# Causes of Land Degradation in Uttar Pradesh, India: An Econometric Analysis


## ABSTRACT

Soil degradation is largely caused by improper maintenance and use of canal irrigation. Land degradation also includes loss in productivity over time due to various natural and artificial causes. The study was based on primary data to identify the causes of land degradation in Uttar Pradesh. The multi-stage stratified random sampling technique was used to select the samples at the zone, district, block, village, and farmer levels. Separately, respondents of different farm categories were found to be very few. That is why the overall number of respondents was used to analyze the study results. The period of the study was 2018-19. Logit analysis was used to analyze the causes of land degradation in the study area. The results indicated that variables such as education, migration, high fertilizer use, mono-cropping, non-farm income, and family labour were responsible for the causes of land degradation. With the increase in population, people's requirements have become complex, resulting in changes in land use, cropping patterns, and irrigation patterns. Industrialization attracted people to urban areas, which provided them with better job opportunities. Rapid population growth followed by industrialization and urbanization has depleted resources and changed the land use patterns. The study suggested that it is urgent to capture the degradation of land and restore the productivity of degraded soils so that a sufficient amount of food can be produced to fulfill the increasing population's requirements without compromising the future generation's requirements.



**Keywords:** Land, Degradation, Mono-cropping, Non-farm Income


## INTRODUCTION

Preventing soil retrogression and degradation, which reduce the ecosystem's potential to produce commodities and services for humans, is essential to preserving global food security. Taking prompt actions to reduce soil deterioration improves land quality and productivity, protecting this irreplaceable resource for the future (Kogut, 2023). Land Destruction has been one of the most serious environmental and human survival challenges in recent decades. Desertification, which is an irreversible Land

Degradation process, has attracted the international community's increasing attention to its devastating potential for the natural which threatens 1,5 billion people and affects around 1,9 billion hectares of land and 250 million people worldwide (Mandal & Chatterjee, 2024). Land is one of the vital natural resources (Li et al., 2014). It is equally essential for all living beings. Therefore, sustainable use of land resources is of crucial importance. Population pressure and poor land use are causing land degradation worldwide (Nachtergaele et al., 2010). 6.056 billion world's population was projected in mid-2000 and further it is projected to be 7.936 billion in 2025 and 9.322 billion in 2050. The environmental impact could be devastating if the population continues multiplying (Adams & Eswaran, 2000). Type and rate of soil erosion or loss in an area depend on different factors including climate, geomorphology, soil type and land use. Deforestation, overgrazing, and unsuitable agricultural practices are the main causes of soil erosion induced by human activities. Considering the different factors involved in soil loss, land use is the most important one due to the potentially destructive role of human effects (Sharma et al. 2024). The rise in population to such an extent will cause an overall scarcity of resources in future. Poor natural resources will create global environmental risks. Because of the competing demands for natural resources due to population expansion, increased need for food, fuel, fodder, timber, and extensive industrial operations, land is degraded to varied degrees and in different ways. The critical land degradation problems are desertification, soil erosion, water logging and salination (Singh et al., 2004). Land degradation also includes loss in productivity over time due to various natural and artificial causes. Deforestation, improper soil conservation practices, an extension of cultivation on marginal lands, improper crop rotation, imbalanced use of fertilizers, excessive surface irrigation and scarcity of land, economic pressure and poverty are some major causes of land degradation. Excess nutrients from heavy fertilizer use, such as nitrates, seep into groundwater and contaminate it.

Soil degradation is also largely caused by improper maintenance and the use of canal irrigation (Azharuddin, 2015). Further, overuse of canal irrigation in arid and semi-arid areas has resulted in water logging and Salination. In the western districts of Uttar Pradesh, *viz*. The soil is typically the same in Bijnor, Moradabad, Pilibhit, Saharanpur, Meerut, Muzaffarnagar, and Bareilly. It is deep brown and loamy in some places, mixed with sand (Reich et al., 2001). Moreover, the soil is generally acidic. The soil in the central regions comprising Kanpur, Lakhimpur Kheri, Sitapur, Lucknow, Barabanki, Hardoi and Azamgarh districts is loamy and sandy loams. In the eastern

part of the state, the districts of Gorakhpur, Basti, Mahrajganj, Siddarthnagar and Gonda contain two types of soil, known as 'Bhat' and 'banjar' in local terms. The alluvial soil is called ‘dhuh’ (Arora & Singh, 2020).

