.676      | 0.456      | 1.212      | 0.859      | 1.168      | 0.615      | 0.330 0.162    |
| Murasan        | 0.219      | 0.204      | 1.258      | 1.006      | 1.048      | 1.325      | -0.694     | -1.254     | 0.314      | 0.908      | 0.061      | 0.851      | 0.040      | 1.029      | 0.321 0.581    |
| Sadabad        | 0.771      | 1.260      | 0.609      | 0.978      | -1.213     | -0.881     | 0.465      | 0.200      | 0.824      | 0.824      | -0.134     | -0.227     | -0.242     | -0.185      | 0.154 0.346    |
| Sahapao        | 1.078      | 1.046      | 0.853      | 0.972      | -1.213     | 1.621      | 1.286      | 0.948      | 0.208      | 0.200      | -0.131     | 0.004      | -0.121     | 0.015       | -0.087 0.218   |
| Sikantrao      | -0.206     | -0.256     | -1.228     | 1.488      | -0.081     | 0.319      | 1.763      | 1.675      | -1.147     | -1.316     | -0.838     | 1.186      | 1.007      | 1.463       | 0.369 0.531   |
| Hasanayn       | 0.523      | 0.099      | 1.224      | 0.773      | 0.009      | 0.278      | 0.340      | 0.650      | -1.663     | 1.524      | 1.458      | 1.557      | 1.248      | 1.083       | -0.774 0.666  |

Source: District Statistical Bulletin and District Census Handbook, Hathras (2000-01 and 2014-15)
index value ranges between -0.23 and 0.22. In the year 2014-15, two blocks Mursan and Sadabad are having an index value of above 0.28 recorded the highest level of socio-economic development, while lowest development reports in the block of Hathras, Hasayan and Sikandra Rao. A medium level of development ranges from 0.18 to 0.28 includes Sadabad and Sahapao block.

The study reveals that the number of blocks under the higher category of socio-economic development has decreased from three (3) to two (2), but in the lower category increased from two (2) to three (3) during the period from 2000-01 to 2014-15. But the index of the blocks particularly, Sahapao, Sadabad, Mursan and Hasayan have significantly increased by 3, 2, 2.6 and 0.10 folds respectively in the region. Therefore, it evident that the study area has been experienced tremendous transformation in socio-economic development during the period of investigation.

**Relationship between use of agricultural technology and socio-economic development (2000-01 and 2014-15)**

The relationship between the use of agricultural technology and socio-economic development in Hathras district is plotted in figures 5 and 6 for the years 2000-01 and 2014-15 respectively. The $R^2$ of regression statistic indicates the percentage of the variance in the dependent variables (socio-economic development) that the independent variables (agricultural technology) explain collectively.
R² measures the strength of the relationship between the dependent and independent variables on a convenient 0-100 per cent scale. Higher the value of R², stronger the relationship; lesser the value of R², weaker the relationship. The study area has experienced a robust relationship between agricultural technology and socio-economic development during the period of research. The R² of regression indicates

**Figure 5:** Relationship between the use of agricultural technology and socio-economic development in Hathras district

**Figure 6:** Relationship between the use of agricultural technology and socio-economic development in Hathras district
that agricultural technology has been explained 83.3 per cent and 76.8 per cent variance of the socio-economic development for the years of 2000-01 and 2014-15 respectively. Therefore, technology-laden agricultural development has made a tremendous contribution to socio-economic development in the chosen district.

**Conclusion**

From the above discussions, it is clear that new agricultural technology, high yielding varieties of seeds, improve access to irrigation, education, efficient use of fertilizers and extension services are capable of enhanced productivity per unit of land. Increased production further reflects on socio-economic development in rural communities. Overwhelmingly, the study area has been experienced a robust transformation in terms of both agricultural technology as well as socio-economic development during the periods of 2000-01 and 2014-15. The contribution of agriculture in transforming both social and economic development is not quantifiable, because it is considered as the mainstay or backbone of societal development (Meijerink, Roza, 2007). The study concludes that the district has experienced tremendous technological changes in agricultural practices; agriculture induced better productivity and productivity further leads to overall socio-economic development during 2000-01 and 2014-15. Therefore, the analyses presented in this paper have shown a strong association between agricultural technology and socio-economic development.

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Socio-economic conditions of women under Saansad Adarsh Gram Yojana: A case study of Jayapur village of Arajiline block, district Varanasi

Abhilasha Sharma1 and Suman Singh2
1Research Scholar, Department of Geography, Institute of Science, B.H.U. Varanasi
2Associate Professor, Department of Geography, Institute of Science, B.H.U. Varanasi
(Corresponding author's email: abhilasha299@gmail.com)

Abstract
Saansad Adarsh Gram Yojana (SAGY) is a rural development programme and it was launched on 11 October 2014 with a mandate to develop three Adarsh Grams by 2019 and to substantially improve the quality of life of all sections of the population through improved basic amenities, higher productivity, enhanced human development, better livelihood opportunities, access to rights and entitlements especially for women and weaker sections. According to the census of 2011, in the Jayapur village, almost 46% of total females were illiterate, only 15% were main-worker and 29% of the total household was in the BPL category. In the present paper an attempt has been made to analyze the socio-economic condition of women after the implementation of SAGY in Jayapur village of Arajiline block, Varanasi District, U.P. The study is carried out in the adopted village of Prime Minister. The study is mainly based on a primary survey of data but secondary source of data also used from the Block Development Office, Gram Panchayat and Anganwadi Centres. Primary data were collected from 80 female respondents in the age group of 18-49 by using purposive sampling through the interview schedule. Both qualitative and quantitative techniques have used in this study. For a graphical representation of the data pie charts, bar diagram, Tables and maps have prepared by using M.S. Excel and Arc GIS software. The results show that inaccessibility of water and sanitation facilities is still a major problem for the women of this village because they spend a lot of time in collecting water through hand-pumps and wells even for using the toilets they stored the water. Due to water scarcity, most of the women used to defecate in open. Although, Availability of electricity has made the life of women very easy especially in the completion of household chores such as serving food for families, teaching their children and in doing some productive works. Hence, there is an improvement in the socio-economic condition of women after the implementation of the SAGY but it is not at a satisfactory level. There is a need to investigate the proper implementation and fill the required gap.

Keywords: SAGY, quality of life, human development, adopted village

Introduction
Saansad Adarsh Gram Yojana (SAGY) was launched on 11 October 2014 with a mandate to develop three Adarsh Grams by
2019 and to substantially improve the quality of life of all sections of the population through improved basic amenities, higher productivity, enhanced human development, better livelihood opportunities, access to rights and entitlements especially for women and weaker sections. Saansad Adarsh Gram Yojna (SAGY) is the Rural Development scheme that adopts the villages and transforms them into the Model Village. It envisages the integrated development of the village across multiple areas such as agriculture, health, education, sanitation, environment, livelihood, etc. and it focuses not only on improving the physical infrastructure and access to basic amenities but also in improving the standard of living and well-being of the people. Mahatma Gandhi in his vision of the ideal village stated that an ideal village will be so constructed as to lend itself to perfect sanitation, cottages with sufficient light and ventilation. He also mentioned about the necessity of primary and secondary schools in the ideal village (SAGY Guidelines, 2014). According to the census 2011, almost 69% of the population lives in rural India. Despite several initiatives by governments, there is a significant gap between rural and urban India (Table 1).

The main reason for the failure of rural development schemes has been the lack of an integrated approach to the village as a unit. Different flagship schemes such as National Rural Health Mission (NRHM), Sarva Siksha Abhiyaan (SSA), and Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) have been launched earlier but achieved limited success. NRHM targeted to reduce the infant mortality rate to 30 per thousand live births, maternal mortality rate to 100 per lakh live births and total fertility rate to 2.1 by 2012. As per the Sample Registration System (SRS, 2015-17), India's maternal mortality rate is 122 per lakh live births, Infant mortality rate is 33 per thousand live births in 2017 to 32 in 2018 and the total fertility rate is 2.2. Sarva Siksha Abhiyaan programme seeks to provide quality elementary education with special focus on girls' education and children with special needs but according to the report of Comptroller and Auditor General of India (CAG) during 2009-2014, enrolment of children in primary school

| Sector          | Parameter                                                                 | Urban | Rural |
|-----------------|---------------------------------------------------------------------------|-------|-------|
| Expenditure     | % people below poverty line (2011 -12) (Tendulkar estimates)              | 14%   | 26%   |
|                 | people below poverty line (2011 -12) (Rangarajan estimates)              | 27.2% | 31.3% |
| Education       | Literacy Rate - 2011#                                                    | 85%   | 68.9% |
|                 | Average years of school education of working population*                 | 8.42% | 4.72% |
| Health          | Infant Mortality Rate (IMR) – 2011##                                    | 28    | 46    |

# Source: Census 2011, *Source: NSS 2009-10, Rural-Urban Divide in India, Hnatkovska and Lahiri, 2012, ##Source: National Health Profile, CBHI, 2011
decreased from 440990 to 361046 while in upper primary school it decreased from 3,26,882 to 2,53,241 (Times of India, 2015). MGNREGA was ranked as the world's largest public works programme by the World Bank in 2015. It aimed to enhance livelihood security in rural areas and estimated that it will provide a social security 15% of our country but on the ground level, it is not performing as expected due to insufficient fund allocation, consistent late payment of wages and corruption. The “Model Village” concept could meet these challenges comprehensively. The idea of an “Adarsh Gram” or model village has been started in the form of Pradhan Mantri Adarsh Gram Yojana, launched by the Central Government in 2009-10. After that Mukhya Mantri Adarsh Gram Yojana was initiated by Himachal Pradesh Government in 2011. Similarly, on Independence Day Prime minister committed to launching the Sansad Adarsh Gram Yojana and it has been launched on 11 October 2014 with the aim that SAGY will keep the soul of rural India alive while providing its people with the physical amenities to enable freedom of choice to shape their destiny. In India, almost two-thirds of the population is living in rural areas and ensuring the country's food and nutrition security through its agricultural and allied activities. Women make up 33% of cultivators and about 47% of agricultural labourers. Rural women play a significant role in the production of food, Sustainment of their families, and strengthening of the rural economy but they live in a poor state. They have always suffered by the name of Religion and Social-cultural practices. Many abhorrent customs, traditional rigidities and vices have made the condition of rural women very miserable and bleak. These are the most vulnerable section of any society because of widespread illiteracy, lack of employment opportunities, inaccessible health-care services, early marriages, and violence. There is Agenda for sustainable development to improve the living conditions of rural women and promote their economic and political empowerment (Hughes, 2008). The condition of rural women can be improved through such measures i.e., by encouraging education, skill development, employment opportunities, and implementing morals and ethics (Kapur, 2019). The introduction of holistic development scheme like SAGY in the rural area have helped to provide a thrust to the development process and can be termed as a boon for the rural women due to its integrated development approach which will contribute in enhancing their socio-economic condition. Therefore, this paper attempts to analyze the socio-economic condition of women after the implementation of SAGY in Jayapur village and to find out the bottlenecks in the implementation of SAGY. This village had been adopted by our honourable Prime Minister and It has been 5 years since the scheme came in to force. This study will provide the present socio-economic condition of women, ground realities of the Sansad Adarsh Gram Yojana (SAGY), and the problems faced by women in accessing their basic facilities.

**The study area**

Jayapur (25.21N and 82.81E) is a village located in the Varanasi district of Uttar Pradesh (Figure 1). As for connectivity with urban areas, it is about 28 km away from the Varanasi Junction railway station and 10 km from the
Rajatalab Tehsil. The Village lacks many basic facilities such as hospitals, Government schools and colleges, markets, medical shops and clinics. The area of Rajatalab caters to the need of the resident of this village and its adjacent villages. As per census 2011, the total population of the village is 3,205 in 430 households. Approximately 10% of households belong to scheduled Caste communities. The Sex Ratio of the population is 930. The literacy is 76.21% where literacy among the male population is 89.12% and literacy among the female population stands at 61.27% which is lower than the district rural female literacy rate of 68.20%. According to the census of 2011, almost 46% of total females were illiterate, only 15% were main-worker and 29% of the total household was in the below poverty line (BPL) category.

Database and methodology
The study is mainly based on the primary survey of data but secondary data has also been used that is collected from the Block Development Office, Gram Panchayat, and Aanganwadi Centres. The Survey was carried out from March to May 2018. Primary Data was collected through purposive sampling by keeping in mind the economic, demographic, and social profile of the village. A total of 80 female respondents were selected for the interview between the ages 18-49 through Interview schedule & personal interview. Women with this age group are mainly interviewed because most of the educated and economically active women come under this age group as well as this is the prime childbearing age group. Thus, they are eligible to fulfil my objectives. There are many variables to analyse the socio-economic condition of women but I have selected those variables which have mentioned under Sansad Adarsh Gram Yojana's guidelines. It has been shown in Table 2. This study is explanatory. Both quantitative and qualitative types of data have been used in this study. M.S. Excel and Arc-Map 10.1 have been used in data analysis and mapping respectively.

Results and discussions
The social condition of women after the implementation of SAGY
Under the SAGY, to improve the social condition of women several activities had been started such as providing pucca houses, safe drinking water, proper electricity, improve sanitation facilities, accessibility to health care services, and a basic level of education. In the following paragraphs we will discuss it:

Types of house
Housing is one of the necessities of life that enhance the quality of life of the individual diversely (Perera and Mensah,
2018). SAGY aimed to provide pucca houses for all houseless poor/poor living in kutcha houses and during the field survey; we found that a beautiful colony (Atal Nagar Colony) had been constructed with all the basic facilities for the Scheduled class and scheduled tribes women (figure 3). However, it was not evenly distributed. Most of the family were houseless and living in huts and shades along the streets. Thus 69% of people had pucca houses after the implementation of SAGY but still, 19% and 12% of people were living in kutcha houses and huts respectively with very limited resources (figure 2).

**Table: 2 Socio-Economic Variables**

| Social                          | Economic                          |
|--------------------------------|-----------------------------------|
| Type of house                  | Source of Income                  |
| Drinking water facilities      | Promotion of diversified agricultural Livelihoods |
| Electricity                    | Development of skills of rural women |
| Sanitation                     | Formation of women's SHGs         |
| Health care services           | Opening of Bank Accounts          |
| Education                      |                                   |

Source: Sansad Adarsh Gram Yojana Guidelines, 2014

**Drinking water facilities**

Without safe drinking water, adequate sanitation, and hygiene facilities at home and in places of work and education, it is disproportionately harder for women and girls to lead safe, productive, healthy lives (UN-Water, 2014). For the well-being of residents of the village SAGY' set the aim to deliver clean and safe water through pipelines to every household. For this, the underground pipeline had been laid out and the water tank was distributed to store the water. But it could not achieve its goal of providing safe drinking water to the women of this village who bring their water from some distances and usually bear the responsibility for collecting water, which is often very time-consuming and arduous.

**Figure 2: Percentage of the population occupying different house type**

**Figure 3: Atal Nagar Colony made for Musahar Caste**
The reason for the failure of the pipeline system was the theft of the water motor. Now women are again dependent on hand-pump and wells for their water supply. We found that the hand pump was the main source of drinking water (70%) and 24% of households were using the wells for drinking purposes and only 5% of households had accessibility to submersible which was clean as compare to other sources (figure 4).

**Electricity**

Under SAGY the goal was set to electrify every house. Electricity plays a very important role in the life of rural women. They frequently use electricity in their working space such as in cooking, making garlands, sewing, knitting & weaving, and other finer tasks that are associated with their livelihood. Electrification helps in reducing the burden of women and positively impacts on health, education, and farm income (Mathur, 2005). It also helps in providing entertainment and information. From the field survey, we found that 80% of households were electrified while 19% were electrified via solar panel and only 1% was without connection of electricity (figure 5&6).

**Sanitation**

Women and Girls are more vulnerable to abuse and attack while walking to and using a toilet or open defecation site (UN-Water, 2014). So, to secure safety and improve the hygienic behaviour of women, the provision of providing toilets to every household had been introduced in this yojana. during the field survey, we found that every household had toilets in front of their houses. There were three types of toilets i.e., biodegradable toilets, plastic shaded toilets, and cemented toilets. The numbers of cemented toilets were very less.
and most of the bio-toilets (figure 7) which had been installed in public places have been disfigured due to storm and mischievous elements. The toilets in the premises of Girls College were also in the worst condition and according to girls, there was no proper facility of watering in toilets and it is difficult to manage their hygienic condition. Therefore, they prefer open fields for defecation. So, here the use of toilets for women is very challenging.

