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Assessing and Monitoring Spatial Distribution of Brick Kilns in a Part of North India, using Remote Sensing & GIS Techniques

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Abstract: ***The quarrying of soil for brick making has negative impacts on land capability, on soil & water management, on land use pattern and thus it plays a negative role in agricultural productivity. The last few decades have experienced a continuous reduction in good quality land due to urbanization and modernization complemented by brick kilns as each one of them consumes a big chunk of fertile land. Soil quarrying activities by the brick kilns cause serious damage to agricultural land. In absence of accurate spatial data sets on brick kilns it is not possible to assess the extent of land degradation. In the present study high resolution satellite imagery from Google Earth and Sentinel - 2 were utilized. It was found that there were 81 more brick kilns in 2020 compared to 2003 while the number of villages with brick kilns increased by 36 only in the same period. The study also revealed 24 abandoned brick kilns in 2020 and 110.8 % increase in area under brick kilns during the period of study.***

Keywords: Brick kiln, Land Degradation, Remote Sensing, GIS

1. Introduction

Agriculture is the basic activity in most of the villages but due to urban influences, social norms keep on changing, and the joint family system is disintegrating leading to change in economic activities. The decline in the share of agriculture in total production and employment is taking place at different speeds and poses different challenges across regions. The needed acceleration in productivity growth is hampered by the degradation of soil and natural resources. Although agriculture at the global level has become more efficient, in recent decades, competition for natural resources has intensified owing to consumption patterns driven mainly by population growth, changing dietary patterns, industrial development, urbanization and climate change. More people are now moving to cities from rural areas, and this rate of migration is increasing with time.

The availability of fertile agricultural land is of vital importance, but the last few decades have experienced a continuous reduction in good quality land due to urbanization and modernization complemented by brick kilns as each one of them consumes a big chunk of fertile land. Soil quarrying activities by the brick kilns cause serious damage to agricultural land. The process of manufacture of bricks is today considered to be a threat to the environment, particularly land. This is because it requires soil quarrying, it causes soil erosion, it generates solid wastes, and it causes water management problems, water logging etc. All these factors result in degradation of the land. Land degradation or deterioration of land quality for agricultural productionand environmental protection has been a matter of concern for land users. Not only is the brick kiln industry fuelled by demand for bricks but there also exists a nexus between rural poverty and brick kilns. Farmers may seasonally lease out their land to sell its soil during periods of unproductive agricultural activity or to stave off their debts. Often this leads to the farmers turning into laborers for the brick kilns. Despite multi - dimensional environmental impacts of brick kilns, there is no publicly available geo spatial database of brick kiln locations or an official estimate of the number of brick kilns. It is assumed that India alone has more than 100, 000 brick kilns [6]. The central pollution controlling body in India recently stated that more than 70% brick kilns were operating without consent [8], hence possibly remain unmapped. Such lack of data prevents assessing the full scale regional environmental impacts of brick kiln operations. In the present study high resolution satellite imageries in association with geographical information system (GIS) have been utilized for identification and mapping of brick kilns to create spatial dataset for a district in North India to demonstrate the capabilities of available technologies.

2. Study Area

Sitapur is a district located at the base of the Himalayas in Tarai region of north India in Uttar Pradesh. It is intersected by numerous streams, rivers and natural reservoirs. The total geographical area of district is 5743 sq. km. On the east of study area lies the districts of Lucknow and Hardoi. The location of study area is shown in Fig.1. The soils are very fertile. The temperature can reach above 40 °C (104 °F) and in winters (October to February) it can drop to around 4 °C (39 °F). The nights are very cold during winter and fog is very common in this season. The annual average rainfall in Sitapur district is 1, 400 mm, mostly occurring in the monsoon months (July to September).

Wheat, rice, maize, mustard, barley, groundnut and pulses are the major food crops grown in the area. Recently few farmers have started menthol mint farming in the district, as Terai region is ideal for mint cultivation. Banana, Sugarcane and oilseeds are the chief non - food crops.