Soil salinity and sodicity are more prominent problems in the semi-arid tract of the Gangetic plain by covering 1.37 m ha, which reduces the productive capabilities of about 4.65% of the land surface in the state (Tucker et al.,1991; Prince et al., 1998; Milich & Weiss, 2000; Weiss et al., 2001; Groten & Ocatre, 2002; Thiam, 2003; Evans & Geerken, 2004; Bai et al., 2008; Hellden & Tottrup, 2008; Vlek et al., 2008). The worst affected districts of the state are Mainpuri, Etah, Etawah, Fatehpur, Aligarh, Farrukhabad, Kanpur, Unnao, Allahabad, Raebareli, Partapgarh, Sultanpur, Lucknow, Azamgarh and western parts of Ballia and Varanasi. Some saline patches have also been identified in the districts of Mathura and Agra due to the high water table, which is brackish mainly (IWMP, 2009). Uttar Pradesh is India's fifth largest state, with a total area of 24.09 million ha in terms of land area, a population of about 200 million and a population density of 830 people per $km^2$. Agriculture is the main occupation of the state, which has 16.8 million ha of cultivated land. About 52.12 percent of the state's total geographical area is affected by various soil degradation induced mainly by human intervention. Water erosion is the major problem causing loss of top soils and or terrain deformation and has affected 11.39 m ha (38.69% area), including ravenous lands along the rivers of the total geographical area. Moreover, Flooding, wind erosion and soil salinization or sodification affected about 4.65, 0.72 and 7.98 per cent of the area of the state. The increased productivity due to input intensification, like chemical fertilizers and pesticides, intensive use of canals and groundwater and modern agro-mechanics, resulted in reversible and irreversible environmental damages to the areas under crops. Thus, it results in a larger area under affected soils. Climate change is also affecting natural resources and the agricultural environment. Land shortage and poverty lead to non-sustainable land management practices vis-à-vis soil degradation.

For sustainable agricultural development, studying the natural resource aspect, particularly the land for its optimum use is essential. In the background of the above facts, the present study, "Causes of Land Degradation in Uttar Pradesh: An Econometric Analysis", was conducted.

## METHODOLOGY

The study was based on primary data to identify the causes of land degradation in the selected zone of the state. The multistage stratified random sampling method was applied to choose the samples at the zone, district, block, village, and farmer levels. To identify the causes of land degradation, the state's three zones, namely "north-eastern plain zone, central plain zone and mid-western plain zone, were selected randomly. Furthermore, from the selected zone, three districts were selected based on having a larger area under degraded land such as salinity, ravine land, waterlogged land, degraded forest land, culturable wasteland and other wastelands. After that, two blocks from each sample district were selected on the basis of a larger area of degraded land. In the next stage, two or more villages from each selected block were selected randomly from each of the six sample blocks. At the final stage, 300 respondents were selected randomly from each of the six sample blocks. Separately, respondents of different farm categories were found to be very few. That is why the overall number of respondents was used to analyze the results.

The study was conducted during 2018-19 as a part of the doctoral research of the first author. Further, the data related to various categories of respondents and causes of land degradation was collected by personally interviewing each sample respondent with the help of a pre-structured schedule.



**Analytical Tools**

**Logit analysis:** Logistic regression or Logit analysis was used to identify the causes of land degradation in the selected zone of the state. Separately, respondents for different farm size groups were found to be very few. That is why, overall, respondents were considered for the analysis to found effective results.

$$Y=P+e=\beta_0+\beta_1X_1+\beta_2X_2+\ldots\ldots\ldots\ldots\ldots+\beta_nX_n$$

Where,

$\beta_0$ = intercept

$\beta_1 \ldots. \beta_n$= regression coefficient associated with each explanatory variable $X_1\ldots\ldots..X_n$

$X_1$ = (-) Total owned land (ha)

$X_2$ = (+) Number of fragments (number)

$X_3$ = (-) Family labour (number)

$X_4$ = (+) Non-farm income (`/annum)

$X_5$ = (-) Farm income (`/annum)

$X_6$= (+) Migration: dummy variable (0-1)

$X_7$= (+) Leased out the land (ha)