Health care services

Health-care in Rural areas always remained a great concern (Economic Survey 2018-19). Under the SAGY, the main objectives were universal access to basic health facilities to women so that they can live a healthy life. During the field survey, we found that there were no sub-centres and clinics in the Jayapur village which is required to serve extremely rural areas. The sub-centres is the most peripheral and first contact point between the primary health care system and the community. Women were dependent on nearby Community Health Centre (CHC, Jakhini) for their maternal and child health, family welfare, immunization, nutrition and control of communicable diseases programmes. Though there were monthly health camps, it was not beneficial for women and others. According to the villagers, they could not recover from the medicine given by the doctors and some were afraid of taking these drugs due to its side effects. They feel vomit and get dizzy after taking drugs by health camps. ANM were regular in their duties. They timely vaccinate the child and pregnant women. Health cards had been issued under the scheme but it was used only by the Gram Pradhan's family. So, immediate access to health care facilities to women in this village is a matter of concern.

Education

SAGY aimed to provide universal access to education facilities up to Class X but in the field study, we found that out of 58 households only 22 families sent their children to government schools and while rest of the study in private school. Further, the disparity in enrolment of the child can be seen as girl children are enrolled in a government school while male children have the priority of attending a private school for quality education. During the survey, in primary school, we found that out of 123 students 71 were girl child and 52 were boys. Out of 80 female respondents 42 out of 80 households) had not attended any college and school education in their life and it can have a bad impact on their children's education. Because most of the female respondent reported that they could not understand the homework, class work and project work of their children that is provided by the private schools. A women's lack of education also harms the health and well-being of their children (Jain, 2016).
The economic condition of women after the implementation of SAGY

According to the survey in Jayapur village, 25 per cent women were house makers and only 10 per cent of women have govt/private jobs (figure 8). Above data depicts that half the population of women are stay-at-home spouses, labourer, and agricultural labour. Therefore, to improve the economic condition of women in Saansad Adarsh Gram Yojna different activities were mentioned such as the development of the skill of rural women to enhance their livelihoods and the formation of women's SHGs and financial inclusion. The status of all the activities can be understood by the following heads:

**Promoting diversified agricultural livelihoods including livestock and horticulture**

In the rural area, women play an important role in the rural economy and perform several agricultural activities from sowing to cutting crops which deteriorate their health conditions but after the implementation of SAGY, 92% women were now using farm machinery for agricultural production which enhanced their agricultural productivity and level of income and improved health and social condition. Few women (8%) were still involved in the traditional form of agricultural activities.

**Development of skill of rural women to enhance their livelihoods**

Under SAGY the aim was set to develop the skill of rural women to enhance their livelihoods. During the field survey, it was found that 25 women were doing training for sewing, knitting, and weaving but they were not sure about the job after completion of the course. Trainer of the institutes stated that they are only responsible for training the candidates not to get a job. So getting a job for women is still a challenge.

**Formation of women's SHGs and financial inclusion**

In Jayapur village 7 self-help groups are working on the National Rural Livelihood Mission. They have their separate Pradhan Mantri Jan Dhan bank accounts. Most of the women don't know how the self-help group works. Only 7% of the women were taking advantage of the
self-help group. Financial inclusion talks about the availability and equality of opportunities to access financial services but in this village, it could not achieve its aim. Although everyone has their bank accounts under the Jan Dhan Yojana schemes only 30% of women have accessibility to bank accounts and financial services while rests are dependent on their husbands or sons for the banking. The main reason behind this is a lack of awareness, mobility, and literacy.

**Bottlenecks in implementation of Sansad Adarsh Gram Yojana**

Based on various findings and observations, it was found that there exist several gaps that are creating problems in the proper implementation of the scheme. The main bottlenecks are listed as:

* Lack of awareness amongst women about the schemes

It has been seen from the field survey that half of the women were not aware of the utility of the scheme. They don’t even know that several health-care schemes are running by the government to improve their health, education and nutritional conditions. Several Poshan Abhiyaan and ante-natal post-natal care services are running free of cost for rural women through Integrated Child Development Services (ICDS).

* The irresponsibility of concerned officers in discharging their duties

The irresponsibility of local officers can be seen by the manner that even after the water motor is stolen they have not taken any action till the date of my field survey and the supply of water remained closed and again they are dependent on their traditional source of water supply i.e. hand-pumps and wells.

* To select the right people as beneficiaries

It can be understood with a few examples of this village. In the case of providing sanitation facilities, most of the toilets were provided to those people who had already toilets in their houses and it was the same in the case of Indira Awash Yojana.

* The improper coverage area of the scheme

It was found that benefits were not received by all equally. Some vulnerable women i.e. old age women, ill-health women, and victim women (those women who have faced different types of violence) were not included in this scheme.

* Poor experience of beneficiaries regarding transparency and judicious use of funds

When we asked the people regarding their experiences on transparency and judicious use of funds they clearly said that we faced much discrimination in receiving several basic and essential services especially in matters of providing toilets and houses. A provision was made to construct a sewer under SAGY’s guidelines and funds were allocated for the same, but there is no evidence of sewer in the village of Jayapur.

**Conclusion**

Jayapur was the first village to be adopted, in November 2014, under the SAGY flagship scheme. In the initial days, the 4500 villagers of Jayapur were euphoric, believing that their lives would transform rapidly as they had come under the focus of none other than the prime minister himself. According to village sarpanch, initially, bureaucrats were monitoring the projects and construction work in the village but later everything was being built at break-neck speed and quality...
suffered. For example, 80 per cent of the toilets are unusable. Their plastic doors have developed holes, and the roads have developed huge potholes. In 2015, 135 solar-powered street light installed in Jayapur. Unfortunately, 80 of these solar batteries had been stolen. After the complaint with the police, no action has been taken against the culprits. A khadi weaving facility has been set up to provide the women in the village training and employment. But it could not get success in providing job to women. Despite, several issues, SAGY has been partially successful in providing basic facilities i.e. houses, electricity, sanitation and health care (through ASHA and ANMs). These facilities play an important role in empowering the women because houses provide shelter for people to lay their heads, develop their skills, socialize and be educated to engage in different activities of their choice while sanitation and health care facilities help in maintaining the physical and mental health of the individual. Although, SAGY has helped the women to live with respect the extent to which it was expected, has not at all been achieved. The reason behind this was illiteracy, lack of awareness and non-exposure to media. These women hardly use any media for their entertainment and knowledge because they generally involve in their household chores and taking care of children and family members. if there is hardly any time left then they go to work in the agricultural field. Overwork has made the condition of women very miserable. socio-economic status of women firstly we need to encourage their educational status and ensure job opportunities for participation in economic activities and this yojana, It has been overlooked as said by respondents. It is suggested by women that the government should provide job opportunities and social security to improve their condition and there is a need for the transparent and responsible system in implementing such a scheme.

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Impact of fear of crimes on public transport usage: A case study of Delhi

Rabindra Nath Dubey
Associate Professor, Dr. B. R. Ambedkar College, University of Delhi, India
(Corresponding author's email: drrndubey@gmail.com)

Abstract
Delhi Transport Corporation (DTC and Delhi Metro-Rail System (DMRS) are two important public transport systems in Delhi. The DMRS has been attractive in respect to ridership but in 2015 it has shown a decrease in its ridership. It has also been found that ridership of the bus service, the most important public transport system for the poor in Delhi, has decreased over time whereas the numbers of private vehicles have recorded phenomenal increase resulting in traffic congestions and pollution problems in the city. The purpose of this study is to explore the role of the fear of crimes along with other reasons for decreasing trends in the usage of public transport in Delhi. The study is based on people opinion and perception for which 350 persons were interviewed with the structured questionnaire from ten transit places having varied socio-economic conditions. Fear of crimes within buses/coaches is considered an important reason for not using public transport in western countries but as per this study, the same is not true in the case of Delhi. Role of fear of crimes along with other factors was verified with the spearman's correlation coefficient. The weak negative correlation has been found between the preference to public bus services and the fear of crimes; the crowding; the unavailability. It indicates that along with these other factors are equally responsible for the choice of public transports in Delhi.

Keywords: transport system, public transport, transit places, transit crimes, commuters

Introduction
The rapid urbanization and concentration of population in big cities of India accentuate the need for a people-friendly public transport system to avoid extensive use of personalized private vehicles. But it has been found that numbers of personalized motor vehicles are increasing more rapidly in comparison to public vehicles in Indian cities. Delhi is the front runner in this matter. There are mainly two types of public transport available in Delhi i.e., Bus Transport System, and Metro-Rail (DMRC). The other one, the local Railways networks has the least importance in city travel. The Delhi Transport Corporation (DTC) considered as a lifeline of Delhi has shown consistently decrease in the numbers of buses and ridership over the years. The Delhi Metro Rail System is another important public transport service which has been successful in providing quality services and has also been successful in reducing traffic on the roads of Delhi by
Increasing daily ridership since its operation in 2002 up to 2014. But in 2015 its ridership has also decreased. During the same period, the share of personal motor vehicles like cars and motorcycles/scooters has increased. The question is why public transports are losing their strength in Delhi?

Various studies have found that crimes and fears of crimes have played important role in the decision of using public transport. Many cities in developed countries have well organized public transportation and billions of trips for public transport take place every year (Madriaza, 2016). However, fear of crimes is a major issue here and people avoid public transport. In London, about 25% of people feel least-safe at transit stops followed by 21% along approaching road to stops and about 17% within the vehicles (Future Thinking, 2015). 'Fear of crimes was more prevalent in trains than buses in Washington'. In contrast, it was more on buses than train in London. About 94% of the personnel of buses and trams were the concern of criminal attacks in France (Madriaza, 2016)'. It was found by Morgan and Smith that 'Generally...men are more victims of crimes on public transports than women (Smith, 2008) whereas fear of crimes was more among women than a man in France (Guilloux 2012)'. FIA Foundation engaged in global road safety, found in a survey that many women do not join job because of unsafe access to means of transport (FIA foundation, 2016). In the cities of developing countries, fear of crimes on public transportation is more acute. In Bogota, the capital of Colombia, it is 74%, in Mexico City 68% (Mantilla, 2016) and in Kathmandu, about 55% women and 45% men feel unsafe and avoid public transports if possible (CANN and CEN, 2012). In the west, fear of crime has been leading researched topics in the contemporary criminology (Farrell et al. 2000) whereas 'there have been far few studies in fear of crime in developing countries' (Bruce, et at., 2012). In India, there are many studies on the incidents of crimes particularly on sexual harassment of women on public transport (Choikalingam and Vijaya, 2008, Joseph's et al. 2014, Natrajan 2016, Tripathi et al. 2017 etc.). Most of these studies are an assessment of the incident of crimes on various modes of public transports. In the present study, an attempt has been made to explore the relationship between the choice of public transports and the fear of crimes along with other factors responsible for the choice in Delhi. The study aims (i) to assess the existing state of affairs of the public transport systems in Delhi and (ii) to explore the reasons for decreasing ridership of the public transports and examine reasons for the people's preference to public transports.

**The data source and methodology**

Both primary as well as secondary data have been used in this study. The secondary data have been collected from the Delhi Transport Department, DTC Operational Statistics, Delhi Master Plan 21, Delhi Integrated Multimodal Transit System (DIMTS), Delhi Metro Rail Corporation (DMRC) and reports of the various organizations for a brief profile of transportation systems in Delhi. The primary data have been collected from transit users and their opinions have been taken on various aspects of the usability of different transport services in Delhi. For this study, ten transit places (Railway/ Metro stations/ bus stops) were selected...
from different locations i.e., the inner city, the periphery area, posh colonies, low-class residential areas and near urban villages which represent all segment of the city. Transit places were chosen because these are the places where commuters are easily available and can respond with a fresh memory of their experiences. The opinions of randomly selected 35 persons from each transit place were taken using a structured questionnaire. Only those respondents have been approached who were residents of Delhi and NCR for at least 2 years and their age was 18 years and above at the time of the survey. While survey, it was kept in mind that the samples must represent all sex, age, religion, education and the users of a different mode of transport appropriately (Table 1).

**The study area**

![Table-1: Demographic Characteristics of Respondents](source: Compiled from Survey, 2015)

| Sample Characteristics | Number | Percentage | 3. Age Group | Number | Percentage |
|------------------------|--------|------------|--------------|--------|------------|
| 1. Sex Male            | 227    | 64.9       | 18-29 years  | 165    | 47.1       |
| Female                 | 123    | 35.1       | 30-44 years  | 143    | 40.9       |
| 2. Religion Hindu      | 244    | 69.7       | Illiterate   | 69     | 19.7       |
| Muslim                 | 103    | 29.4       | Literate     | 281    | 80.3       |
| Others                 | 03     | 0.9        | Total Number of Sample | 350   | 100        |

Source: Compiled from Survey, 2015

Delhi, the capital of India is located in prosperous northern plain and has 1.68 crore population with a density of 11297 persons/sq. km. (Census, 2011). It attracts population from all over the country, particularly from neighboring states. The annual growth rate of population is 3.2%. The city had 9 districts in which about 1.05 crores motorized vehicles were running on its 33,868 km of road networks in 2017 (DES, Delhi 2016-17). The maximum space (about 70 %) of the road is occupied by cars which carry only less than 10 per cent of the passengers. The Metro-rail has 160 stations on its 213 km network. About 3547 DTC buses carried daily 31.55 lakhs passengers while daily average ridership in Metro-Rail was recorded more than 23 lakhs in 2015 (DMRC,16). The samples for this study were selected from ten transit places each from almost all districts of Delhi keeping in mind that each one represents specific locality of Delhi. Anand Vihar transit place having stoppage of all the three transport systems i.e., Inter-State Bus Terminus (ISBT), Metrorail Station (MS) and Railways Station (RS) is located along Uttar Pradesh border. It is the busiest transit place. Seemapuri Bus depot/stop (SP) surrounded by slums and low-class residential areas is at the eastern edge of Delhi bordering U.P. Gokalpur Bus Stop (GP) is located near an urban village in the north-east Delhi which is considered among most crime sensitive areas. Old Delhi (OD) and New Delhi (ND) Railways
Stations (RS) both having Metro station (MS) and bus stop (BS) are situated in the central Delhi dominated by commercial areas. Nizamuddin (NZ) RS & Sarai kala khan ISBT is in the middle-class residential areas located in South-east Delhi. Kashmiri Gate transit station surrounded by commercial area in the south and the high-class residential area in North has MS and busiest ISBT in Delhi. Vishvidyalaya (VV) MS is surrounded by elite Delhi University in the South and High-class residential areas in the North. Vasantkunj (VK) BS at Nelson Shopping Centre is a famous Bus Stop located within posh colonies in South Delhi where Nirbhaya rape case happened. Jahangirpuri (JP) MS/BS is located in low-class residential areas in the North-West Delhi (Figure: 1).

Most of these transit stations are very crowded with diverse nature and values of people conversing daily here (Dubey, 2019). Despite a wide administrative setup, crimes rate is very prevalent in Delhi. As per the NCRB (2015), the crime rate in Delhi was 310.6 per lakh population. The Commonwealth Human Rights Initiative (CHRI) found that about 10% of all crimes in Delhi occurred on public transport highest being theft (12%)
followed assault (5%), sexual crime (4%) excluding crimes at transit stations in 2015 (CHRI, 2015). The incidents of crimes within vehicles and at the transit stops create fear of crimes and discourage the use of public transport. Hence, it is a fit case to investigate the reasons behind the unattractiveness of public transport in Delhi.

Results and discussion

In section, profiles of modes of public transportation in Delhi, public opinion/perception on it and correlation between various variables along with findings will be discussed.

Profile of Public Transport Systems in Delhi

At a time, the public transport system in Delhi was considered very strong in the county, but now it suffers from various deficiencies such as insufficient route-network coverage, overcrowding, unreliable services, inadequate fleet, crimes at transit stations and within vehicles, and the missing coordination among three systems i.e., us, metro rail and local train services. The Govt. of India has launched several schemes like JNURM to encourage the use of public transport in cities and to discourage that of personal private vehicles. However, the share of all public transport (Bus, DMRS, and Local Rail) in Delhi has decreased from 64.1 per cent in 2001 to 54.02 per cent in 2010. At the same period, the share of all personal vehicles has increased by 35.9 per cent to 45.98 per cent during the same period (MPD-2021 DDA, 2021). The share of buses which is the main mode of common public travel in Delhi has decreased drastically from 1.08% in 1991 to 0.36% in 2017. Even the proportion of motorcycles and scooters which occupy less space on road has also decreased (Table-2).