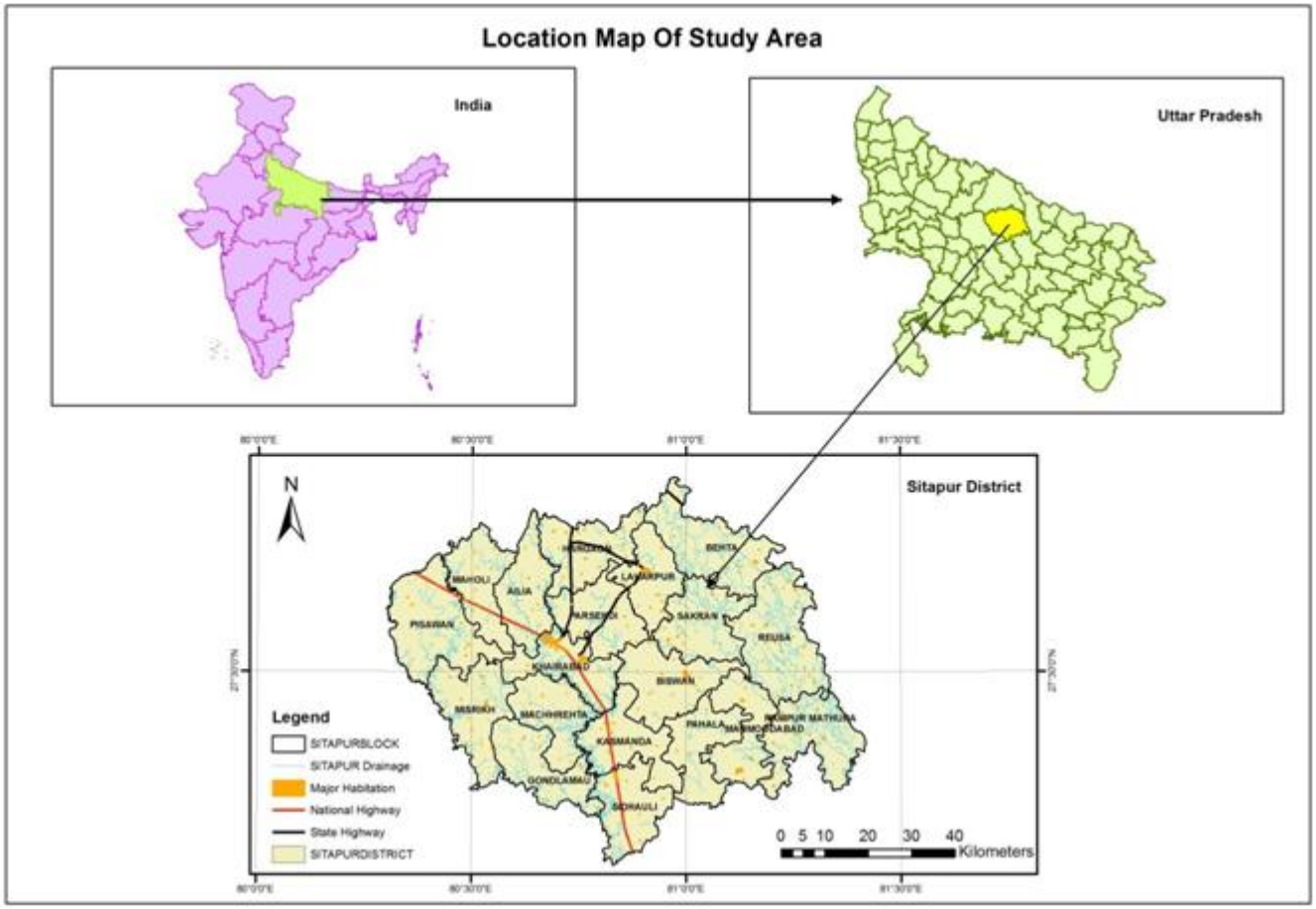

Figure 1

3. Methodology

For the identification of brick kilns and adjoining quarrying land, satellite data of 1M spatial resolution from Google Earth and 10 M spatial resolution of SENTINEL - 2, of March have been used. The Arc/Info GIS with image processing capabilities software was used for on screen visual image interpretation, identification and mapping of brick kilns, built up area and land use changes in the present study.