$X_8$ = (+) Fertilizers use (q/ha)

$X_9$ = (+) Mono-cropping: dummy variable (0-1)

$X_{10}$ = (-) Higher education in the family: dummy variable (0-1)

Y = A dichotomous outcome (value '1' was assigned if cultivators have degraded land and '0' for otherwise)

e = error term

The above probable factors were considered along with the hypothesis to study the cause of land degradation,

## RESULTS AND DISCUSSION

### Causes of Land Degradation in Kushinagar district of the North-Eastern Plain Zone of Uttar Pradesh

It was observed that in the Kushinagar district of the north-eastern plain zone, the variables such as education and migration were significant causes of land degradation as their coefficients were positive, that is, 0.585 (education) and 0.923 (migration) during the study period (Table 1). The possible reason may be that people depend less on agriculture as they become educated. They shifted to the urban areas for better employment and income. Hence, land degradation increased due to improper management of land. (Codjoe, 2006; Mcleman, 2017) also observed a similar result in their investigation. It can be concluded that the variable number of fragments showed a reverse trend with land degradation. The coefficient value for it was observed to be negative (-0.767). The reason behind this could be that farmers managed the small size of the holding properly.

**Table 1. Causes of land degradation in Kushinagar district of the north-eastern plain zone of Uttar Pradesh**

| Variable | Coefficient | Standard error | Z-value | p-value |
|---|---|---|---|---|
| Education | 0.585*** | 0.145 | 4.034 | 0.000 |

| | | | | |
|---|---|---|---|---|
| Fertilizer use (q/ha) | 0.148$^{NS}$ | 0.181 | 0.815 | 0.415 |
| Farm income (`/annum) | -0.668$^{NS}$ | 0.478 | -1.398 | 0.162 |
| Family labour (number) | -0.720$^{NS}$ | 0.527 | -1.365 | 0.172 |
| Leased out land (ha) | -0.380$^{NS}$ | 1.384 | -0.275 | 0.784 |
| Migration | 0.923$^{*}$ | 0.504 | 1.830 | 0.067 |
| Mono-cropping | 0.128$^{NS}$ | 0.549 | 0.232 | 0.816 |
| Non-farm income (`/annum) | -0.172$^{NS}$ | 0.138 | -1.251 | 0.211 |
| Number of fragment | -0.767$^{***}$ | 0.301 | -2.551 | 0.011 |
| Total land (ha) | 0.147$^{NS}$ | 0.894 | 0.164 | 0.869 |

****** and * indicate significant at 1 and 10 per cent level.***
***NS: Non-significant.***

**Causes of land degradation in Lucknow district of the central Plain zone of Uttar Pradesh**

The perusal of Table 2 revealed the causes of land degradation in the Lucknow district of the central plain zone of the state. It was observed from the table that in the district, the causal factors of land degradation were identified as fertilizer use, mono-cropping, non-farm income and total land. In Lucknow district, over 90%of farmers were marginal and minor categories. They used high consumption of fertilizers to get more output from the less land. The most considerable amount of fertilizer use reduces the fertility of the soil (Chowdhury et al., 2018). Another one was that many more areas of the district were unirrigated, and the types of soils were alkaline/saline and sandy. Cultivators grew only paddy in unirrigated conditions, and in sandy soil, they produced only wheat in one agricultural year. Consequently, as mono-cropping practices with fertilizer consumption increased, land degradation also increased in the district. (Massah & Azadegan, 2016; Chandini et al., 2019) observed in their study that the overuse of inorganic chemicals reduces the fertility of soils. The cultivators ' non-farm income was also found to be low. Hence, they could not manage the land properly. Thus, land degradation increased in the district.