It means a large space on the road is being occupied by private vehicles (Cars & TWs) making travelling speed slow and leaving little space for public transport, disadvantageous group, pedestrians etc. (Table 2). This indicates the state of affairs of the public transports in Delhi. Hence, a brief description of the profile of various public transport systems in Delhi becomes imperative.

Public Bus Transport System in Delhi

In respect of accessibility, affordability and suitability to large scale transition, buses have an important role in the mobility of cities. At present, two types of organized public bus services are in Delhi i.e. Govt. owned Delhi Transport Corporation (DTC) and the private-owned Cluster Bus service,

| Types of Vehicles    | 2017 | 2011 | 2001 | 1991 |
|----------------------|------|------|------|------|
| Cars                 | 30.17| 31.35| 26.65| 21.76|
| Motor cycles/scooters| 64.17| 62.63| 64.64| 67.48|
| Auto rickshaw        | 1.66 | 1.27 | 2.52 | 3.51 |
| Taxi                 | 1.42 | 0.85 | 0.52 | 0.57 |
| Buses                | 0.36 | 0.89 | 1.19 | 1.08 |
| Goods Vehicles       | 2.22 | 3.01 | 4.58 | 5.60 |
| Total Number of Vehicles in Lakhs | 104.53 | 69.32 | 34.57 | 17.65 |

Source: Delhi Statistical Hand Book-2012 & 2017
The DMRC owned Metro Feeder Buses, Charter buses and private Minibuses (RTV) also provide services at a limited scale. DTC and Cluster buses are the main players in Delhi (Figure: 2).

Private Stage Carriage Bus system, now known as Cluster buses, is the oldest one running in Delhi since before independence in different form, scheme and nomenclature changing from time to time. These buses come under State Transport Authority which is responsible for registration and routing of buses. The DTC is an agency of the department of transportation of the Govt. of Delhi established in 1971. Both DTC and Cluster Scheme Buses are managed by the Delhi Integrated Multimodal Transit System (DIMTS). In 2016, total 5482 (DTC 3789, and Cluster Bus 1693) bus were being operated on a total of 659 routs (DIMTS, 2016). Although, the fleet size of the Cluster Buses System introduced in May 2011 has increased from 231 buses in 2011 to 1693 in 2016 but its contribution to public transport is not much in comparison to DTC. The fleet size of the DTC has decreased from 6204 in 2011 to 3789 in 2016 (DIMTS, 2016). It is important to note that the daily ridership has also decreased drastically (35%) from 46.77 lakh to 30.33 lakh during the same period (DTC operational statistics 2016). The decreasing ridership of the bus services is a matter of serious concern as it would further lead to increase in personalized vehicles which Delhi cannot afford due to clogging of the city and phenomenal increase in pollution.

Delhi Metro Rail System

Considering the heavy traffic congestion and pollution in Delhi, there was an urgent need for a rapid mass transport system which can make hassle-free travel providing the comfort of personalized vehicles without much cost. To reduce personal motor vehicles on the road, Delhi Metro Rail is operated by the Delhi Metro Rail Corporation (DMRC) was launch in 2002. Now, it provides service to Gurugram, Noida, Ghaziabad and Faridabad along with Delhi. The existing network length is about 213 km with 160 stations on its 6 lines. Since its inception, the ridership of the metro rail has recorded remarkable growth from 0.82 lakh in 2002 to 23.38 lakh persons per day.
in 2015 (Fig.3). In a very short span, it has been able to attract a large number of passengers of the higher and middle-income groups of which a large portion have been using/owning motor vehicles. As per Dwivedi and Gupta (2015), 'about 44 and 33 per cent of metro riders belong to the income group of Rs. 20,000 -50,000, and Rs. 50,000 & above per month respectively. This study also reveals that about 78 per cent of the metro passengers owned a vehicle at the time of the study. The feeder buses run by DMRC for providing services to nearby colonies from Metro stations has not been much successful as most of its buses are non-AC and do not match with the status of the metro riders forcing commuters to use personal vehicles from residence to station resulting in high congestion in parking. 'The main drawback of the metro rail is that it has limited spatial coverage and only 20 per cent areas of Delhi come under its influence (Dwivedi and Gupta, 2015)'. It is also a matter of concern that Metro rail ridership has recently decreased from 23.57 lakh in 2014 to 23.38 lakh in 2015.

**Local Rail System**

The local rail network in Delhi also known as ring railway system was constructed in the 1930s mainly for freight transport. At present, it carries only less than 1 per cent of passenger load mainly due to limited capacity, inadequate feeder services and lack of its integration with another mode of transport in Delhi. Hence, it has a little role in public mobility in the city.

**Opinions and Perception of Usage on Public Transports**

It has been established by many studies in western countries that fear of crimes and public transports are closely related. As discussed above mental map affects the behaver of a person in normal conditions. Therefore, public opinion is important in the assessment of public transport. In this section, the discussion will be on the peoples' preference of modes of transport along with reasons of their preference and the safety level within the public transport i.e., Metro rail and bus services in Delhi. The perception study shows some interesting aspects of it.

**Preference of Modes of Transportation**

Despite frequent congestion on the roads of Delhi, about half (49.23%) of respondents gave choice for own vehicles-cars/two-wheelers while preference to public buses was given by only 23%.
Preference for Metro was low (18%) because its operation was in limited areas of the city. Taxies and auto-rickshaws are the last choices for travel because of affordability and safety reasons. No one referred to travel on the road of Delhi on foot. This can be attributed to the safety concerns of pedestrians (Figure 4). There is much spatial variation in preference to private cars. Peoples at transit places located in posh colony prefer car or taxi (Vasant Kunj, Old Delhi etc.). While at Seemapuri BS (60%) and Anand Vihar ISBT (50%) preference was given to buses to travel. Auto is very popular at Gokalpur (36%) as auto-rickshaw runs on sharing basis in this locality. More developed areas like Vasant Kunj, old Delhi and Kashmiri gate recorded highest preference (between 60-80%) to the private vehicles whereas respondents at the areas with low socio-economic conditions i.e., Anand Vihar and Seemapuri, preferred bus services the most. The most affluent area New Delhi preferred Metro rail (39%) over another mode of travel probably due to high parking charges. Jahangirpuri, the area of the lower middle class also preferred private vehicles particularly two-wheelers (Figure 5).

### Reasons for Opting Own Vehicles over Public Buses:

Based on trends in the western countries where fear of crimes is the prominent reasons while choosing public transport it was presumed that the same trend would be in the cosmopolitan Delhi. But it was found contrary to them as crowding in public buses of Delhi was the main reason for opting own vehicles over public buses by the majority (42%) of respondents followed by fear of crime.
(26%). About 21% of respondents preferred their vehicles due to irregular timings in the running of buses. About 8% believe that unavailability of buses is the main reason for not opting for public buses. Reasons for opting private vehicles over metro train:

Crowding (41%) and fear of crime (30%) in the metro are two major drawbacks in the choice of metro and opting for their vehicles to commute. The other important reason is unavailability. Only about 4% of the respondents preferred to travel by own vehicle due to the parking problem at the metro station.

Safety in the public transport system

Safety and security in public transport have been a grave concern for the general public, particularly for women. About 22% and 9% of the people feel unsafe and very
unsafe respectively in the public transports (Fig.8). Respondents at Anand Vihar (20%), Vasant Kunj (20%), and Jahangirpuri (20%) felt very unsafe. However, only 2% of respondents in Delhi rated public transport as very safe. Only Vishwavidyalaya MS (20%) was reported to be very safe among 10 transit stations in Delhi. People travelling in a metro feel fairly safe as it is a closed system operating under high security, CCTV surveillance and presence of security personnel.

**Association between preference to bus services and crimes**

It has been observed that the choice of a mode of transport has a certain relation with the factors like fear of crimes, crowding, unavailability, irregular timing, and safety level within the vehicles. Many studies have found the fear of crime one of the important reasons in the choice of public transport. In this study, the Spearman's rank correlation coefficient has been applied to verify the degree of relationship between these variables. Table-3 depicts a weak correlation between the preference to bus service and the variables like fear of crimes (-0.180), unavailability (-0.142), irregular timing (-0.006) and safety level (unsafe -0.035).

The weak correlation may be attributed to the specific spatial pattern of transit places where the same set of people use it. Hence, the negligible correlation between fear of crime and preference of bus service does not support the assumption that crime directly impacts the choice of public bus transport in Delhi. The weak correlation may also be attributed to the contradictory behaviour of the general public who do not go by their opinion/perception due to the inability generated by weak socio-economic conditions to choose an alternative mode of transport. There is a moderate negative correlation (-0.468) between irregular timing and fairly safe means irregular the timing of buses lesser the sense of safety.

**Conclusion**

The study reveals that the public transport system particularly the bus transport system in Delhi is not in proper condition and it has lost its ridership over time. Majority of the population have
chosen to use private vehicles instead of public transports. The Metro rail system is a comparatively better mode of public transport but it has limited spatial expansion. Its ridership has also decreased recently mainly due to crowding as per respondent opinion. The studies in western countries show that fear of crimes in public transport is a prime reason to avoid it whereas this study has found that crowding is a prominent reason followed by fear of crimes in Delhi. This is true for both public buses and Metro rail. The other reasons for not preferring public bus service are low level of safety, irregular timing and unavailability of buses. The assumption that the fear of crime has a strong negative impact on the choice of public buses is not true in the case of Delhi as it has very weak negative correlation \( r = -0.180 \) having no any statistical significance. The weak statistical correlation may be due to the spatial pattern of transit places in Delhi where, by and large, the same set of people use the public buses. A well-coordinated, well managed public transport system is need of the hour especially for Delhi as pollution and congestions have reached its level of crisis. Expansion of the Metro train system to all corners of the city and up-gradation of the safety surveillance system, GPS monitored the operation of the bus transport system would reduce the private vehicles on the roads of Delhi.

There is a need for more studies on the problem of public transport systems in Indian cities particularly in metro and intermediately ones as a problem are going to intensify more in near future. The main hindrance to such studies is lack of data at the micro-level on crimes, operation of transportation systems etc. The attention of administration is required towards these aspects.

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Land use and cropping pattern change in Chandauli district, Uttar Pradesh: A geographical analysis

Akhilesh Kumar Singh¹ and Arun Kumar Singh²
¹Research Scholar, Department of Geography (MMV), B.H.U. Varanasi
²Professor, Department of Geography (MMV), B.H.U. Varanasi
(Corresponding author's email: akkibhu84@gmail.com)

Abstract
Observation of land uses is an important tool to assess surface change at different spatio-temporal scales. There are six categories of land use discussed in which agricultural land-use class one. Any plan or policy related to agricultural land use brings change in agricultural performance and cropping patterns. Apart from this, the cropping pattern is also governed by the law of comparative advantage concerning Agro-climatic conditions. The present paper focuses on the changes that have taken place in land use and cropping pattern in Chandauli district from 2000-01 to 2015-16. The study reveals that there has been a significant change in land use pattern and cropping pattern as settlement class of land use increase 22.72 per cent in 2015 and the area of rice and wheat crops increase 12829 ha. and 9767 ha. respectively from 2000-01 in the study area.

Keyword: Land use, cropping pattern, transformation, Spatio-temporal scale, agro-climatic condition.

Introduction
Land use and land cover (LULC) is a dynamic and continuous process (Mondal, et al. 2016) as a progressive man continuously transforms the pattern of land use according to his requirement concerning space and time. Land-use change is an important tool to assess surface change at different Spatio-temporal scales (Lambin et al., 2001). Therefore, an extensive, as well as intensive research on LULC pattern is very important along with their social and environmental implications at different spatial and temporal scales (Lopez, et al., 2001). There are six categories of land use are discussed in which agricultural land use is one. If any plan or policy related to agricultural land-use change is effective, then definitely brings change in agricultural performance and cropping pattern (Purushothaman and kashyap, 2010) because agricultural land use and cropping pattern are interdependent. However, the cropping pattern implies the proportion of area under different crops at a point of time, but a change in a cropping pattern thus implies a change in the proportion of area under different crops (Mishra and Puri, 2015). The cropping pattern of any region is influenced by mainly two factors,
geographical features of the area such as soil, climate, rainfall and availability of irrigation facility and another are irrigation facilities (Vidyarnath, 1987). Its deterministic thought, but more effective because a specific climate, soil and certain quantity of water produce specific crops and make regions very famous for those respective crops. Besides these factors, the cropping pattern is also governed by the law of comparative advantage concerning agro-climatic conditions (Vyas, 1996). Therefore, the farmer will go in favour of cultivation of those crops which are characterized by high yield and high suitability index. District Chandauli is constructed in 1997 from Varanasi. After this process trend of urbanization gradually increase with time. The urban sprawl of the main city (Chandauli) and local service centre (Block headquarters) has been bringing a change in land use and cropping pattern, therefore the study is necessary to measure these changes. The objectives of the study are to examine the land use and cropping pattern change in Chandauli district and to find out the factors responsible for land use and cropping pattern change in the study area.

**Study area**

District Chandauli is a part of the middle Ganga plain, and it is situated in the eastern part of Uttar Pradesh, lying between 24.42' to 25.35' north latitudes and 83.00' to 83.24' east longitudes with the total area of 2441 sq. Km. The study area bounded by both political and natural boundaries in the north-west to north all boundaries covered by river Ganga, in the northeast to southeast cover by Bihar state, in the south by Sonbhadra district and in the west of Mirzapur district. This region belongs to a humid subtropical monsoon climate with mild winter and severe summer, characterized by cwg, according to Koppen's climate classification. About 85 percent of annual rainfall is received during June to September and remaining rainfall is received through western disturbance during the winter season (Tiwari, 2016) The district is divided into four micro agro-climatic situations, low laying paddy land, hill area, irrigated upland, and rain-fed area (Krishi Vigyan Kendra, 2015).

**Data sources and methodology**

The present paper is empirical and the study is based on secondary sources of data. The data have been collected for two times of period 2000-01 and 2015-16 from various sources like Zila Sankhiyiki Patrika (land use and cropping pattern, irrigation), agriculture commission report (Minimum support price). The above data
prepare with simple statistical calculation, tables and diagrams are drawn on MS-Excel. Besides this, using the United States geological survey (USGS) satellite image for prepare land use maps with the help of ERDAS Imagine 2014 and Arc GIS 10.4 software. The whole methodology has been summarized in the diagram given above. As there has been a change in the boundary of the study area, so every map is based on the new boundary (2015).

**Results and discussion**

**Land-use change**

Land-use changes are generally grouped into two broad categories of conversion and modification. Conversion refers to the intended shift from one land cover or use type to another, while modification involves maintaining the land cover or use type in the face of changes in its attributes (Baulies and Szejwatch, 1998).

Forest is the most common feature in southern blocks (Figure 2) because this area is under the Kaimur range (Figure 1), this forest is the part of 'Chandraprabha Wildlife Sanctuary'. At the district (Table 1), as well as the block level (Table 2), the forest area does not show any significant changes in 2015. Such a situation may be attributed to environmental awareness among people. The government, as well as a private intellectual, has stopped the degradation activities in reserve forest through the steadfast forest (conservation) act 1980 and various non-governmental organization programs launched for forest conservation and wildlife protection (Pawar and Rothkar 2015).

The general perception about fallow land is that the land which is kept without crops for the current year or till five years to absorb nutrients from the environment and produce better outcomes in upcoming years, those area comes under the fallow land (Brahmbhatt et al., 2000). However, the concept of fallow land in the study area shows different scenarios. Most of the land is fallow not to gain nutrition, but here farmers are forced not to perform any cultivation due to adverse topographic conditions, e.g., Tal (low land in the study area) like situation. At the district level the total fallow land area has decreased (Table 1) therefore share of fallow land has also got decreased in 2015-16 (Fig. 2) while block-wise analysis reveals that three blocks show a decrease in fallow land (Table 2) because these areas merge by Settlement class land use (Figure 3) and six

| Category      | 2000-01 | 2015-16 | Change in Area | % Change |
|---------------|---------|---------|----------------|----------|
| Forest        | 77400   | 77400   | 0              | 0.00     |
| Fallow land   | 8047    | 7518    | -529           | -6.57    |
| Barren land   | 5160    | 3190    | -1970          | -38.17   |
| Settlement    | 22018   | 27022   | 5004           | 22.72    |
| B.F.G         | 1323    | 1115    | -208           | -15.72   |
| Agricultural land | 136848  | 134930  | -1918          | -1.40    |

Source: Calculated data from Zila Sankhyiki Patrika, Chandauli
blocks depict increase area under fallow this, an increment of the total study area and land in 2015-16 (Table 3) Factors behind decreased net shown area in related blocks
In the study area, barren land classified into three categories which are rocky (hilly block Naugarh and Shahabganj), sandy (together Ganga River) and plain (degraded land) barren land (Figure 1). The area under barren land decreased at the district level (Table1) and the share of barren land also decreased in 2015-16 (Figure 2). While at the block level, seven blocks show decreased area (Table 2) as these areas occupied by settlement (Figure 3) and two blocks show increase barren area in 2015-16(Table 2). The factor behind its increment is the occupancy of human activity on agricultural land in that blocks.