Google Earth Imageries and SENTINEL - 2 data of the study area were Georefrenced using ground control points with the help of Google map for creating different vector data sets for the years 2003 and 2020. The on screen visual interpretation was carried out on 1: 25, 000 scale and all maps were generated on the same scale to determine spatial changes in brick kiln areas, habitations and land use changes from 2003 to 2020.

Table 1

S. No.	Observations	Year		Change	% Increase
		2003	2020		
1.	No. of Brick kilns	120	201	81	67.5%
2.	Land used by Operational Brick Kilns in (ha.)	589.32	1242.41	653.09	110.8%
3.	Abandoned Brick kilns	_	24	24	-
4.	Built up Area in (ha).	16567.73	18005.06	1437.73	8.7%
5.	No. of Village they are Located	72	108	36	50%

Table 2: Quantity of soil required for making Bricks

Top soil required (in cu. m)	Quantity Of Bricks (in million)
9, 000	3
12, 000	4
15, 000	5
18, 000	6
21, 000	7
24, 000	8
27, 000	9
30, 000	10

Source - (10) Central Building Research Institute, Roorkee (2001).

Table 3: Population growth of District Sitapur

Year	Population	+, - , % P. a.
1951	13, 86918	+ 0.65 %
1961	16, 08057	+ 1.49 %
1971	18, 84400	+ 1.60 %
1981	23, 37284	+ 2.18 %
1991	28, 57009	+ 2.03 %
2001	36, 19661	+ 2.39 %
2011	44, 83992	+ 2.16 %

Source - (11) Census of India (2011).