**Table 2.Causes of land degradation in Lucknow district of the central plain zone of U.P.**

| Variable | Coefficient | Standard error | Z-value | p-value |
|---|---|---|---|---|
| Education | 0.140$^{NS}$ | 0.183 | 0.767 | 0.443 |
| Fertilizer use (q/ha) | 0.823$^{***}$ | 0.307 | 2.680 | 0.007 |
| Farm income (`/annum) | 0.747$^{NS}$ | 0.561 | 1.332 | 0.183 |
| Family labour (number) | -0.059$^{NS}$ | 0.469 | -0.125 | 0.901 |
| Leased out land (ha) | 3.974$^{NS}$ | 2.671 | 1.488 | 0.137 |

| | | | | |
|---|---|---|---|---|
| Migration | 0.676$^{NS}$ | 0.667 | 1.015 | 0.310 |
| Mono-cropping | 1.341$^{*}$ | 0.729 | 1.841 | 0.066 |
| Non-farm income (`/annum) | -1.127$^{**}$ | 0.512 | -2.201 | 0.028 |
| Number of fragment | -0.135$^{NS}$ | 0.286 | -0.471 | 0.637 |
| Total land (ha) | -1.710$^{*}$ | 0.965 | -1.771 | 0.077 |

******, ** and * indicate significant at 1, 5 and 10 per cent level.***
***NS: Non-significant.***

**Causes of land degradation in Shahjahanpur district of the mid-western plain zone of U.P.**

The causes of land degradation in Shahjahanpur district are presented in Table 3. It was evident from the table that in Shahjahanpur district of the mid-western plain zone, fertilizer use, family labour, leased-out land and total land were identified as significant causes of land degradation. The western plain zone is a highly developed zone of the state, and it is the state's industrial hub. To earn better employment and income, cultivators of the zone migrated to the urban areas by leasing out their land. Thus, as the migration and leased-out land increase, family labour and total self-cultivated land decline. Hence, degraded land increased in the zone because the tenant did not care about the leased out land correctly, and on the other hand, land owner with less family labour could not correctly manage their field. Cultivators of the district had grown more area under sugarcane crops which consume more fertilizers (Wood, 1985). Sugarcane crops are dominant because of the marshy land and frequent floods in the rainy season. No other crop can survive in water logging conditions (Khan & Ahmad, 2019). Hence, as the consumption of fertilizers increased, land fertility declined, resulting in degraded land.

**Table 3. Causes of land degradation in Shahjahanpur district of the mid-western plain zone of U.P.**

| Variable | Coefficient | Standard error | Z-value | p-value |
|---|---|---|---|---|
| Education | -0.066$^{NS}$ | 0.161 | -0.409 | 0.683 |
| Fertilizer use (q/ha) | 0.257*** | 0.079 | 3.247 | 0.001 |
| Farm income (`/annum) | 0.357$^{NS}$ | 0.560 | 0.637 | 0.524 |
| Family labour (number) | -0.454* | 0.244 | -1.861 | 0.063 |
| Leased out land (ha) | 1.098* | 0.618 | 1.775 | 0.076 |
| Migration | 0.484$^{NS}$ | 0.547 | 0.885 | 0.376 |
| Mono-cropping | 0.692$^{NS}$ | 0.500 | 1.386 | 0.166 |
| Non-farm income (`/annum) | -0.091$^{NS}$ | 0.262 | -0.347 | 0.728 |
| Number of fragment | 0.003$^{NS}$ | 0.082 | 0.036 | 0.972 |
| Total land (ha) | -1.244$^{**}$ | 0.565 | -2.203 | 0.028 |

******, ** and * show significance at 1, 5 and 10 per cent level of probability.***
***NS: Non-significant.***

## CONCLUSIONS

Agriculture is the primary source of livelihood for the majority of the population of Uttar Pradesh. About 59 percent of the population of Uttar Pradesh directly or indirectly depends on agriculture and allied sectors. Without land agricultural production cannot be imagined. With the increase in population, people's requirements have become complex, resulting in changes in land use, cropping patterns, and irrigation patterns. Industrialization attracted people to urban areas, which provided them with better job opportunities. Rapid population growth followed by industrialization and urbanization has depleted resources and changed land use patterns. Changes in land use patterns cause land degradation**.** In Uttar Pradesh, the total wasteland area was 8537.06 sq km in 2015-16, which decreased by 1082.29 sq. km. over 2008-09 (9619.35sq km). In the Kushinagar district of the northeastern plain zone, education and migration were significant causes of land degradation during the study period. In Lucknow district, the causal factors for land degradation were identified as fertilizer use, mono-cropping, non-farm income and total land. In the Shahjahanpur district of the mid-western plain zone, fertilizer use, family labour, leased-out land, and total land were significant causes of land degradation. Sustainable agricultural development is the only remedy to control land degradation.

## Consent

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

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1.

2.

3.

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