The human settlement refers to such a region where human beings are involved in organized activities (Suixin et al., 2018) that includes a residential area, Industrial area, road etc. The settlement is the second-highest land-use class after agricultural land-use class (Table 1) and shows the highest growth rate in terms of the total area in comparison to other land use classes in 2015(Table 3). The settlement is only a land use class which increased in area in 2015-16 (Figure 2) at the district level as well as block-level also. The analysis of settlement at the block level reveals that area under settlement has increased in 2015 (Table 2) because the number of households, industries and area under other urban features (Figure 1) have gone up by encroaching the area under other land use classes (Figure 3). These are the factors responsible for the increase darea of settlement lands.

Land use comprising Bush, Forest and Garden (BFG), is different from forest land use based on compactness and spread. Generally, B.F.G land use can be found mainly along the state highway and its adjoining roads, around villages and in Urban Parks (Figure 1). Besides decreasing total area under the bush, forest and garden land use, its share has also been decreased (Table 1) at the district level in 2015-16.

Table 02: Block wise land use category and area (ha.)

| Block     | Year  | Total area | Forest | Fallow land | Barren Land | Settlement | B.F.G | N.S.A  |
|-----------|-------|------------|--------|-------------|-------------|------------|-------|--------|
| Chahniya  | 2000-01 | 22078      | 1      | 2815        | 1623        | 3519       | 189   | 13931  |
|           | 2015-16 | 19978      | 1      | 1032        | 457         | 4223       | 205   | 14062  |
| Dhanapur  | 2000-01 | 22920      | 9      | 804         | 384         | 3523       | 239   | 17961  |
|           | 2015-16 | 22455      | 9      | 1019        | 393         | 3871       | 152   | 17011  |
| Sakaldiha | 2000-01 | 21671      | 0      | 866         | 400         | 2841       | 121   | 17443  |
|           | 2015-16 | 22051      | 0      | 723         | 326         | 3301       | 94    | 17607  |
| Niyamatabad| 2000-01 | 16495      | 0      | 566         | 490         | 3044       | 107   | 12288  |
|           | 2015-16 | 16850      | 0      | 982         | 329         | 3324       | 85    | 12130  |
| Chandauli | 2000-01 | 19475      | 0      | 369         | 234         | 2060       | 110   | 16702  |
|           | 2015-16 | 20260      | 0      | 610         | 254         | 2414       | 147   | 16835  |
| Barahani  | 2000-01 | 27149      | 0      | 369         | 566         | 2255       | 99    | 23860  |
|           | 2015-16 | 28852      | 0      | 691         | 359         | 2958       | 67    | 24777  |
| Chakiya   | 2000-01 | 32762      | 14855  | 750         | 519         | 1541       | 55    | 15042  |
|           | 2015-16 | 33585      | 14855  | 917         | 330         | 3316       | 74    | 14093  |
| Sahabganj | 2000-01 | 17519      | 2092   | 421         | 414         | 1807       | 37    | 12748  |
|           | 2015-16 | 17175      | 2092   | 515         | 330         | 1918       | 46    | 12274  |
| Naugarh   | 2000-01 | 70701      | 60443  | 1087        | 530         | 1428       | 340   | 6873   |
|           | 2015-16 | 69969      | 60443  | 1029        | 412         | 1697       | 247   | 6141   |

Source: Calculated data from Zila Sankhyiki Ptrika, Chandauli
But, the block level analysis reveals that only five blocks out of total nine blocks have experienced a reduction in area under the BFG land use in 2015 (Table 2) due to being encroached by the settlement land use (Figure 3), while the area under BFG of remaining four blocks has been enlarged due to tree plantation irrespective blocks in 2015-16 (Table 2).

Except for block Naugargh, the entire study area is characterized by plain surface (figure 1) with 1 to 2-degree slope per km. towards the northeast (Tiwari, 2016). It is fertile land which provides favorable conditions for agricultural activities therefore the share of agricultural land use is higher than other land use types in the given time frame (Figure 2). However, the proportion of agricultural land is decreased at the district level in 2015-16 (Table 3) but at the block level, only six blocks show decreased proportion of agricultural land use (Table 2) as agriculture land has been utilized by the settlements (Figure 3) while the remaining blocks show an increased proportion of agricultural land use owing to increasing total geographical area (Table 2). This agrarian transshipment is one of them to bring changes in crop and cropping pattern in the study area.

Cropping pattern

Rice (Paddy)

Rice is the highly consumed crop in north India (Chandauli) therefore, it occupies a larger area in comparison to other crops. Analysis of rice cropping pattern in the study area shows that the total area under rice crop increased in 2015-16 (Table 3). At the block level analysis, eight-blocks have increased in the area under rice crop while block Brahani recorded a decrease in area under rice crop in 2015-16 (Table 4) there are several factors responsible for an increase in the area of rice such as expansion of area under Kharif crops at the district level in 2015-16 (Figure 7), increase in net irrigated area (N.I.A) and gross irrigated areas (G.I.A) (Figure 4), increase in minimum support price of rice by 176.46% (Figure 6), the propensity of farmers and growth in consumption pattern and national demand of rice. While
Barahani block depicts reduced area under rice in 2015-16 as causes of more fallow land (Figure 2) and net irrigated and gross irrigated area have decreased (Figure 4).

**Wheat**

Wheat is the second important crop after rice in the study area and farmer’s first choice crop of both time frames in the Rabi season. In the study area, the area under wheat crop increased in 2015-16 at the district level (Table 3), but at the block level analysis unveil that eight blocks have gotten increased in area (Table 4) behind this positive changes, group of factors work. These factors support to each other to increase the area under wheat crop like the area under Rabi crop is increase at the district level in 2015-16 (Figure 7), increase net irrigated and gross irrigated area (Figure 4), increase minimum support price wheat by 150% (Figure 6). All these things increase the cultivation of the wheat

### Table 3: Change in cropping pattern

| Crop           | 2000-01 Area | 2015-16 Area | Change |
|----------------|--------------|--------------|--------|
| Gross sown area| 225765       | 241315       | 15550  |
| Rice (%)       | 101655 (45)  | 114484 (47.4)| 12829  |
| Wheat (%)      | 89274 (39.5) | 99041 (41)   | 9767   |
| Barley (%)     | 817 (0.36)   | 825 (0.34)   | 8      |
| Jowar (%)      | 937 (0.41)   | 783 (0.32)   | -154   |
| Millet (%)     | 3902 (1.72)  | 4867 (2.01)  | 965    |
| Lentil (%)     | 9501 (4.20)  | 8440 (3.49)  | -1061  |
| Pigeon pea (%) | 2485 (1.10)  | 2973 (1.23)  | 488    |
| Pea (%)        | 1190 (0.52)  | 1197 (0.49)  | 7      |
| Gram (%)       | 3072 (1.36)  | 1547 (0.64)  | -1525  |
| Other pulse (%)| 370 (0.16)   | 193 (0.07)   | -177   |
| Mustard (%)    | 438 (0.19)   | 289 (0.11)   | -149   |
| Flax seed (%)  | 2039 (0.90)  | 515 (0.21)   | -1524  |
| Other oil seeds| 220 (0.09)   | 12 (.004)    | -218   |
| Sugar Cane (%) | 1734         | 664 (0.27)   | -1067  |

Source- Calculated data from Zila Sankhyiki Ptrika,
crop. While Barahani block shows recorded decrease in the area under wheat crop in 2015-16 (Table 4) as net irrigated, and gross irrigated area both are showing decreased (Figure 4), and there is increased land under fallow (Table 2) therefore these are the causes responsible for the decreased Wheat cropped area in Barahani block.

Coarse cereals

Barley, Jowar

The area under barley crop increased at the district level in 2015-16 (Table 3). However, at the block-wise analysis of barley crop, five blocks show increased in area (Table 5) because of decreased fallow land and barren land (Table 2) and increase area under fallow land in these blocks (Table 2). Block Chakiya shows not any significant change in 2015-16 for barley crop (Table 5).

Jowar is grown in tough environments where other crops do not grow well. Therefore, in the study area, this crop is grown successfully where receiving river effect (Ganga, Karmnasa) occur (Figure 1 and 2). The area under jowar decrease in 2015-16 (Table 3) but at the block level only five blocks show decreased in the area under jowar crop in 2015-16 (Table 5) as other Kharif crops have utilized area in these blocks (figure 7) and four blocks area under Rabi crops in these blocks (Figure 7). While three-block depicts decreased in the area under barley crop (Table 5) factor behind it that area substituted by wheat crop (Table 3) and increase area under fallow land in these blocks (Table 2). Block Chakiya shows not any significant change in 2015-16 for barley crop (Table 5).

Table 4: Block wise crop pattern of major crops (Rice and Wheat)

| Name of the block | year   | Net shown area in Rice (ha.) | Change area in Rice crop (ha.) | Area covered by Rice in GSA (%) | Net shown area in Wheat (ha.) | Change area in wheat crop (ha.) | Area covered by Wheat GSA (%) |
|-------------------|--------|-----------------------------|------------------------------|--------------------------------|-----------------------------|-----------------------------|-------------------------------|
| Chahaniya         | 2000-01| 5768                         | 24.88                        | 10013                          | 43.19                       |                            |                               |
|                   | 2015-16| 8991                         | 3223                         | 12142                          | 2129                        | 50.13                       |                               |
| Dhanapur          | 2000-01| 8770                         | 35.39                        | 11631                          | 46.93                       |                            |                               |
|                   | 2015-16| 12433                        | 3663                         | 13943                          | 2312                        | 47.83                       |                               |
| Sakaldiha         | 2000-01| 13170                        | 45.97                        | 13799                          | 48.16                       |                            |                               |
|                   | 2015-16| 16204                        | 3034                         | 15022                          | 1223                        | 51.01                       |                               |
| Niyamatabad       | 2000-01| 9090                         | 47.07                        | 8825                           | 45.70                       |                            |                               |
|                   | 2015-16| 9157                         | 67                           | 9403                           | 578                         | 44.94                       |                               |
| Chaudoli          | 2000-01| 14101                        | 50.70                        | 11192                          | 40.24                       |                            |                               |
|                   | 2015-16| 14404                        | 303                          | 11432                          | 240                         | 38.34                       |                               |
| Barahani          | 2000-01| 20407                        | 48.13                        | 13114                          | 30.93                       |                            |                               |
|                   | 2015-16| 13457                        | -6950                        | 12218                          | -896                        | 27.03                       |                               |
| Chakiya           | 2000-01| 12213                        | 47.36                        | 9896                           | 38.38                       |                            |                               |
|                   | 2015-16| 13457                        | 1244                         | 11906                          | 2010                        | 43.41                       |                               |
| Sahabganj         | 2000-01| 11995                        | 51.70                        | 7839                           | 33.79                       |                            |                               |
|                   | 2015-16| 12213                        | 218                          | 9883                           | 2044                        | 42.80                       |                               |
| Naugrah           | 2000-01| 5418                         | 50.82                        | 2965                           | 27.81                       |                            |                               |
|                   | 2015-16| 7218                         | 1800                         | 3092                           | 127                         | 25.61                       |                               |

Source: Calculated data from Zila Sankhyiki Ptrika, Chauduli
depict increased area under jowar crop in 2015-16 (Table 5) factor behind this increase, the nature of jowar crop is compatible with the physical condition of that blocks (figure 1).

Table 5; Block wise cropping pattern of Corse cereals (Barley, Jowar)

| Block       | Rabi crop                      | Kharif crops                      |
|-------------|--------------------------------|----------------------------------|
|             | year | Net shown area in Barley (ha.) | Change area in Barley crop (ha.) | Area covered by Barley in GSA (%) | Net shown area in Jowar (ha.) | Change area in Jowar crop (ha.) | Area covered by Jowar in GSA (%) |
| Chahaniya   | 2000-01 | 238 | 1.02 | 426 | 1.83 |
|             | 2015-16 | 190 | -48 | 0.78 | 322 | -104 | 1.32 |
| Dhanapur    | 2000-01 | 177 | 0.71 | 193 | 0.77 |
|             | 2015-16 | 121 | -56 | 0.41 | 123 | -70 | 0.42 |
| Sakaldiha   | 2000-01 | 53  | 0.18 | 80  | 0.27 |
|             | 2015-16 | 60  | 7   | 0.20 | 53  | -27 | 0.18 |
| Niyamatabad | 2000-01 | 6   | 0.03 | 78  | 0.40 |
|             | 2015-16 | 39  | 33  | 0.18 | 95  | 17  | 0.45 |
| Chandauli   | 2000-01 | 29  | 0.10 | 53  | 0.1 |
|             | 2015-16 | 40  | 11  | 0.13 | 46  | -7  | 0.15 |
| Barahani    | 2000-01 | 148 | 0.34 | 60  | 0.14 |
|             | 2015-16 | 117 | -31 | 0.25 | 40  | -20 | 0.08 |
| Chakiya     | 2000-01 | 100 | 0.38 | 26  | 0.10 |
|             | 2015-16 | 100 | 0   | 0.36 | 46  | 20  | 0.16 |
| Sahabganj   | 2000-01 | 31  | 0.13 | 17  | 0.07 |
|             | 2015-16 | 70  | 39  | 0.30 | 35  | 18  | 0.15 |
| Naugarh     | 2000-01 | 35  | 0.32 | 4   | 0.03 |
|             | 2015-16 | 88  | 53  | 0.72 | 23  | 19  | 0.19 |

Source: Calculated data from Zila Sankhyiki Ptrika, Chandauli

depict increased area under jowar crop in 2015-16 (Table 5) factor behind this increase, the nature of jowar crop is compatible with the physical condition of that blocks (figure 1).

Millet and Sugarcane

Millet crop has the quality of both food and fodder crop basically, it requires little moisture. (Clottely et al., 2014). In the study area, this is the substitute crop of rice because weak monsoon promotes millet farming. Especially these practices are done on a large scale in 'Barrah' (Chahaniya and Dhanapur) region farmer (Table 5). At the district level (Table 3) as well as block-level, every block depicts increased in the area under millet crop in 2015-16. While block Chahaniya and Dhanapur cover the highest area under millet crop (Table 5).

In the study area, sugarcane was being practiced on a larger area, but its cropping pattern show vast differences in both periods. At the district level, Sugarcane cropping pattern is declining (Table 3) but, at the block level where only one block shows an increase in the area whereas two blocks show not any significant change, and the data of six blocks depicts a decrease in area under cropping pattern of sugarcane in 2015-16 (Table 6) while, minimum support price (MSP) of Sugarcane (Figure 6) net irrigation area (NIA) and gross
irrigated area (GIA) have also increased (Figure 4). Factors behind these changes are zero commercial consumption of sugar-cane, still, 2005 sugarcane market (factory) was near to district boundary, but after 2005 sugar factory closed by the government, therefore, Comparative advantage of the crop is not beneficial in comparison to other Kharif crops, another reason may include nature of sugarcane.

