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Research Paper

Economic Implications of Land Degradation in Rajasthan: An Assessment

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ABSTRACT

This study was carried out to estimate the economic losses caused by land degradation in different agro-climatic zones of Rajasthan. The economic losses were calculated by using an estimation model based on the amount of degraded land in each zone multiplied by the total value of output per hectare. Economic losses due to land degradation in the state as a whole ₹ 55.24 billion per year at 2017-18 prices. The highest losses were reported in the flood-prone eastern plain (₹ 10.67 billion) and the lowest in the Luni basin transitional plain (₹ 1.37 billion). The magnitude of economic losses in Rajasthan varied according to the severity of degradation, climatic factors, farming activities (including the number of crops cultivated and crop productivity) across agro-climatic zones.

Highlights

- Rajasthan loses ₹ 55.24 billion every year at 2017-18 prices in terms of the economic losses due to land degradation.
- In Rajasthan the highest economic losses were observed on the flood-prone eastern plains zone due to higher agricultural activities.
- Wind erosion (55.91%) and water erosion (42.26%) contribute major portion to total land degradation in Rajasthan.
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Keywords: Economic losses, land degradation, water erosion, wind erosion

Land is a vital resource for the production of food, forestry, biodiversity, natural water management and acting as a carbon store. Land is a key agricultural input and one of the key resources needed for a modern economy (Ramasamy *et al*. 2005). One of the major agendas of the overnment of India on farming policies in recent years has been to improve farm incomes mainly by increasing productivity. However, one of the most serious environmental issues impeding Indian agriculture is land degradation. Worldwide, approximately 1100 million hectares is affected by land degradation. Water erosion affects 56 per cent of the total degraded area, whereas wind erosion affects about 28 per cent of the total degraded land area (Oldeman, 1994). Around 52 per cent of total productive land has been degraded by various degradation processes

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worldwide, and water erosion affects around 80 per cent of terrestrial land (UNCCD, 2015). Water erosion is a major problem among various land degradation processes, affecting 68.4 per cent of India's total land area (ICAR and NAAS, 2010 and Bhattacharyya *et al.* 2015). Land degradation is the decline in an ecosystem's productive capacity caused by a variety of both man-made and natural factors. Overexploitation of forest and agricultural lands, increasing urbanization and industrialization, and increasing overstocking of grazing lands are all examples of human factors. Natural factors include salinity and alkalinity, as well as droughts, floods, and water logging. Land degradation is a major threat not only for the present generation, but also for the future generations towards sustainable agricultural production and food security. The loss of the productivity of the scarce resource like land would severely affect the livelihoods of the majority of human and animal populations, in particular the degrading of the ecosystem and the component of the land.

Land degradation is a major concern not only for India, but also for Rajasthan agriculture, on which the majority of the population depends for their livelihood. Many policies and programs have been implemented in Rajasthan over the last few decades to address this issue, but the results have been disappointing (Sharma *et al.* 2014a). The analysis of the causes and extents of land degradation is critical for developing appropriate policies to address the degradation problem. Keeping the preceding context in mind, it is worthwhile to estimate the economic losses caused by land degradation, which threatens the sustainability of agricultural production in the state of Rajasthan.

MATERIALS AND METHODS

Rajasthan is India's largest state in terms of area, encompassing 342239 km^2 (or 10.40% of India's total geographical area), lies on the western side of India, between 23° 30′ to 30.11′ North latitude and 69° 29′ to 78.17′ East longitude. Rajasthan state has been divided into ten agro-climatic zones based on climatic conditions and prevalent agricultural practices, each with its own distinct characteristics. Across the agro-climatic zones, there are significant differences in land use pattern, rainfall, temperature, humidity, wind velocity, and sunshine duration. The eastern and southern parts of Rajasthan are wetter, hillier, and more fertile, whereas the northern and western parts of Rajasthan are generally sandy and dry. In Rajasthan, the temperature ranges from 49°C in the summer and drops to -2°C in the winter. The annual rainfall average ranges from less than 100 mm to 1100 mm. Therefore, the state of Rajasthan was purposefully chosen for the study.

The model uses the extent of degraded land in each zone (estimated by ICAR and NAAS) multiplied by the per hectare total value of output to calculate the economic losses due to land degradation (*ELn*). This model used to calculate the economic losses caused by land degradation was as follows.

$$ELn = SX_{dlk} * [(SY_{ik} * P_{ik})/N_K]$$

ELn = Economic losses as a result of land degradation

Y_{ik} = amount of crop output in the k^{th} district/region

P_{ik} = farm harvest price of crop in the k^{th} district/region

N_k = net sown area in k^{th} district/region

X_{d1k} = area under d^{th} category of degraded land and l^{th} group of losses in the k^{th} district/region

A sensitivity analysis serves as a way to determine the robustness of results *b* considering the extent to which changes in variable values affect the results. The sensitivity analysis for economic losses was also performed by assuming 10 per cent higher and 10 per cent lower in prices of agricultural crops than prices under consideration.