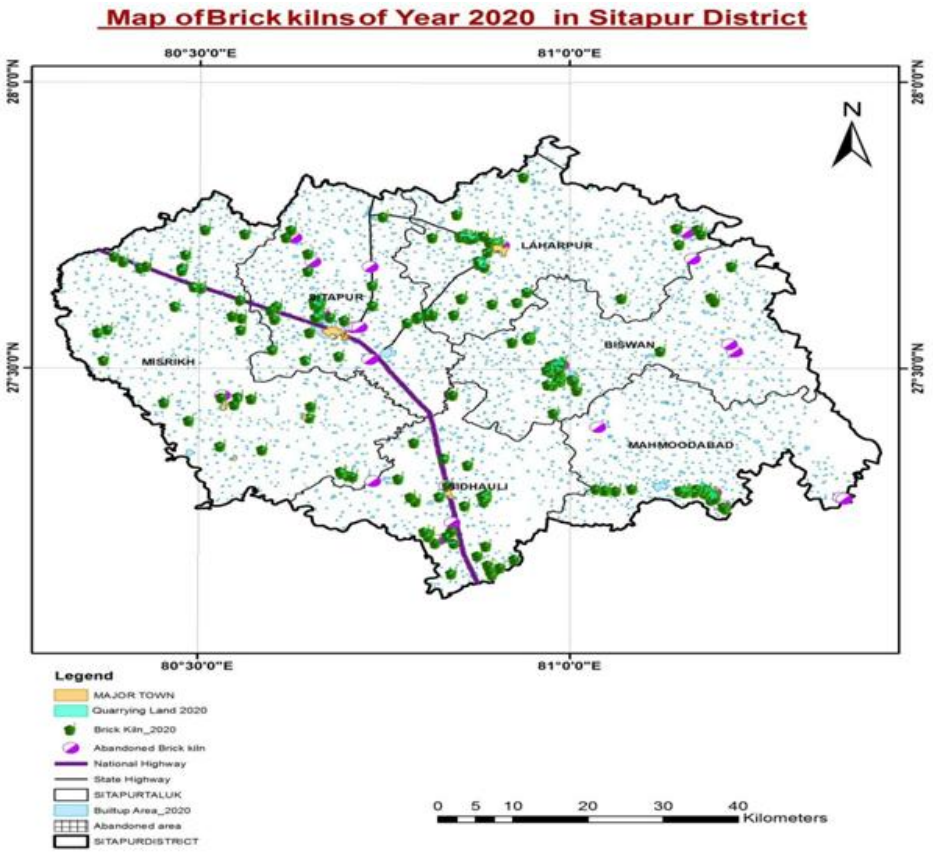

Figure 2

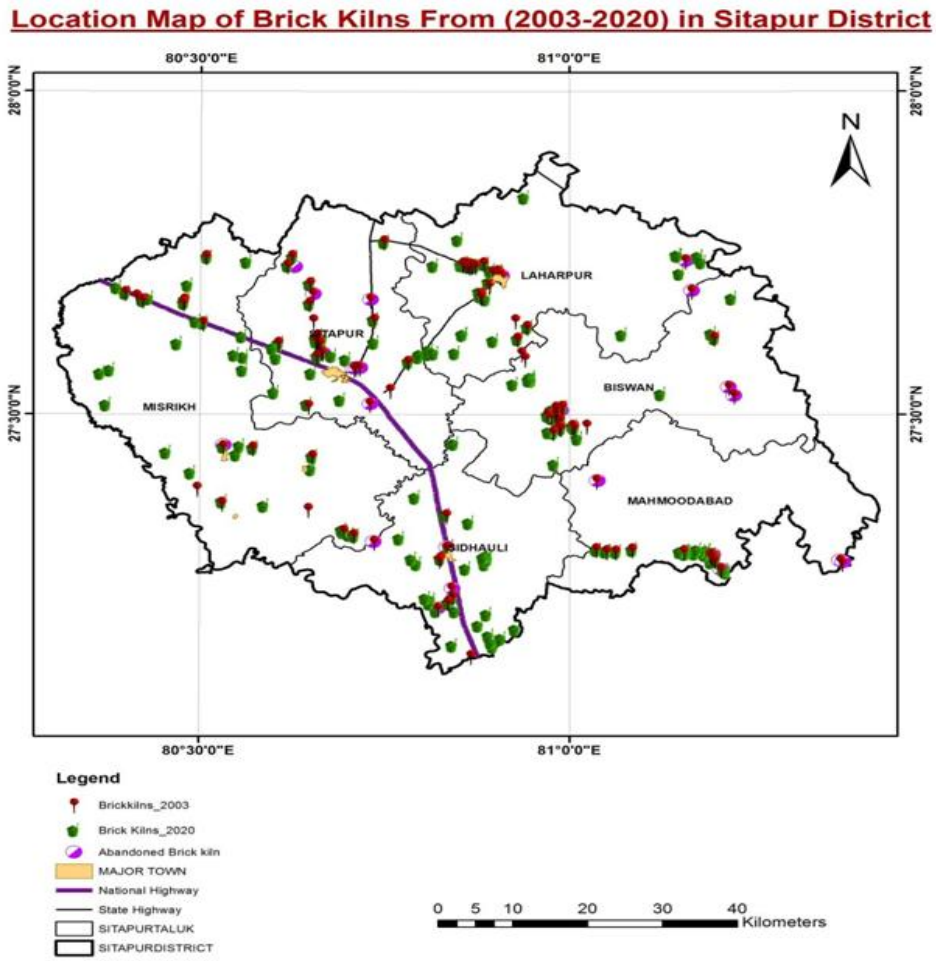

Figure 3

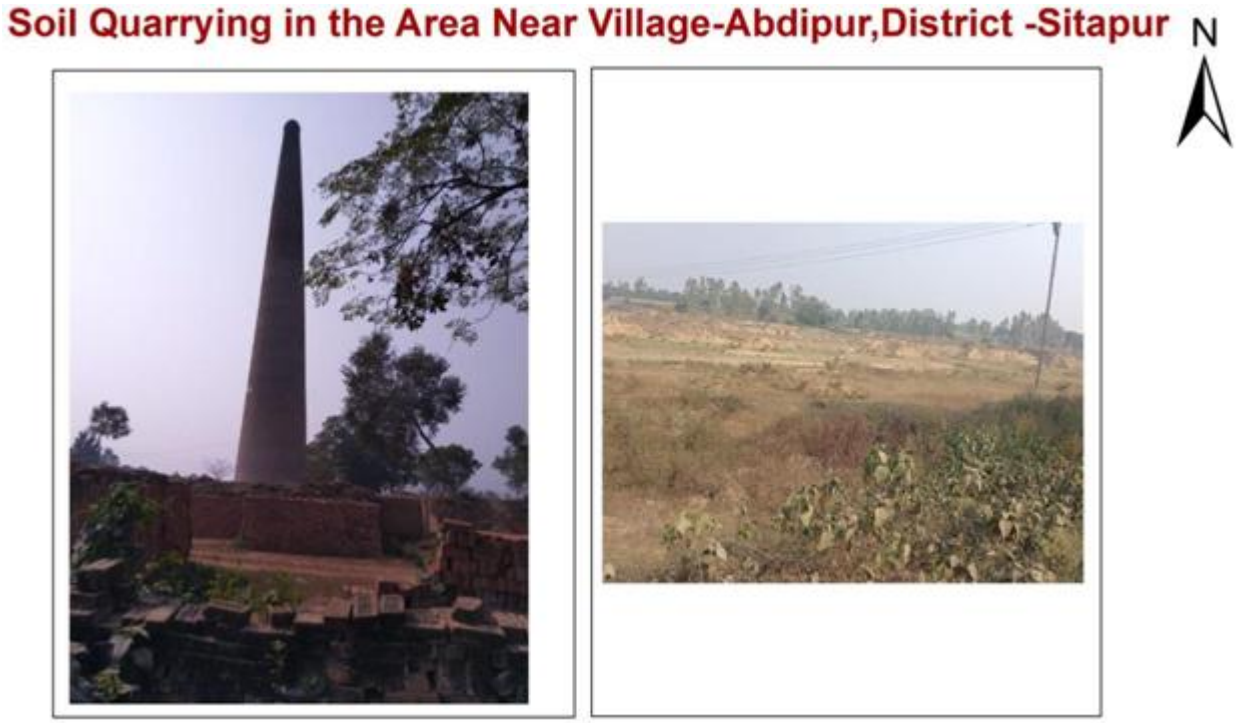

Figure 4

4. Results and Discussion

The study shows that the number of brick kilns jumped from 120 to 201, an increase of 81 brick kilns in 17 years. Table.1 also show an increase of 110.8% in land area under operational brick kilns and an increase of 8.7% built up area in district Sitapur between 2003 and 2020. Calculating on the basis of Table 2 the number of bricks produced can be roughly estimated from the area under brick kilns found in 2003 & 2020. Assuming that only half of the area under brick kilns was used for excavating soil for brick making, 1.0 billion bricks were produced in 2003 and 2.2 billion in 2020 that is more than 100% increase in consumption of bricks for development activities. It can also be estimated from table - 1 that on an average, a brick kiln covered an area of 4.91 ha in 2003 which increased to 6.18 ha in 2020. This further indicates the increasing loss of top fertile soil with passage of time and with increasing urbanization. For making 10 million bricks 30, 000 cu. m. of soil is required (Table 2), thus for making 2.2 billion bricks 6, 60000cu. m. of soil has been removed, which has not only caused land degradation but also impacted the soil productivity. It is important to note here that the large quantity of bricks produced are not necessarily used up within the district, but have been transported to adjoining districts also which can be confirmed from locations of many brick kilns near the district boundary (Fig.2). It was found that in 2003 only 72 villages had brick kilns but in 2020 the number of villages increased to 108 showing an increase of 36 villages in 17 year. Removal of a huge quantity of top fertile soil for brick making is not only cause of land degradation and change of land use but it is also a huge loss of plant nutrients. The study also revealed an increase of 110.8% in area under brick kilns from 2003 to 2020 while the built up area increased by 8.7 % during the same period. The study also found 24 abandoned brick kilns in 2020. Abandoned brick kilns could not be mapped in 2003 because of low spatial resolution of satellite images. The population of Sitapur district has increased many fold since 1951 (Table 3) and has been increasing 2.16% per annum in the district. This will put more pressure on brick kilns to produce more bricks and thereby leading to further deterioration of fertile soils in the region.

5. Conclusion

The quarrying of soil for brick making has negative impacts on land capability, on soil & water management, on land use pattern and it plays a negative role in agricultural productivity. There is a need to create and monitor a nationwide spatial database in order to understand the impact of brick kilns on land quality. Such a database will guide in regulating the brick kiln industry and will be of great help in taking up the requiste measures for restoration of soil health. For saving the fertile soil it is equally paramount to find eco - friendly brick making material to meet the increasing demand of bricks.

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