Table 6: Block wise cropping pattern of Millet and Sugarcane

| block         | year  | Net sown area in millet crop (ha.) | Change area in Millet crop (ha.) | Area covered by Millet in GSA (%) | Net sown area in Sugarcane crop (ha.) | Change area in Sugarcane crop (ha.) | Area cover by sugar cane in GSA (%) |
|---------------|-------|-----------------------------------|----------------------------------|-----------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|
| Chahaniya     | 2000-01 | 2946                             | 12.70                            | 333                               | -198                                 | 0.55                              | 1.43                              |
|               | 2015-16 | 3451                             | 14.24                            | 135                               | -198                                 | 0.55                              | 2.42                              |
| Dhanapur      | 2000-01 | 681                              | 2.74                             | 601                               | -426                                 | 0.60                              | 0.84                              |
|               | 2015-16 | 765                              | 2.62                             | 175                               | 0.42                                 | 0.42                              | 0.21                              |
| Sakalghiha    | 2000-01 | 17                               | 0.05                             | 242                               | 0.16                                 | 0.16                              | 0.09                              |
|               | 2015-16 | 90                               | 0.30                             | 64                                | -178                                 | 0.21                              | 0.21                              |
| Niyamatabad   | 2000-01 | 159                              | 0.82                             | 49                                | 128                                  | 0.46                              | 0.46                              |
|               | 2015-16 | 205                              | 0.97                             | 47                                | 0                                    | 0                                 | 0.09                              |
| Chandauli     | 2000-01 | 45                               | 0.16                             | 86                                | 0                                    | 0                                 | 0.19                              |
|               | 2015-16 | 89                               | 0.29                             | 29                                | 0                                    | 0                                 | 0.20                              |
| Barahani      | 2000-01 | 11                               | 0.02                             | 86                                | 0                                    | 0                                 | 0.19                              |
|               | 2015-16 | 87                               | 0.19                             | 86                                | 0                                    | 0                                 | 0.19                              |
| Chahiyani     | 2000-01 | 14                               | 0.05                             | 202                               | 0                                    | 0                                 | 0.78                              |
|               | 2015-16 | 57                               | 0.20                             | 61                                | -141                                 | 0.22                              | 0.38                              |
| Sahabganj     | 2000-01 | 22                               | 0.09                             | 90                                | 0                                    | 0                                 | 0.06                              |
|               | 2015-16 | 86                               | 0.37                             | 16                                | 0                                    | 0                                 | 0.10                              |
| Naugarh       | 2000-01 | 7                                | 0.06                             | 11                                | 0                                    | 0                                 | 0.09                              |

Source: Calculated data from Zila Sankhyiki Pritika, Chandauli.

irrigated area (GIA) have also increased (Figure 4). Factors behind these changes are zero commercial consumption of sugar-cane, still, 2005 sugarcane market (factory) was near to district boundary, but after 2005 sugar factory closed by the government, therefore, Comparative advantage of the crop is not beneficial in comparison to other Kharif crops, another reason may include nature of sugarcane.
farming is labor-intensive, require more investment, and protection.

Pulses

**Lentil, Pigeon pea, Pea, Gram and Others**

Lentil is the important pulse in the study area as it covered the highest area in pulses in both time but, the total area under lentil crop decreased in 2015-16 (Table 3). At the block level analysis, only five blocks depict increased in area 2015-16 (Table 7) because this crop includes some areas of other crops and increase area under Rabi season crop (Figure 7). At the same time, the other four blocks showed decreased cropped area in 2015-16. The factor behind it, that area has been occupied by wheat crop (Table 4) and others Pulses (Table 6) in related blocks and decreased agricultural land in 2015-16 (Figure 3).

Pigeon pea takes annual time to be mature. It is the third major pulse of the study area in both time frames. Crop pattern of pigeon pea increased in 2015-16 at the district level (Table 3) while, analysis of six blocks depict the increased area in 2015-16 as some of the areas of other crops have been merged by pigeon pea and three blocks show a decrease in area under the pigeon pea crop (Table 6) as, those area occupied by settlement class (Figure 3) and increased area under rice crop (Table 4).

The area under pea crop has increased in 2015-16 (Table 3) while, analysis of five blocks depict increased area under pea crop in 2015-16 (Table 7). the factor behind this, Pea crop merges some area of the gram, others pulses (Table 8) and flaxseed (table 9) and increase Rabi season crop area (fig. Table 7; Block wise crop pattern of Pulses (Pigeon pea, Pea and lentil)

| Name of the block | year | Net shown area in Pigeon pea (ha.) | Change area in Pigeon pea (ha.) | Area cover by Pigeon Pea (%) | Net shown area in Pea (ha.) | Change area in Pea (ha.) | Area cover by Pea (%) | Net shown area in lentil (ha.) | Change area in lentil (ha.) | Area cover by lentil (%) |
|-------------------|------|-----------------------------------|--------------------------------|-----------------------------|---------------------------|------------------------|------------------------|-----------------------------|----------------------------|--------------------------|
| Chahaniya         | 2000-01 | 1112                              | 4.79                            | 78                          | 0.33                      | 194                    | 1.39                   |                             |                            |                          |
|                   | 2015-16 | 1084                              | -28                             | 4.47                        | 73                        | -5                     | 0.30                   | 366                         | 172                       | 2.60                     |
| Dhanapur          | 2000-01 | 444                               | 1.79                            | 122                         | 0.49                      | 253                    | 1.40                   |                             |                            |                          |
|                   | 2015-16 | 474                               | 30                              | 1.62                        | 11                        | -111                   | 0.03                   | 619                         | -366                      | 3.63                     |
| Sakaldiha         | 2000-01 | 89                                | 0.31                            | 141                         | 0.49                      | 254                    | 1.45                   |                             |                            |                          |
|                   | 2015-16 | 412                               | 323                             | 1.39                        | 180                       | 39                     | 0.61                   | 422                         | -168                      | 2.39                     |
| Niyamatabad       | 2000-01 | 149                               | 0.77                            | 75                          | 0.38                      | 81                     | 0.65                   |                             |                            |                          |
|                   | 2015-16 | 162                               | 13                              | 0.77                        | 107                       | 32                     | 0.51                   | 344                         | -263                      | 2.83                     |
| Chandauli         | 2000-01 | 154                               | 0.55                            | 179                         | 0.64                      | 1164                   | 6.96                   |                             |                            |                          |
|                   | 2015-16 | 182                               | 28                              | 0.61                        | 303                       | 124                    | 1.01                   | 872                         | 292                       | 5.17                     |
| Barahani          | 2000-01 | 90                                | 0.21                            | 191                         | 0.45                      | 4431                   | 18.57                  |                             |                            |                          |
|                   | 2015-16 | 200                               | 110                             | 0.44                        | 188                       | -3                     | 0.41                   | 3959                        | 472                       | 15.97                    |
| Chakiya           | 2000-01 | 272                               | 1.05                            | 239                         | 0.92                      | 1305                   | 8.67                   |                             |                            |                          |
|                   | 2015-16 | 361                               | 89                              | 1.31                        | 191                       | -48                    | 0.69                   | 650                         | 655                       | 4.61                     |
| Sahabganj         | 2000-01 | 135                               | 0.58                            | 112                         | 0.48                      | 1506                   | 11.81                  |                             |                            |                          |
|                   | 2015-16 | 106                               | -29                             | 0.45                        | 117                       | 5                      | 0.50                   | 836                         | 670                       | 6.81                     |
| Naugarh           | 2000-01 | 40                                | 0.37                            | 53                          | 0.49                      | 313                    | 4.55                   |                             |                            |                          |
|                   | 2015-16 | 28                                | -12                             | 0.23                        | 27                        | -26                    | 0.22                   | 372                         | -59                       | 6.05                     |

Source: Calculated data from Zila Sankhyiki Pträika, Chandauli
6) while four blocks show decrease area in 2015-16 because of this area occupied by Wheat (table 4) lentil (table 7) and flaxseed crops (Table 9) and decreased agriculture land in 2015-16 (Fig. 3). Gram is the second important pulse of the study area in both the given period (Table 3) but, crop pattern of Gram shows decreased at the district level in 2015-16 (table 3) as well as block-level in 2015-16(Table 8) factors behind these changes, the area under gram crop is substituted by wheat crop (table 4), and other Rabi season crops.

Agricultural land substituted by settlement (Figure 4) and other Five blocks depicted an increase in area as others pulses occupied some area of gram (Table 8) pea and lentil crops (Table 7) and increased area under rabi season crops (Figure 7).

**Oilseeds**

*Flaxseed, Mustard and other oil seeds*

There are a variety of seeds that are grown as a source of oil and other products. Oilseeds in study area practice under rabi crops because of this season provide favorable climate conditions for their growth.

### Table 8: Block wise crop pattern of Pulses (Gram and others pulses)

| Name of the block | year | Net sown area in Gram (ha.) | Change area in Gram (ha.) | Area cover by Gram in GSA (%) | Net sown area in Others pulses (ha.) | Change area in Others pulses (ha.) | Area cover by Others pulses in GSA (%) |
|-------------------|------|-----------------------------|---------------------------|-----------------------------|-------------------------------------|-------------------------------------|----------------------------------------|
| Chahaniya         | 2000-01 | 420                         | 1.81                      | 234                         | 1.0                                 |                                     |                                        |
|                   | 2015-16 | 321                         | -99                       | 1.32                        | 23                                  | -211                                | 0.09                                   |
| Dhanapur          | 2000-01 | 986                         | 3.97                      | 59                          | 1.06                                | 41                                  | 0.23                                   |
|                   | 2015-16 | 311                         | -675                      | 1.06                        | 41                                  | -18                                 | 0.14                                   |
| Sakaldiha         | 2000-01 | 154                         | 0.53                      | 10                          | 0.31                                | 31                                  | 0.03                                   |
|                   | 2015-16 | 92                          | -62                       | 0.31                        | 31                                  | 21                                  | 0.10                                   |
| Niyamatabad       | 2000-01 | 51                          | 0.26                      | 5                           | 0.12                                | 13                                  | 0.02                                   |
|                   | 2015-16 | 26                          | -25                       | 0.12                        | 13                                  | 8                                   | 0.06                                   |
| Chaudauli         | 2000-01 | 134                         | 0.48                      | 8                           | 0.33                                | 18                                  | 0.02                                   |
|                   | 2015-16 | 99                          | -35                       | 0.33                        | 18                                  | 10                                  | 0.06                                   |
| Barahani          | 2000-01 | 273                         | 0.64                      | 6                           | 0.59                                | 27                                  | 0.01                                   |
|                   | 2015-16 | 267                         | -6                        | 0.59                        | 27                                  | 21                                  | 0.05                                   |
| Chakiya           | 2000-01 | 464                         | 1.7                       | 31                          | 0.72                                | 13                                  | 0.12                                   |
|                   | 2015-16 | 199                         | -265                      | 0.72                        | 13                                  | -18                                 | 0.04                                   |
| Sahabganj         | 2000-01 | 410                         | 1.76                      | 8                           | 0.68                                | 15                                  | 0.03                                   |
|                   | 2015-16 | 158                         | -252                      | 0.68                        | 15                                  | 7                                   | 0.06                                   |
| Naugarh           | 2000-01 | 180                         | 1.68                      | 324                         | 0.61                                | 12                                  | 3.03                                   |
|                   | 2015-16 | 74                          | -106                      | 0.61                        | 12                                  | -312                                | 0.09                                   |

Source: Calculated data from Zila SankhyikiPTRika, Chaudauli
growth. The Cropping pattern of all oilseeds and as well as of individual oil seed decreased in 2015-16 (Table 3) at the district level in 2015-16. But at the block-wise analysis of oil seeds shows the difference (Table 9). Flaxseed is an important oil seed in the study area. This farming cost is very cheap as farmer use spread method without tillage after paddy harvesting. According to the block-wise analysis of flaxseed, four blocks show little increase in area in 2015-16 (Table 9) as some area of other Rabi crops merged by flaxseed in these blocks (Table 7,8 and 9) and increased area under Rabi season crops (Figure7) while five blocks depict decreased in area factor behind this some area of flaxseed merge by wheat crop (Table 4) and remain area occupied by settlement class (Figure4).

Mustard is the second important oilseed crop in the study area. At the block level analysis only three blocks show an increase in the area because some area has been substituting by flaxseed (Table 9) and Gram (Table 8) and remain area came from increase total study area in 2015-16 (Figure4) while, six blocks show the decreased area in mustard crop pattern (Table 9) factor behind this, area of mustard crop replaced by wheat crop (Table 4) as increase irrigation facility (Figure 4).

Others oilseeds include Sunflower and Groundnut. At the block level analysis of others oilseeds, five blocks show decreased in the area in 2015-16 (Table 9) as this area merges by wheat crop (Table 4) while four blocks show little increase in cropped area (Table 9) factor behind it, others oilseeds merge some area of other Rabi crops (Table 7,8 and 9).

Table 9: Block wise crop pattern of Oilseeds (Flaxseed and Mustard)

| Name of the block | year | Area under Mustard (ha.) | Change area in Mustard (ha.) | Area Cover by mustard (%) | Area under Flaxseed (ha.) | Change area in flax seed (ha.) | Area cover by flax seed (%) | Area under Other oilseed (ha.) | Change area in Other Oilseed (ha.) | Area cover by Other oilseed (%) |
|-------------------|------|--------------------------|----------------------------|--------------------------|--------------------------|-------------------------------|---------------------------|-------------------------------|-------------------------------|-------------------------------|
| Chahaniya         | 2015-16 | 55                     | 39                          | 0.22                      | 43                        | -25                           | 0.17                      | 2                            | -105                          | 0.008                          |
|                  | 2015-16 | 47                     | 0.18                        | 43                        | 0.17                      | 0                             | 0                         | 0                             | 0.006                          |
| Dhanapur         | 2015-16 | 31                     | -16                         | 0.10                      | 44                        | 1                             | 0.15                      | 2                            | 0.006                          |
|                  | 2015-16 | 27                     | -9                          | 0.09                      | 43                        | 1                             | 0.14                      | 3                            | 0.01                           |
| Sakaldihia       | 2015-16 | 25                     | 0.12                        | 182                       | 0.94                      | 0                             | 0                         | 0                             | 0.004                          |
|                  | 2015-16 | 25                     | 6                           | 0.14                      | 85                        | -97                           | 0.40                      | 1                            | 1.004                          |
| Niyamatabad      | 2015-16 | 33                     | 0.11                        | 9                         | 0.03                      | 0                             | 0                         | 0                             | 0.006                          |
|                  | 2015-16 | 53                     | 20                          | 0.17                      | 27                        | 18                            | 0.09                      | 2                            | 0.006                          |
|                  | 2015-16 | 67                     | 0.15                        | 16                        | 0.03                      | 0                             | 0                         | 0                             | 0.002                          |
| Barahani         | 2015-16 | 22                     | -45                         | 0.04                      | 44                        | 28                            | 0.09                      | 1                            | 1.002                          |
|                  | 2015-16 | 32                     | -4                          | 0.10                      | 34                        | -202                          | 0.12                      | 0                            | -0.14                          |
| Chakiya          | 2015-16 | 90                     | 0.38                        | 374                       | 1.61                      | 2                             | 0.08                      | 0                            | 0.008                          |
|                  | 2015-16 | 20                     | -70                         | 0.08                      | 55                        | -319                          | 0.23                      | 0                            | -2                            |
| Sabhanganj       | 2015-16 | 92                     | 0.86                        | 1069                      | 10.0                      | 97                            | 0.90                      | 0.008                         |
| Naugar           | 2015-16 | 22                     | -70                         | 0.18                      | 140                       | -929                          | 1.15                      | 1                            | -0.96                          |

Source: Calculated data from Zila Sankhyiki Ptrika, Chandrauli
Conclusion

In the present study, it is observed that there is an unexpected increase in settlement land use class within 15 years. However, the study area has an increase of 405 ha. and the forest is untouched land use class, causes of administrative limitation, but the sprawl of concretization influence the other land use class mainly B.F.G, Barren and Agriculture land use because they have lost their own area 182 ha., 1970 ha. and 1918 ha. respectively in 2015-16. It is a serious issue in the study area to maintain environmental balance. However, despite the reduction in agriculture land, there is the remarkable increase in cropping pattern of Rice and Wheat as daily demand in food and agro-climatic suitability promote the more practice of both crops on a large area; therefore, sugarcane have lost their identity and some crops like Jowar, lentil, gram and others pulses, mustard, flaxseed and other oilseed nominally practicing in the study area in comparison to 2000-01. The decreasing trend of land use(except settlement) and cropping pattern(except rice and wheat) is a major concern for the study area these trends happen because of settlement class land use and the duopoly of rice and Wheat (89 % area covered). It is the farmer compulsion to sow the rice and wheat crop on a big scale because the majority of farmers support them. But, small farmers of the study area facing more challenges due to the concentration of rice and wheat crop.

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Assessing landslide vulnerability in Kohima city, Nagaland: A geospatial approach

Yhoshu Kedovikho and Y.V. Krishnaiah

1 Assistant Professor, Department of Geography, Nagaland University (Central), Lumami, India
2 Associate Professor, Department of Geography & Disaster Management, Tripura University (Central), Suryamaninagar, Tripura, India
(Corresponding author’s email: yvkrishna09@gmail.com)

Abstract
Kohima located in the Eastern Himalaya of Northeast India experience numerous landslides and soil creeps annually. Landslides, the resultant of various interactions i.e., geological, geomorphologic, meteorological factors etc., caused immense loss economically and environmentally. Kohima city experiences torrential amount of rainfall which further aggravate landslide hazard. This paper implores the use of high-resolution satellite data for deciphering landslide vulnerability mapping through remote sensing and GIS technique. Factors such as land use and land cover, lithology, lineament, drainage, road, aspect and slope were used as thematic input layers for landslide vulnerability mapping. Bivariate statistical method particularly Information Value method was used to extract the information from the landslide and the various controlling factors to generate the landslide vulnerability map. Validation of the landslide vulnerability mapping using classification and R-index methods along with ground observation were used to create the final vulnerability map.