RESULTS AND DISCUSSION

Extent of land degradation in Rajasthan

Rajasthan as a whole was subjected to 11 different kinds of degradation viz., (i) exclusively water erosion (>10 tonnes/ha/year), (ii) water erosion under open forest, (iii) exclusively wind erosion, (iv) exclusively saline soils, (v) eroded saline soils, (vi) saline soils under wind erosion, (vii) exclusively sodic soils, (viii) eroded sodic soils, (x) sodic soils under wind erosion, (x) sodic soils under open forest, and (xi) eroded sodic soils under open forest. Later on, all these compressed into four broad classes, viz., water erosion, wind erosion, saline soils and sodic soils. The extent of land degradation

caused by various factors thathas been depicted in Table 1.

It is evident from Table 1 that total area under different kinds of degraded land in Rajasthan state was accounted about 20424 thousand hectares. About 11419 thousand hectare area was affected with wind erosion followed by water erosion (8632 thousand hectares). Chemical degradation was estimated to affect 373 thousand hectares area; out of this 192 thousand hectare was affected by salinity, and 181 thousand hectares by sodicity. Out of total degraded lands, 55.91 per cent area was affected by wind erosion, followed by water erosion (42.26%), sodicity (0.94%) and salinity (0.89%). Sharma *et al.* (2015) found that 67 per cent of area was affected by desertification and/or land degradation in Rajasthan, where the wind erosion (44.2%) was the maximum contributor followed by water (11.2%), and salinization (1.07%). The percentage of land degradation in relation to total geographical area was revealed about 59.68 per cent, which ranged from 98.19 per cent in humid southern part to 24.72 per cent in transitional plain of Luni basin. The extent of land degradation was observed greatest in the hyper-arid partial irrigated zone (6273 thousand hectares), followed by arid western plain (3163 thousand hectares) and sub-humid southern plains (2524 thousand hectares) and lowest land degradation was noticed in Irrigated North Western Plain (672 thousand hectares).

Water erosion and wind erosion were the main causal factors for degradation of land in different agro-climatic zones of Rajasthan. Water erosion was dominant in Humid Southern Eastern Plain, Humid Southern, Sub-Humid Southern Plains, Flood Prone Eastern Plain, Semi-Arid Eastern Plain and Transitional plain of Luni basin, and wind erosion in Arid Western, Irrigated North Western Plain, Hyper Arid Partial Irrigated, and Inland Drainage Dry region. These regions covers parts of the Thar Desert, hence, wind erosion are the major cause of land degradation in Rajasthan followed by water erosion. Narain *et al.* (2000) suggested that alternate strips crops such as pearl millet, moong, moth and cluster beanss, and shelter belts plantation of tree like *Zizyphus nummularia, Harrdwickia binata, Prosopisj uliflora* in pyramid shape can check wind erosion effectively while bench terracing, contour bunding and contour furrowing in watersheds and contour vegetative barriers of grasses such as *Cyrnbopogan jwarancusa*, *Cenhrus ciliaris* (buffel grass), *Cenchrus setigerus* may prevent water erosion.

Economic losses due to land degradation

Table 2 explains economic losses due to land degradation in different zones of Rajasthan. The total economic loss due to land degradation was estimated about ₹ 55.24 billion based on 2017-18 prices. The maximum loss due to land degradation in Rajasthan (₹ 10.67 billion)was reported in flood prone eastern plain, followed by hyper arid partial irrigated western plain (₹ 9.84 billion), sub-humid southern plains (₹ 9.38 billion), humid southern eastern plain (₹ 9.16 billion), Semi-arid eastern

Table 1: Extent of Land Degradation in Different Zones of Rajasthan ('000 ha)

Agro-Climatic Zones	Water erosion	Wind erosion	Saline	Sodic	Total degraded land	Degraded land out of total land (%)
IA: Arid Western	0 (0)	3143 (99.37)	16 (0.51)	4 (0.13)	3163 (100)	62.34
IB: Irrigated North Western Plain	1 (0.15)	514 (76.49	78 (11.61)	79 (11.76)	672 (100)	32.56
IC: Hyper Arid Partially irrigated Zone	1 (0.02)	6218 (99.12)	46 (0.73)	8 (0.13)	6273 (100)	75.88
IIA: Internal Drainage dry zone	7 (0.52)	1298 (97.16)	31 (2.32)	0 (0.0)	1336 (100)	42.69
IIB: Transitional Plain of Luni Basin	436 (62.82)	245 (35.3)	3 (0.43)	10 (1.44)	694 (100)	24.72
IIIA: Semi-Arid Eastern Plain	1058 (97.15)	1 (0.09)	17 (1.56)	13 (1.19)	1089 (100)	36.20
IIIB: Flood Prone Eastern Plain	1729 (98.86)	0 (0.0)	1 (0.06)	19 (1.09)	1749 (100)	67.47
IVA : Sub Humid Southern Plain	2478 (99.76)	0 (0.0)	0 (0.0)	46 (1.82)	2524 (100)	69.29
IVB: Humid southern	822 (100)	0 (0.0)	0 (0.0)	2 (0.24)	824 (100)	98.19
V: Humid Southern Eastern Plain	2100 (100)	0 (0.0)	0 (0.0)	0 (0.0)	2100 (100)	86.35
Rajasthan State	8632 (42.26)	11419 (55.91)	192 (0.94)	181 (0.89)	20424 (100)	59.68