Keywords: Geospatial approach, Kohima, landslide, landslide vulnerability, Nagaland

Introduction
Landslides usually occurs in hilly terrain which disrupts the normal lives of the populace by causing damage to transportation system, water supply, property damage etc. The causative reason for the slope instability is numerous and it may be caused by the inherent property of the rock or soil, in its composition or structure, inclination of undisturbed slopes is relatively constant and some are variable, such as ground water level, some are transient (seismic vibration) and some imposed by new events like constructional activity (Varnes & IAEG, 1984; Kim et al., 2018 and Lee et al., 2019). Landslide occurrence depends on complex interaction among large number of factors explained by Hong et al., (2007) that is geology, geomorphology, soil, land cover and land use, hydrology, human impact etc. Landslide hazard are caused by various factors such as anthropogenic, geomorphological and meteorological elements (Ciurleo et al., 2017 and Kalantar
et al., 2018). By susceptibility it refers to the spatial future likelihood or probability for landslides to occur (Guzzetti et al., 1999; Harvas & Bobrowsky, 2009; Sujit et al., 2012; Ali et al., 2014; Junyi et al., 2015; Patra & Devi, 2015; Maurizio & Dario, 2016; Ghani et al., 2019; Zhuo et al., 2019 and Mahvash et al., 2019). The identification of landslide vulnerable areas is becoming more crucial and vital for regional and local planning (Radha & Milap, 2012; Vijith et al., 2014; Chalkias et al., 2014; Steger et al., 2016; Wang et al., 2016 and Suchita et al., 2018). Deaths, causalities, economic losses may be minimised giving early information to vulnerable areas (Sarkar & Kanungo, 2004; Yensilnacar & Suzen, 2006; Sujatha et al., 2014; Sarkar et al., 2016; Kumar et al., 2017; Sharma & Mahajan, 2018; Pradhan & Kim, 2018; Deniz et al, 2019; Yan et al., 2019). Losses can be minimised by referring a landslide susceptible map which is at the disposal of the planners and policy makers. The problem of landslide hazard can be mapped by identifying the causative factors. The various causative or parameters causing landslide can be mapped and extracted from remote sensing through satellite images and workout under GIS environment (Van, 2000; Kai & Wei, 2017; Wu & Song, 2018; Harjeet et al., 2019). The landslide distribution with the causative factors can delineate the zones which are susceptible to landslide but not the probability of occurrence of the instability processes (Aste, 1991; Zabuski et al., 2015 and Tewari & Misra, 2019). The advancement in technology has generated high resolution imageries which can assist in identification of landslide at a local scale. High resolution satellite images (Quick bird 2 and World View 2) were used to identify and delineate the land slide inventory for generating the landslide susceptibility map (Arif et al., 2015; Weichi et al., 2016; Rohan & Anbalagan, 2019). Hence, in this paper the usage of high resolution imageries have been explored to generate a landslide vulnerability map for Kohima, the capital of Nagaland in Northeast India. Landslide vulnerability mapping provides valuable information concerning the stability conditions of the territory and serve as the first step in a hazard assessment towards the mitigation of natural landslide disaster (Ladas et al., 2007; Mehmet & Basak, 2012; Emrehan et al., 2017 and Kadavi et al, 2019). The main objective of this study is to delineate a landslide vulnerability map for Kohima city, Nagaland.

**The Study area**

Kohima City is the capital of Nagaland state (Figure 1). Geographically, Kohima city lies between 94°05'04"E to 94°07'23"E latitude and 25°38'28"N to 25°39'24"N longitude and geographical area is 14.03 km². The terrain elevation ranges from 800 to 1500 m above MSL. Kohima, is tectonically unstable lying in Seismic Zone-V and the Seismic Intensity-IX (Khatsu & Van, 2005 and Tirthankar & Pal, 2018). The lithology of Kohima sediments made of Disang and Barail groups of flysch and its surrounding, where Disang is dominantly argillaceous and of Upper Cretaceous-Eocene age and Barail group is dominantly arenaceous and of Upper Eocene- Oligocene age (Aier et al., 2012). In location map highlighted like location- 1, 2, 3 and 4 are explained and inserted relevant content.

**Data Sources and Methodology**

The satellites imageries considered for the study was Quick bird-2 acquired on 06th
November, 2009 from Urban Development Department, Kohima and google earth platform for getting the latest landscape of Kohima city. Survey of India (SOI) topographic map (No. 83 K/2) was consulted to geo-rectify and generate the various thematic maps. The thematic maps were categorised into four themes based on their controlling factors such as topographical, geological, anthropogenic and hydrological factors respectively. Geological parameter based on fault and lithology was used to generate thematic layers by consulting maps and satellite imageries. Hydrological map was created from SOI map and satellite imagery. Topographic map- slope and aspect layers were generated by rasterizing the contour map from SOI topographical maps. Anthropogenic based thematic layers such as road, land use maps was generated using SOI maps and satellite imageries. Land use and land cover map was interpreted and manually classified and validated through field survey. Landslide inventory map was generated by interpreting satellite imageries, consulting literatures and field observation. The landslide susceptibility map delineated was based on the Bivariate method-Information Value Method (IVM). The relationship between landslides with the contributing factors was determined to generate a cross weighted class value based on the principle of bivariate method. For the tabulation process, the seven thematic geospatial maps were crossed with the
landslide map, the crossed layers were ranked as “0” and “1”, where “0” means no landslide and “1” indicates presence of landslide. The weighted class value was determined by using IVM (Yin & Yan, 1998) where it denotes the ratio between the landslide densities of the total area. The equation is represented as

\[ \frac{N}{\sum} \frac{(s)}{(N)} \]

Where,
- \( N \) represents number of pixels in each class
- \( s \) represents number of landslide pixels
- \( N \) represents total number of pixels

### Results and discussion

The controlling factors are topographical (slope, aspect), geological (lineament, lithology), anthropogenic (land use and land cover, road) and hydrological (drainage).

**Topographical factors**

Slope and aspect are representing the topographical parameters in the study area. Aspect determines the direction of maximum slope of the terrain surface will be influenced the occurrence of landslides. Slope plays more influence on landslide that is greater slope more effective on landslide and occurrences are high. According to Dai & Lee (2002), landslide frequency will be increased in higher slope.

**Geological factors**

The structural geology of the study area is marked with faults and lineaments (Figure 2). Lithology and structural faults constitute in the geological parameter of

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**Figure 2**: Fault map of the study area  
**Figure 3**: Lithology map of the study area
the present study. Underlying geology and structure of rocks are very important which determines the strength of the surface and various erosional processes. Geologically, the broad-based lithology stratigraphy is divided into two Barail sandstone and Disangshales. Further it's divided into five classes for the present study area that is shale with minor sandstone, weathered shale, shale, crumpled shale and sandstone with minor shale (Figure3).

**Anthropogenic factors**

Man-made activities such as building construction and road cutting have influenced the land use land cover (LULC) which directly affects the susceptibility of an area to landslide. Landslides are confined to certain distances in a road corridor, therefore, a 20m buffer for landslide study in road corridor was considered (Figure 4). LULC has been classed into water body, open space, built up, barren ground, agriculture and vegetation to highlight and determine the impact of LULC pattern on landslide events (Figure 5).

**Hydrological factors**

The proximity of an area near drainage sources is important and that drainage can affect the area by eroding the soil. For the drainage delineation, only the natural stream was considered and not the drainage line within the settlement area which has been cemented. In case of cemented drainage canal, erosion is negligible or absent, as the study on the landslide, the cemented drainage line has been ignored (Figure 6 & 7).

**Landslide parameter**

The landslide distribution is mapped through the satellite imageries as well as field verification for preparing the landslide inventory input to generate the susceptibility map (Figure 8 & 9). It is seen that landslide is more concentrated towards the central west and central east where the structural fault, steeper slope, drainage and road parameter are observed.

Association of all the crossed weighted parameters with landslide distribution, and made landslide susceptibility map. The different parameter after crossing the

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Figure 6: Location 1 showing Building construction on deep slope, houses affected by soil creep in Paramedical (Ward no.18), the circled portion shows the affected foundation and the red arrow the direction of the creep movement & Location- 2 showing landslide along Asia Highway 1.
landslide distribution along with its weight measured (Table 1). The slope angles between 10°-20° shows the highest weight (0.05) means maximum landslide occurrence prone area as geographical covered about 56.78%, and between 20°-30° slope angles shows a weight of 0.01 indicating landslide presence. The slope angle is greater than 30° doesn't show any value which means it is less landslide distribution. In the aspect wise North area shows highest value (0.62) and followed by Southwest (0.47) area, it means the highest values indicate susceptibility of landslide. Under the fault category greater than 10m showed more extensively landslides are distributed. The lithology category showed weathered shale area weight is high (0.68), it means the highest susceptibility for landslide and its covered geographical area about 39.22%. The road and landslide show positive correlation where landslide is most susceptible along the road and it decreases as one moves away from the road corridor. The built-up area has the highest value (14.52) of landslide vulnerability zone; it covered an area about 63.57% of the total geographical area. The positive correlation occurred between drainage and susceptibility of landslide; the susceptible
Figure 7: Hydrological parameter

Figure 8: Distribution of Landslide

Figure 9: Location-3 showing Landslide at Kitsubozou (Ward No.5), the affected area is shown in red line and Location-4 showing affected settlement observed at High School colony (Ward No.1), the bigger red arrow indicates the direction of slide movement and smaller arrow the direction of the house.
Table 1: Information values obtained from the various parameters

| Parameter       | Category                  | Number of Pixel | Percentage (%) | Weight |
|-----------------|---------------------------|-----------------|----------------|--------|
| Slope           | 0-10                      | 1363            | 24.81          | -0.16  |
|                 | 10-20                     | 3119            | 56.78          | 0.05   |
|                 | 20-30                     | 944             | 17.19          | 0.01   |
|                 | 30-40                     | 66              | 1.20           | -      |
|                 | 40-50                     | 1               | 0.02           | -      |
| Aspect          | North                     | 651             | 11.85          | 0.62   |
|                 | Northeast                 | 656             | 11.94          | -0.32  |
|                 | East                      | 712             | 12.96          | -0.10  |
|                 | Southeast                 | 738             | 13.44          | -0.64  |
|                 | South                     | 699             | 12.73          | -0.48  |
|                 | Southwest                 | 670             | 12.20          | 0.47   |
|                 | West                      | 653             | 11.89          | 0.22   |
|                 | Northwest                 | 714             | 13.00          | -0.73  |
| Fault           | 0-10m                     | 29321           | 20.89          | 0.57   |
|                 | >10m                      | 111017          | 79.12          | -0.23  |
| Lithology       | Shale                     | 47813           | 34.08          | -0.64  |
|                 | Crumpled weathered shale  | 5809            | 4.14           | -1.50  |
|                 | Weathered shale           | 55033           | 39.22          | 0.68   |
|                 | Shale with sandstone      | 753             | 0.54           | -      |
|                 | Sandstone with shale      | 30906           | 22.03          | -1.79  |
| Road            | 0-20                      | 47516           | 33.86          | 0.21   |
|                 | >20                       | 92822           | 66.14          | -0.62  |
| Land use/land  | Water body                | 22              | 0.02           | -      |
| cover           | Open space                | 1049            | 0.75           | -      |
|                 | Built-up                  | 89070           | 63.57          | 14.42  |
|                 | Barren land               | 27629           | 19.72          | 1.25   |
|                 | Agricultural land         | 3548            | 2.53           | -0.31  |
|                 | Vegetation                | 18800           | 13.42          | 0.04   |
| Drainage        | 0-50                      | 37927           | 53.84          | 0.96   |
|                 | 50-100                    | 32515           | 46.16          | -0.18  |

weight is 0.96.

**Landslide vulnerability zones**

The present study area has been divided into four vulnerable zones i.e., very high vulnerable zone covered about 12% with an area of 1.68 km², high vulnerable zone about 30% with an area of 4.21 km², moderate vulnerable area covered by 32% an area about 4.49 km² and low vulnerable zone consist of an area about 3.65 km².
covered by 26% of the total geographic area (Table 2).

### Landslide relative index (R)

The relative landslide density index (R) which represents the ratio of percentage of total landslide area in each zone of the total area. The R index value increases as for the vulnerability zone progresses from low to very high. In R index value, the landslide factors are only considered, very high susceptible zone (82.61%), followed by high susceptible zone (10.72%) which together constitute a R index value of 93.33% which is high and shows a good landslide density index (Table 3).

### Table 2: Landslide vulnerability zones

| Zone      | Land distribution in % | Area (km²) |
|-----------|------------------------|------------|
| Very high | 12                     | 1.68       |
| High      | 30                     | 4.21       |
| Moderate  | 32                     | 4.49       |
| Low       | 26                     | 3.65       |

### Table 3: Landslide relative index (R) value from landslide vulnerable zones

| Vulnerable Zone | Area (Pixel) | Landslide area (pixel) | R index (%) |
|-----------------|--------------|------------------------|-------------|
| Low             | 36581        | 150                    | 2.67        |
| Moderate        | 43637        | 269                    | 4.01        |
| High            | 41630        | 686                    | 10.72       |
| Very high       | 16887        | 2145                   | 82.61       |

### Landslide vulnerability mapping

The map was delineated by bivariate statistical method and also worked out on the basis of seven controlling parameters (Figure 10). The zones are observed high and very high in built-up area where the underlying geologic structure was constituted by weathered shale's. The occurrences of landslide in those areas are triggered by anthropogenic activities (Figure 11). The study area shows land-people pressure where the citizens owing to the scarcity and high demand for land have resorted to build their houses in those highly landslide vulnerable area.

### Conclusion

Landslide vulnerability of Kohima city was worked out on the basis of few controlling factors like topography, geology, anthropogenic activities, drainage etc., and bivariate statistical method was applied on the factors. For a better demarcation of landslide susceptible distribution zones, various classification techniques like equal interval, geometric interval, quartile and natural break method of classification was applied and the most accurate landslide vulnerable map was considered after close ground observation and further validated by using R index showing a score of 82.61%.

In this paper, highlighted research findings are very high to high landslide susceptible zones occurred mainly due to geologic conditioned triggered by developmental activities mainly construction of buildings without proper plan and execution. Other factors like population pressure on scarce land resources have created an environment of
unstained design and planning. The study area is expanding vertically as well as horizontally within the limited sphere. Owing to dearth of RS and GIS data's along with low resolution ward shape layers it was a challenge to bring out this landslide susceptibility map. Despite its limitation, it can still be used by planners and researchers as a reference map for future developmental work plan. The landslide hazard map can be improved and updated by considering more input parameters like seismic data, soil depth etc. For now, the landslide susceptible map can serve its purpose by providing the researchers, developers, policy makers and planners as a reference map.

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An empirical comparative study of changing utilization pattern and problems of Rural and Urban Lakes of Gorakhpur, India

Alka Singh¹ and Vishwambhar Nath Sharma²
¹Senior Research Fellow, Department of Geography, Institute of Science, B.H.U. Varanasi
²Professor of Geography, Institute of Science, B.H.U. Varanasi
(Corresponding author's email: alkasinghbhu121@gmail.com)

Abstract
Lakes are the natural habitat of aquatic animals and plants. At the same time, it ensures the recharge of groundwater storage and also caters to the recreational and aesthetic requirements of people. A Lake can control surroundings temperature by keeping it fairly constant, this, in turn, can facilitate to support life forms. Balanced ecosystem enabled by lakes promotes not only healthy plants and animal communities but their clean water increases the security of animal nesting and resting places along with the livelihood of humans in its vicinities. Some of the losses (environmental degradation, extinction of species, etc.) occur through intentional exploitation of resources. Lakes are of value to humans in form of drinking water, agriculture, industry, livestock and energy generation; they become storage for flood water; sinks for sediment and contaminants to protect downstream areas and habitat for flora and fauna. Therefore, Lakes experience pressure of high population growth owing to human dependence on them. Economic uses, depleting factors and stewardship of urban and rural lakes are different. n Chilua lake, highest change during 1980 to 2019 was 65 per cent in dumping site followed by irrigation (61.66 per cent) and boating for person use whereas negative change was in washing site and use of water for cooking but it was different in Ramgarh Lake. During the above period Ramgarh Lake experienced highest positive change in dumping sites (88.34 per cent) followed by boating (40 per cent) for fishing and recreation while highest negative change was in cropping followed by cattle bathing. This study is a comparative assessment of economic and other utilities and problems of Ramgarh (urban) and Chilua (rural) lakes of Gorakhpur. The study is based on primary data collected from the surrounding dwellers of both lakes and supported by secondary data collected from different offices and laboratory-based investigations related to lakes.

Keywords: Economic utilization, depleting factors, water quality, stewardship

Introduction
Healthy lakes provide several economic and environmental benefits to humans. Lakes ensure water supply, tourism, recreational activity, livelihood, and irrigation too. Lakes are known for their traditional and historical values and used as sources of drinking water and livelihoods in its vicinities. A lake is capable to facilitate better climatic control, recharge of groundwater, control droughts, floods and maintain a sustainable aqua culture in the lake basin.
Several studies have been done related to their use and environmental values. Sharma (2001) focused on a geographical survey of morphology, economic use, and deteriorative factors of Ramgarh lake, a highly polluted water body due to urbanization of adjoining areas of Gorakhpur town. He wrote that dumping of wastes into the lake had resulted in the menacing growth of aquatic weeds, serve eutrophication and sedimentation that altered the lake morphology and the volume, depth, and quality of lacustrine water. Mahapatra et al., (2011) discussed the macrophytes that play a major role in maintaining the nutrient levels due to the prolific growth of invasive species such as hyacinth (Eichhornia crassipes) in urban aquatic systems. This condition hinders aerobic functioning of the lake by restricting sunlight penetration and affecting algal photosynthesis which necessitates the regular removal of macrophytes from the lake. Tiwari (2013) revealed an aspect of physio-chemical factors and zooplankton of Ramgarh Lake. He mentioned that the lake was gradually tending towards eutrophication. Bharati and Pandey (2015) focused on proper conservation and management of the lake. Water quality monitoring and analysis of the Ramgarh Tal was carried out for various physio-chemical, and bacteriological parameters i.e., pH, total dissolved solids, turbidity, acidity, alkalinity, total hardness, chloride, DO, BOD, COD, a faecal coliform. Pandey and Prakash (2016) analysed monthly variation in physio-chemical parameters of the water of Ramgarh lake, Gorakhpur. Rajinikanth and Ramachandra (2000) provided a detailed investigation covering physical, chemical, and biological parameters, which were carried out in two lakes namely Rachenahalli and Amruthalli. The socio-economic survey was done to find the level of dependency on these lakes. Kumar and Kumar (2013) examined the water quality of Surha Tal which was still free from any kind of pollutants due to its higher assimilative capacity. That indicates the higher potential for pisciculture and drinking water sources (after disinfection) for the nearby villages it may ultimately improve the economic condition of the surrounding habitation.

In urban areas, pollution levels have reached their maximum and possibly only lakes are capable to resolve this ecological puzzle. Near the lakes, air pollution is controlled by a self-regulating process of evaporation from lakes which enable micro-climate mechanisms of rainfall and if the pollution levels are extreme then spray of water may revive the lake environment. Lake water may be replenished by strictly stopping disposal of municipal sewage waste, ensuring alum treatment, aeration and air circulation, harvesting of weeds and so on. Lakes also positively influence the water quality of downstream watercourse and preserve the biodiversity and habitat of many living organisms in the lake basin area. The bigger picture about the importance of lakes is clear which suggests that lakes are more than just simple bodies of water used to enjoy an aesthetic value. They enable a good environment in their vicinities in both urban and rural areas. Lake boundary zones enable the growth of fodder crop to agricultural crop and can be utilised as jogging tracks, parks, mini forests, resorts and last but not the least, they provide for livelihood. It is therefore our responsibility to continue to practice stewardship in our
lakes by keeping them healthy. Moreover, the function of the lake as a tank that can ease the impact of floods and drought by storing a large amount of water and releasing it during shortage is undeniable. The objective of this study is to put forth a comparative analysis of the changes in utilization pattern and problems of an urban (Ramgarh lake) and a rural (Chilua lake) lake.

Data sources and methodology

Analysis of changing pattern of utilization of rural and urban lakes have been done for the years 1980, 2004 and 2019. For the primary survey, an area of influence surrounding the urban and the rural lake where people depend on the lake basin for their livelihoods, covering about 200 meters was considered. Information was collected using interview schedule from 60 households in surrounding villages of Chilua lake (Mahesra breeze and chilua) and 60 households in surrounding villages of Ramgarh lake (Taramondal, Padleyganj, J h a r k h a n d i, K u n d a g h a t and Maharbakibari). Through the interview, schedule data had been collected regarding utilization of lakes in 1980, 2004 (based on

Figure 1: Location of Ramgarh and Chilua lakes
respondents' memory) and survey year (2019). The data regarding problems of the lakes had also been collected through a primary survey.

The study area

Gorakhpur district, (26° 13 to 27°29 N and 83° 05 to 83°56 E), covers an area of 3484 km²) is situated in the eastern Uttar Pradesh about 84 m above mean sea level. The major part of this district is in Tarai region supporting to agriculture. The remarkable characteristics of the district are the presence of numerous annual and perennial ponds and lakes of varying dimensions. The district has two main river systems namely the Ghaghra and Rapti, both of which ultimately are part of Gangetic plain, the other streams are Kuwano, Ami etc.

Ramgarh lake (26°42'26" to 26°44'55" to 83°23'11" to 83°25'4") and Chilua lake (26°49'15" to 26°56'50" to 83°20'9" to 83°25'56") are ox-bow lakes left by Rapti river located in the centre and north-eastern end of Gorakhpur district (Figure 1). These lakes are a rich source of fish and its water is also used for irrigation that supports the livelihood of many people (Singh, et. al., 2019).

Results and Discussion

Changing the utilization pattern

Rural lakes are normally healthy, and fruitful for all aquatic organism and livelihood for people agriculture, vegetable cropping, irrigation, cattle bathing, religious activities, vermi culture and use as drinking water etc. which have been catering to the anthropogenic, ecological, and environmental needs in the catchment. Moreover, some potential use of lakes are also prominent like forest surrounding the lake, development of aquatic biota, sink for air, water and soil pollutants and healthy aquifer. It is relatively easier to maintain lake ecology in the rural area because they are used more according to need not to greed. The rural lakes are untouched by some anthropogenic activities like pollution from industries, domestic sewage waste and waste from recreational activities etc. Therefore, in the absence of overuse, lakes maintain their ecology. In Gorakhpur, Chilua lake is the most suited example of this type of lake where sustainable use of the lake resource is being ensured by the people of its surroundings.

In urban lakes, the utilization pattern was observed to be different as compared to the rural lakes where more commercial use is being exercised with increasing population pressure that created environmental degradation related problems. However, it is important to understand that Commercial uses of lakes with an urban concern for development are not negative if their sustainability is maintained because lakes do have substantial potential for supporting multiple livelihoods and good environment for humans. Therefore, the local people, tourist, governments, researchers must come together for and every duty to restoration and conservation of lake ecology which is economical and sustainable.

Chilua lake (Rural)

In 2018-2019, Fishing in Chilua lake was in moderate condition due to lack of proper storage of water in different seasons. 60 persons (100%) responded for fishing activities in this lake for their use and sometimes for sailing in the market. Irrigation in Chilua lake was moderate and locally used but this lake has vast potential for irrigations in its surroundings. Agricultural activities were going on in the
Lake bed area in the winter season like wheat, mustard, vegetables (potatoes, peas, carrots, cauliflower etc.). Total 60 persons (100%) responded for agricultural production and the same number of people also confirmed vegetable cropping. They produce for own and commercial use. Recreational activities were very less and used by locals only due to not any private or government concern for the park, hotel, restaurant etc. Religious use in the lake was very high by local people and surrounding areas such as Chhat puja, marriage and other social ceremonies, idol immersion in many festivals etc. Dumping site in the lake area was in very less because surrounding community life and livelihood was based on natural resources. Therefore, the lake was rarely used as a dumping site and total of 39 persons (65%) responded rarely saw this activity near lake zone but recently it is increased in the periphery of the city. Cattle bathing in the lake area was high which was accepted by 42 persons (70%). In Chilua lake, boating was done for fishing, fodder crop collecting etc. In Chilua lake, washing was moderately used by local people. Only 7 respondents accepted for doing this activity in Chilua lake (Table 1). Brick chimneys were seen surrounding the lake which uses sediment deposit of lake bed area. Vermiculture like earthworm flourishes in lake bed area for bio-fertilizer in agricultural land by local people (Figure 2).

In Chilua lake basin, fishing was done for personal eating purpose in 1980 and maintained as moderate in 2005 but measured with high production in 2019 with more than 10 varieties of fish due to increasing manner of residential habitats. Irrigation recorded as low in 1980; moderate in 2005 due to growing population and also remain moderate in
2019 due to fulfilment of water for cropping. Recreational and religious activities were maintained as low in 1980 and moderate in 2005 due to growing number of depending people and recorded moderately up to 2019. Reversibly, in 1980 no point source was available for dumping site in the lake basin but recently dumping point was seen. Boating was done mainly for fishing. In Chilua lake area, most parts were used for cropping either of cereals or vegetables owing to huge siltation in the lake basin. Now, the lake is increasingly becoming shallow and remains dry for seven to eight-month in a year. Washing activity in lake reported as low in 1980 but from 2005 to 2019, it was moderate due to lack of facility for this activity but local people still carried on. In recent years, the lake water was found not suitable for cooking or drinking due to whereas, in 1980 the lake water was used for cooking and drinking purposes. The local people used the silt of the lake for brick making and making walls of huts etc. Vermiculture was done on the shallow part of lake basin in recent years for bio-fertilizer in surround agricultural land. Chilua lake needs some specific maintenance due to some problems that occurred either due to natural or anthropogenic activities. The highest change was in washing sites and irrigation that were increased during 1980 to 2019 while washing sites and use of water for cooking were reduced.

In rural areas, lakes face different types of problem like lack of proper embankment surrounding the lake area, lake water storage and seasonal variation in water content. In the summer season, the lake becomes a rill like a channel in their catchment area and the surrounding people try to encroach into the lake bed area especially where sediment deposition is huge and recent. It was observed that heaps of municipal solid waste deposits from nearby Gorakhpur city were dumped in the boundary of the lake basin. This activity helps in filling the lake zone and enables its encroachment. Proper monitoring and management of degrading factors of the lake either natural (siltation, growing of the littoral plant, basin shallowness) or anthropogenic (washing, dumping, agricultural cropping) are needed. A great healthy lake environment can be created by combined efforts for local communities, governments, researchers, private institutions, and all others who either directly or indirectly are related to the lake environment. Steps for stewardship such as forestation in the surrounding, ban on the input of any sewage waste disposal, detergent, and fertilizer release into the lake water, proper embankment for developing fishing activity and protection from any residential encroachment etc. shall ensure healthily and livelihood of the people in a sustainable manner in a sustainable environment. Therefore, we can achieve economically relevant, and a naturally sustainable interrelationship between life in water and life on land.

**Ramgarh lake(Urban)**

There were tremendous changes in the utilization status of Ramgarh lake (urban) due to increasing population pressure with the passing time. It is supporting that Ramgarh lake water was used for drinking purpose up to 1980, according to the responses during the household survey but is now water quality is degraded. BOD was 21.09 mg/L and DO was 3.39 mg/L in the water of the lake in 2018, this means lake water is in eutrophic condition (Singh, 2019). The agricultural activities and
vegetable cropping also have disappeared and were in use up to 2005. Moreover, cattle bathing, washing, religious activities have been banned to save the aquatic life from pollutants. Washing was responded to be in use only up to 2005. Ramgarh lake was used for fishing, recreational purposes, and also as dumping sites for city's garbage which come from the residential area, railways quarters, nearby hospital etc. in 2019. Since 1980, Ramgarh lake had been fulfilling the needs and greed of people in its surroundings, the governments, and others. The devastation is revealed owing to the emergence of a hyper-eutrophic condition due to enough entry of sewage waste from the whole city into lake catchment.

In 1980, fishing was recorded as moderate due to low need and pressure of locals but since then this activity was recorded as high due to increasing demand and availability of facilities made available through GDA (Gorakhpur development authorities). The irrigation activities reported higher in 2004 due to fair water quality and were used for crop cultivation but in the recent year quality of water had
immensely depleted and was thus not suitable for cropping in 2019. The recreational activities after 2004 were highly developed till recent times owing to many initiatives taken by Gorakhpur development authority and the lake area was cleaned from non-renewable materials (plastics bottles, packets etc.). Idol immersion was banned in the lake water in current decades whereas, in 1980, many religious activities (Chhat puja, part of marriage activity, etc.) were carried on in the lake.

The use of Ramgarh lake as a sewage dumping site increased in 2019 due to increasing pressure of residential colonies in comparison to 1980 and 2004. Cattle bathing activity was recorded high in 1980 and 2004 due to lack of concrete embankment but in 2019, this activity had been stopped. In recent years, boating activity in Ramgarh lake for tourism purpose developed but was not practised in the past. This was also done for fishing and care for the lake. How the livelihood of surrounding fishers, farmers and washermen threatened and influenced due to set up of new developmental activities by the GDA in the lake. Activities like, irrigation, cattle bathing, cropping, washing site and use of water for cooking and drinking had been zero in 2019.

The principal responsibility of the communities and the government is to understand that the utilization of lakes demands extensive management as well as maintaining a sustainable lake environment. The potential use of lake without disturbing aquatic life by the local communities through surrounding is good because the presence of a lake ensures several benefits in urban areas such as climatic control, reduction in the air pollution, recharge of groundwater, absorption, and release of water during floods and droughts, the hub of the recreational centre, tourist attraction, use of silt as fertilizer after store of phosphate and nitrate in silt, a huge place for pisciculture etc. This type of activities seen in Ramgarh lake in Gorakhpur city. Therefore, Ramgarh lake provides more opportunity of livelihood, therefore need for development and adjustment with nature is important because the urban lake face so many problems like decreasing water quality, areal encroachment by surrounding, dumping of municipal sewage waste and extinction of species of
an aquatic living organism. Thus, stewardship of urban lake is needed for development such as setting up of STP (Sewage Treatment Plant) for maintaining the water quality of lake in oligotrophic status, green and clean park, forest track, ban on dumping waste material either domestic or recreational etc.

**Problems and recommendation**

Some specific problems were found in Chilua lake (rural) and Ramgarh lake (urban) in the context of their physical, economic and social characteristics. Water quality of Chilua lake is not so bad but it has been started to degrade. Presently it is in mesotrophic status whereas in Ramgarh lake's water quality is highly degraded and the lake became eutrophic to hyper-eutrophic.

Encroachment in Chilua lake basin accounted for 343.92-hectare from 1922 to 2019 due to siltation where agricultural sediments are deposited therein whereas encroachment in Ramgarh lake was recorded 390.06-hectare from 1922 to 2019 due to excessive anthropogenic activities. (Singh et al., 2019) Plundered livelihood was seen in Chilua lake with rural appearance where proper recreational activity, vermiculture, fishing etc. are not maintained while near Ramgarh lake only urban nature of livelihood can be seen like high-quality recreational activities, commercial fishing and a huge amount of waste dumping. Extinction of species in Chilua lake is not in alarming situation but due to depletion of water quality 10 types of fishes remained in Ramgarh lake out of 28 types of fishes which were in existence in 1998. In Chilua lake, nowhere control on siltation and lake become channel like in its basin during winter to the summer seasons due to lack of embankment while in Ramgarh lake it was controlled after the construction of the embankment. In Chilua lake, little input of sewage by local people was seen and only one sewage entering source was found whereas, in Ramgarh lake, reckless and huge input of solid waste and sewage water were entering from 10 point sources.

After observing the problems in both rural (Chilua lake) and urban (Ramgarh lake) some recommendations are suggested here to prevent the degradation of the lake ecosystem. Ban on the entry of domestic sewage and any kind of sewage disposal; Set up of proper STP for treatment of sewage water before entering in the lake; Harvesting of weeds, aeration, and alum treatment etc; Beautification of the lake like gardening, park, jogging path, the forest surrounding the lake; Making proper embankment to develop lake basin for storing water; Ban on idol immersion and religious wastes; Ban on use detergent during washing activity; Control on silt deposition in the lake basin area; Community participation and public awareness about restoration and conservation of lake; Monitoring and management of water quality and lake ecology; Environmental mapping using GIS and research for proper management of lakes should be incorporated for lake stewardship. Moreover, increasing the potential utility in both lakes is required. Development of proper fishing sites, irrigation facility, aqua-herbal park, jogging track, resort station, boating sites, meditation site, bird sanctuary, water sport site etc. are potential activities that can be executed for lake conservation.