Source: *ICAR and NAAS (2010), Figures in parentheses denote percentage of total degraded land.*

Table 2: Economic Losses due to Land Degradation in Different Zones of Rajasthan

Agro Climatic Zones	Degraded land ('000 ha)	Value of output * (₹/ha)	Economic losses (billion rupees)
IA: Arid Western	3163	977.72	3.09
IB: Irrigated North Western Plain	672	4229.50	2.84
IC: Hyper Arid Partially irrigated Zone	6273	1568.80	9.84
IIA: Internal Drainage dry zone	1336	2064.70	2.76
IIB: Transitional Plain of Luni Basin	694	1975.40	1.37
IIIA: Semi-Arid Eastern Plain	1089	3411.50	3.72
IIIB: Flood Prone Eastern Plain	1749	6099.80	10.67
IVA : Sub Humid Southern Plain	2524	3717.50	9.38
IVB: Humid southern	824	1925.10	1.59
V: Humid Southern Eastern Plain	2100	4363.70	9.16
Rajasthan State	20424	2704.60	55.24

Note: **Information is based on author's own research work and calculation.*

Table 3: Economic losses due to land degradation under two alternative scenarios

Agro Climatic Zones	Economic losses (billion rupees)		
	Current scenario	Scenario-I*	Scenario-II**
IA: Arid Western	3.09	3.40	2.78
IB: Irrigated North Western Plain	2.84	3.12	2.56
IC: Hyper Arid Partially irrigated Zone	9.84	10.82	8.86
IIA: Internal Drainage dry zone	2.76	3.04	2.48
IIB: Transitional Plain of Luni Basin	1.37	1.51	1.23
IIIA: Semi-Arid Eastern Plain	3.72	4.09	3.35
IIIB: Flood Prone Eastern Plain	10.67	11.74	9.60
IVA : Sub Humid Southern Plain	9.38	10.32	8.44
IVB: Humid southern	1.59	1.75	1.43
V: Humid Southern Eastern Plain	9.16	10.08	8.24
Rajasthan State	55.24	60.76	49.72

**Scenario-I: Increased economic losses by 10 per cent due to anticipated growth in farm harvest prices.*

***Scenario-II: Reduced economic losses by 10 per cent due to anticipated reclamation of degraded lands.*

plain (₹ 3.72 billion), Arid western (₹ 3.09 billion), irrigated north western plain (₹ 2.84 billion), internal drainage dry (₹ 2.76 billion), humid southern (₹ 1.59 billion), and transitional plain of luni basin (₹ 1.37 billion).

The extent of losses varied with the amount of land degraded and the total value productivity. Vasisht *et al.* (2003) observed that India loses ₹ 285.51 billion annually at 1995·97 constant prices which was around 12 per cent of total value of agricultural output in the country. Sharda *et al*. (2010) and Sharma *et al*. (2015) estimated losses of total value of agriculture due to water erosion, sodicity and salinity was ₹ 10266, ₹ 433 and ₹ 3938 million, respectively in Rajasthan based on 2014-15 prices. Raju *et al.* (2017) estimated monetary loss of rupees 23.81 million in food grain production of Haryana state due to land degradation. The annual economic loss due to land degradation and change in land use in India was valued at ₹ 3.17 lakh crores i.e. 2.54 per cent of India's GDP in 2014-15 by The Energy and Resource Institute (TERI, 2018).

Sensitivity Analysis

Reclamation measures may result in extent of land degradation over the time period or it might increase due to the anticipated growth in prices of agricultural output. To capture this sensitivity, analysis was also performed in two scenarios. Scenario-I studied the 10 per cent higher extent of degradation and Scenario-II studied the 10 per cent lower extent of degradation. The results were portrayed in the Table 3. Table elucidate that total economic loss under Scenario-I was reported to be

₹ 60.76 billion, where as it was ₹ 49.72 billion in Scenario-II. Extent of economic losses due to land degradation over two scenarios in the different zones was observed to follow the same pattern as was observed in original scenario. Effective implementation of the silviculture system is necessary to reduce the economic losses caused by land degradation.

CONCLUSION

On the basis of the foregoing results, it is clear that roughly 59.68 per cent of the area of Rajasthan is degraded by different kinds of degradation. Rajasthan loses ₹ 55.24 billion every year at 2017-18 prices in terms of the economic losses due to land degradation. The magnitude of economic losses in Rajasthan varies widely due to the severity of degradation, climatic factors, and cropping patterns across different agro-climatic zones. In Rajasthan the highest economic losses were observed on the flood-prone eastern plains zone, because in this zone, there were higher agricultural activities, such as number of crop and their productivity. Wind erosion and water erosion were the two main causes of land degradation in Rajasthan. Reclamation of degraded areas in Rajasthan calls for a strict land-use policy, better land regulation and reinforcement of watershed management initiatives including afforestation and other programmes aimed at conserving soil and water.

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