**Conclusion**

Rural and urban lake both have specific and different economic and environmental relevance and potential use, but their problems and their conservational methods are the same to some extent. In the urban lake, commercial and in the rural lake, the
natural point of view provides a better opportunity for a livelihood and healthy, sustainable lake environment. The urban lake depleted through entering of sewage waste in the lake and its hyper-eutrophic status and encroachment for infrastructural development due to which numerous extinctions of species took place and threatened the livelihood of those depending on it. In rural areas, water quality has started to deplete to a mesotrophic level and encroachment mainly through agricultural activity due to huge siltation in the lake basin, but the depended livelihood continues to sustain. For getting healthy mechanism of Lake Ecosystem, awareness among people about the importance and conservation of lakes is urgently needed.

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Assessment of land use /land cover changes using Landsat data series: A case study of Chandauli district

Kaushalendra Prakash Goswami¹, Sushil Kumar Yadav² and Himanshu Shekher³
¹Professor, Department of Geography, Institute of Science, B.H.U. Varanasi
²Research Scholar, Department of Geography, Institute of Science, B.H.U. Varanasi
³Research Scholar, Department of Geography, Institute of Science, B.H.U. Varanasi
(Corresponding author's email: goswamikp2004@gmail.com)

Abstract
The rapid growth of population, urbanization, economic activities and natural phenomena have affected and simultaneously changed the land use land cover pattern. The main aim of this study is to gain a quantitative understanding of land use land cover changes in Chandauli district from 2000 to 2019. The maximum likelihood supervised classification in ERDAS imagine and ARC GIS software is applied in this study for the preparation of land use land cover maps and analysis of the pattern of land cover through satellite data for the years 2000, 2010 and 2019. The classification of land use land cover is divided into nine major classes i.e. water bodies, sand, cropland, built-up land, fallow land, wasteland, dense forest, open forest and scrub forest. Change detection analysis was also included in this analysis. The general pattern of LULC in this area includes an expansion of Fallow land (18.31 per cent), built-up land (13.43 per cent), open forest and water bodies as well as a reduction in the wasteland (12.59 per cent) and dense forest areas in the reference period (2000-2019). The result also indicates that the dominating forest cover exists in southern Chandauli district. The mapping of land use land cover classes is also helpful in the study of change detection and natural resource management.

Keyword: land use, land cover, change analysis, supervised classification.

Introduction
Land use Land cover changes is an important field in global environmental changes Research. Inventory and monitoring of land use land cover are indispensable aspects for future understanding of changes mechanism and modelling the impact of change on the environment and associated ecosystem at a different scale. Land cover change resulting from human land uses represents a major source and a major element of global environment change (Turner, 1994) Land-use and land-cover (LULC) change has been considered an important topic for global environmental change and sustainable development. Land use generally refers to the human purpose or intent applied to these attribute while land cover refers to biophysical attributes of the Earth's surface. Many previous studies have focused on revealing the effects of LULC, e.g., the significant effects on
resource production and the influence on climate change, soil erosion, biodiversity, food security, and even threats to public health. An interpreter uses tools, texture, pattern, shape, size, shadow, site association to drive information about land cover, (Anderson, 1971). The changes of land use and land cover by its physical dimension of the spatial extent, of land use and land cover classes and also influences many of the secondary processes which lead to the environmental degradation of the ecosystem of the Earth (Dregne and chow, 1992). Chandauli was chosen as a case study since the eastern area of Uttar Pradesh has experienced conflict between urbanization and basic arable land protection in the past several decades. The acceleration of urbanization and industrialization has led to serious ecological destruction, such as a decrease in ecological carrying capacity, vast coverage and intensity of water and soil loss, desertification, soil erosion, vegetation degradation, biodiversity losses, invasion of alien species, environmental pollution, natural hazards, geological hazards, and forest hazards. Considering these conditions.

Landsat images can be used at the local level with the 30 m resolution for the identification and mapping of the land use and land cover (Jenson, 2005). Generating valuable information by the satellite-based data is good for land use and land cover mapping and analysis (Hathout, 2002). Remote sensing is a very valuable tool for the monitoring of the areas having rugged topography and poor accessibility and also analyses the spatial and temporal changes in land use and land cover in the district. The study of land use and land cover in Chandauli district by the Landsat satellite data with the spatial resolution of 30m is playing an important role to identify the different land use classes and also focuses the relation with land-use changes in the temporal period. The present work is an attempt to study the changes in the land use pattern between 2000, 2010 and 2019 in the district. The spatial distribution of each land use classes is done by the supervised image classification system with the help of ArcGIS. The nine land use classes used for the study namely water bodies, sandbar, crop land, fallow land, wasteland, dense forest, open forest and scrub land. The objectives of this research to identify the land cover changes and to assess the land use pattern in the study area over the period by using remote sensing and GIS techniques.

Study area

Chandauli district is situated in the easternmost of the state of Uttar Pradesh. Chandauli was a tehsil of Varanasi district but it was constituted as a new district in 1997. Geographically the area under study is a part of the Middle Ganga plane region. The extension of the area is 24° 56ʹ N to 25° 35ʹN latitude and 81° 44ʹ E to 83° 24ʹ East longitude (Figure 1). Chandauli district is bordered by Ghazipur district in the north whereas Varanasi and Mirzapur districts lie in its north-western parts. The North to south extent of the district is 82.5 km, while the East to West extent is about 50 Km. The North side of the district consists the Plain and South part of the district cover the Hill plateau area. The district is drained by rivers Ganga, Karmanasa, Garai and Chandraprabha rivers. Ganga flows along the north-western part whereas Karmanasa Rivers flow along the south-eastern boundary. The district is covered in 11 topographical sheets of the Survey of India.
on 1:50,000 scale (63O/2, 63O/3, 63O/4, 63O/5, 63O/6, 63O/7, 63O/8, 63P/1, 63P/2, 63P/5, and 63P/6).

Database and methodology

The multispectral Landsat satellite data downloaded from the USGS earth explorer site has been used for the present study of land use land cover analysis. (Table 1).

Hence the data had to be rectified and subset for input into the classification and change detection process. Maximum supervised Likelihood classifier methods were used in this particular study. After the supervised land use, the land cover map has been edited based on the actual site with the help of the Google earth software.

In the present paper satellite image processing software have been used like,

Table 1: Information about Satellite data

| Image Type   | Sensor      | Path | Row  | Resolution | Sources |
|--------------|-------------|------|------|------------|---------|
| Landsat5 March 2000 | TM         | 142  | 42,43| 30m        | USGS    |
| Landsat5 March 2010 | TM         | 142  | 42,43| 30m        | USGS    |
| Landsat8 March 2019 | OLI and TIRS | 142  | 42,43| 30m        | USGS    |

*TM (Thematic mapper), OLI (Operational land Imager), TIRS (Thermal Infrared Sensor)
Earth resources Data analysis system (ERDAS) Version 13.0 and ArcGIS 10.1 for the mapping and analysis of land use land cover.

A classified image or Change detection map needs to be compared against reference data, assume to be true, to assess its performance and quantify its accuracy. The process had used to estimate the accuracy of image classification by comparing the classified map with a reference map. Therefore, full accuracy assessment needs to include the report on overall accuracy, user accuracy, and producer accuracy had investigated using the kappa coefficient.

Result and discussion

Land use/land cover classification in the District

Nine major land use land cover classes have been delineated in the District supported by Figure 3, showing the LULC for three different years.

Land use/land cover change detection from 2000 to 2010

The result from classified map indicated that in 2000 (Figure 3, Table 2) are occupied by different classes such as water bodies (2.1 per cent), sand (0.66 per cent), crop land covered by (53.0 per cent) built upland (0.12 per cent), fallow land (6.9 per cent), wasteland (12.87 per cent), and dense forest (3.2 per cent), the open forest that is the largest part of occupied land as a forest (17.2 per cent) and scrubs forest (3.7 per cent). In the other hand in 2010 (Figure 3) the result from occupied supervised classes such as water bodies (3.0 per cent), sand (0.9 per cent), cropland (28.67 per cent), built-up land (1.06 per cent), fallow land is the largest occupied land (40.45 per cent), wasteland (4.0 per cent).
cent), dense forest (4.1 per cent), open forest (11.58 per cent), and scrub forest (6.05 per cent). The images of supervised land use and land cover of the year 2000 and 2010 are clearly shown the changes of built-up land that is (0.12 per cent) in the year of 2000 and its increases to 2010 in 1.06 per cent due to rapid growth of population.

The changes of forest dense, forest open, and forest scrub in the year of 2000 to 2010 are (3.2 per cent), (17.2 per cent), (3.7 per cent), whereas forest dense increases as 4.1 per cent, and open forest decreases in the compression of 2000 data as (11.5 per cent), scrub forest increases in 2010 in compression of 2000 as (6.05 per cent) (Table 2)

### Land Use in Chandauli District 2000 to 2010

| Land use Class       | Area (sq. km) 2000 | Area (per cent) 2000 | Area (sq. km) 2010 | Area (per cent) 2010 |
|----------------------|--------------------|----------------------|--------------------|----------------------|
| Water Bodies         | 46.91              | 2.10                 | 66.95              | 3.00                 |
| Sand                 | 14.71              | 0.66                 | 21.92              | 0.98                 |
| Crop Land            | 1181.02            | 53.05                | 638.31             | 28.67                |
| Built Up Land        | 2.73               | 0.12                 | 23.73              | 1.06                 |
| Fallow Land          | 154.89             | 6.95                 | 900.42             | 40.45                |
| Waste Land           | 286.62             | 12.87                | 90.22              | 4.05                 |
| Dense Forest         | 71.81              | 3.22                 | 91.61              | 4.11                 |
| Open Forest          | 383.81             | 17.24                | 257.85             | 11.58                |
| Scrub Forest         | 83.36              | 3.74                 | 134.86             | 6.05                 |

Source: Computed by the authors from LANDSAT 5 (2010) Satellite Image

The changes of forest dense, forest open, and forest scrub in the year of 2000 to 2010 are (3.2 per cent), (17.2 per cent), (3.7 per cent), whereas forest dense increases as 4.1 per cent, and open forest decreases in the compression of 2000 data as (11.5 per cent), scrub forest increases in 2010 in compression of 2000 as (6.05 per cent) (Table 2)

### Land use land cover change from 2010 to 2019

The major changes of 2010 to 2019, water bodies (3.0 per cent to 2.1 per cent) it indicates that water bodies' decreases in 2019. Built-up land is the highest land occupied categories in 2019, (13.5 per cent) in compression of 2010 and open forest
also increasing (11.5 per cent) to (19.55 per cent) in 2019. Sand, crop land, fallow land, wasteland, dense forest, and scrub forest decreases (4.9 per cent), (26.5 per cent), (25.2 per cent), (0.27 per cent), (2.5 per cent), (5.07 per cent) respectively (Figure 3).

The total changes of the land use land cover categories from the year of 2000 to 2019 in the Chandauli district according to the satellite data water bodies (0.04 per cent), sand (4.32 per cent), crop land (26.48 per cent), built upland (13.43 per cent), fallow land (18.31 per cent), wasteland (12.59 per cent), dense forest (0.67 per cent), open forest (2.33 per cent), scrub forest (1.32 per cent) respectively (Table 4). The total changes in 2019 built-up land are the dominant factor of the land use categories due to the rapid growth of population.

**Conclusion**

![Figure 4: Percentage change in land use (2000-2019)](image)

Table 4: Changes in Land use from the year 2000 to 2019

| Class Names     | Area 2000 (per cent) | Area 2010 (per cent) | Area 2019 (per cent) | Changes from 2000 to 2019 (per cent) |
|-----------------|----------------------|----------------------|----------------------|---------------------------------------|
| Water bodies    | 2.10                 | 3.00                 | 2.15                 | 0.04                                  |
| Sand            | 0.66                 | 0.98                 | 4.96                 | 4.30                                  |
| Crop Land       | 53.05                | 28.67                | 26.57                | 26.48                                 |
| Built-up Land   | 0.12                 | 1.06                 | 13.55                | 13.43                                 |
| Fallow Land     | 6.95                 | 40.45                | 25.27                | 18.31                                 |
| Waste Land      | 12.87                | 4.05                 | 0.27                 | 12.59                                 |
| Dense Forest    | 3.22                 | 4.11                 | 2.55                 | 0.67                                  |
| Open Forest     | 17.24                | 11.58                | 19.57                | 2.33                                  |
| Scrub Forest    | 3.74                 | 6.05                 | 5.07                 | 1.32                                  |

Source: Calculated by the Authors based on Land use map 2000, 2010 and 2019
Land use and land cover analysis can provide important information for global environmental change, which can also be useful for decision-makers. In this research, using a long-time-series of (2000, 2010, and 2019) remote sensing images with resolution (30m), we obtained detailed information of LULC and highlighted the crop land conversion process in Chandauli district during the periods of 2000-2010 and 2010–2019. The general pattern of LULC in this area included an expansion of built-up land (13.43 per cent), Fallow land (18.31 per cent), open forest and water bodies as well as a reduction in the wasteland (12.59 per cent).

### Table 5: Confusion Matrix for the classification of 2019

| Classes          | Water Bodies | Wasteland | Scrub | Sand | Open forest | Fallow land | Dense forest | Cropland | Built upland | Total user |
|------------------|--------------|-----------|-------|------|-------------|--------------|--------------|-----------|--------------|------------|
| Water Bodies     | **5**        | 0         | 0     | 0    | 0           | 0            | 0            | 0         | 0            | 5          |
| Wasteland        | 0            | **1**     | 0     | 0    | 0           | 1            | 0            | 0         | 0            | 1          |
| Scrub            | 0            | 0         | **3** | 0    | 0           | 3            | 0            | 0         | 0            | 3          |
| Sand             | 0            | 0         | 0     | **2**| 0           | 0            | 1            | 0         | 0            | 4          |
| Open forest      | 0            | 0         | 0     | 0    | **3**       | 0            | 0            | 0         | 0            | 3          |
| Fallow land      | 0            | 0         | 1     | 0    | 0           | **2**        | 0            | 1         | 0            | 4          |
| Dense forest     | 0            | 0         | 0     | 0    | 0           | 1            | **3**        | 0         | 0            | 1          |
| Crop land        | 0            | 0         | 0     | 0    | 1           | 0            | 8            | **1**     | 0            | 9          |
| Built up land    | 0            | 0         | 0     | 0    | 0           | 1            | 4            | **5**     | 0            | 5          |
| Total producer   | **5**        | 0         | 2     | 0    | 3           | 4            | 11           | 4         | 30           |            |

Source: Calculated by the Authors based on Google Earth Pro Software of 30 Sample site of 2019 LULC Image.

### Table 6: Summary of accuracy assessment of 2019

| classes         | producer Accuracy (%) | User Accuracy (%) |
|-----------------|-----------------------|-------------------|
| Water Bodies    | 100                   | 100               |
| Wasteland       | 100                   | 100               |
| Scrub           | 50                    | 50                |
| Sand            | 00                    | 00                |
| Open forest     | 100                   | 100               |
| Fallow land     | 50                    | 50                |
| Dense forest    | 100                   | 100               |
| Cropland        | 88                    | 72                |
| Built upland    | 80                    | 100               |

Overall Accuracy 80 (%) Kappa Statistics is 76.1 (%)

Land use and land cover analysis can provide important information for global environmental change, which can also be useful for decision-makers. In this research, using a long-time-series of (2000, 2010 and 2019) remote sensing images with resolution (30m), we obtained detailed information of LULC and highlighted the crop land conversion process in Chandauli district during the periods of 2000-2010 and 2010–2019. The general pattern of LULC in this area included an expansion of built-up land (13.43 per cent), Fallow land (18.31 per cent), open forest and water bodies as well as a reduction in the wasteland (12.59 per cent).
cent) and dense forest areas in the study period (2000-2019). The transition from crop land and forest to built-up land in addition to the transition from crop land and wasteland to the forest has been the dominant LULC patterns over the past 19 years. Crop land is the dominant land-use type in Chandauli district. From 2000 to 2019, deforestation and afforestation have both occurred, with deforestation being the major ecological problem during the past 19 years. After the formation of Chandauli district is 1997, the conversion from crop land to build up land effectively occurred in this region. Therefore, improved land management practices (soil and water conservation), and active participation of the local community should be advance to prevent undesirable LULC dynamics in the study area. In this study, the change detection analysis using GIS and remote sensing could deliver useful information to understand the seasonal patterns of land use dynamics for planners and decision-makers consequently sustainable land management planning is possible.

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