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Research Article

A Macroeconomic Analysis of Forest Land Degradation in the State of Jharkhand: The Total Economic Value (TEV) Approach

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Abstract

Jharkhand State contains 31.51% under total forest cover of its geographical area, currently experiencing high degradation rates, thus highlighting the need for conservation efforts and change in the forest management practices. The full potential of the forests in the state has never been quantified, the economic valuation approach considering both the use value and non-use value is capable of estimating the full range of benefits provided by the forests in the state. In the case of Jharkhand, forest degradation is a cause of concern rather than deforestation, as more than 45% of forests are unproductive. Soil erosion and vegetal degradation are the two major determining factors that increase land degradation in Jharkhand. The analysis of causes of land degradation and their extent is also very important in designing suitable policies to overcome degradation. This paper identifies the actual benefits derived due to the state's conservation and forest management practices. The Total Economic Value (TEV) concept has been used in deriving the costs and benefits. The analysis of the cost of action versus inaction indicates the benefits that will accrue if the right approach and efficient conservation practices are undertaken.

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1. INTRODUCTION

Forest cover and Recorded Forest Area (RFA) are the two terms generally used by the Forest Survey of India (FSI) to depict the status of forests in India. Forest Cover on the one hand gives information about the forest canopy area covered on the ground irrespective of the actual forest canopy cover on the ground. The recorded forest area of Jharkhand is 25118 sq. km (2.5 Mha) covering 31.51% of Jharkhand's geographical area. On the other hand, the total forest cover of Jharkhand is 23,721 sq. km (2.37 Mha) which is 29.75% of Jharkhand's geographical area (FSI, 2021). Apart from the area recorded as forest and tree cover, Jharkhand has 58400 ha of Scrub (degraded forest with canopy density <10%) (FSI, 2021). The difference between the Recorded Forest Area and Forest Cover is 1.4 Lakh Ha (1,397 sq. km) which is the blank area in the Recorded Forest Area (RFA) and is excluded from the assessment of Forest Cover. Similarly, the Forest Cover of 23,721sq.km include all the tree patches that have a canopy density of more than 10% and are one hectare or more in size, irrespective of land use, legal status, and ownership. So, the forest cover area mentioned also includes green areas of non-forest land. India's State of Forest Report indicates that Jharkhand's Forest cover has stabilized. However, the India State of Forest Reports do not provide disaggregated data on plantation and natural forests. The real status of

Jharkhand's natural forests will only become clear once this disaggregation is done (Md Omar Sarif, C. Jeganathan, et al, 2017). While the forest cover has stabilized degradation is an issue. As per the FSI, 2021 report 0.26 Mha (3.26% of geographical area) is under Very Dense Forest (VDF), 0.97 Mha (12.15% of GA) is under Moderately Dense Forests, while as much as 14.33% (1.14 Mha) is under Open Forests (OF) and 0.73% of GA (0.58 Mha) is under scrub (Fig. 1). Apart from VDF and MDF forest, the other two categories i.e. open forest and scrub are considered a degraded forest, hence resulting in a total degraded area of 1.2 Mha i.e. 15% of GA of Jharkhand. According to the latest SAC Atlas (2016), vegetal degradation ranks second to water erosion in terms of area degraded. The knowledge of the benefits forfeited when forest utilization becomes unsustainable is important in making choices between the conservation and restoration of forest ecosystems for the continued provision of valued ecosystem goods and services (Kalaba, 2014). However, the economic valuation of these goods and services requires quantification and measurement which include demanding tasks (Kalaba, 2014). In the present study, the economic impacts of forest degradation are calculated using the Total Economic Value (TEV) Framework (MEA). The TEV approach captures the total costs of forest degradation more comprehensively (Nkonya *et al.,* 2013) than other methods.

2. OBJECTIVES

The major objectives of this study are to scientifically support policy actions in Jharkhand on sustainable forest management, and are as below;

(i) The key causes of forest degradation in the state of Jharkhand.
(ii) To calculate the costs of degradation or the benefits lost due to the non-conversion of a high-value biome from a low-value biome (i.e. the non-conversion of open forests to moderate dense forests and very dense forests) due to the present management practices in terms of TEV approach.

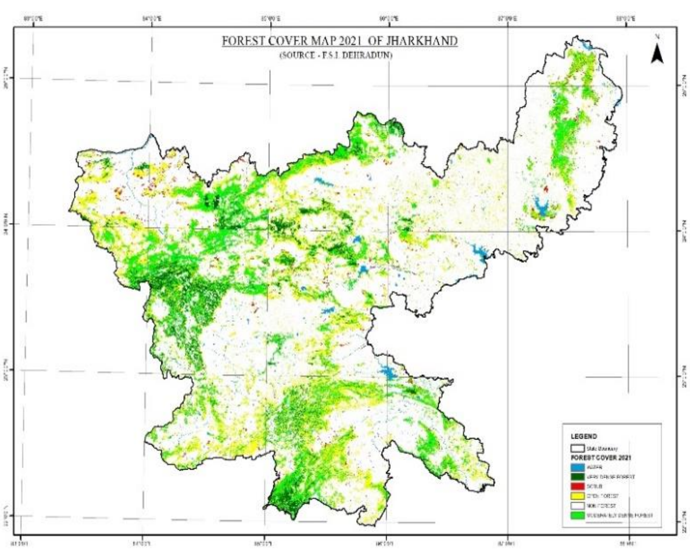


Fig 1: Map showing forest cover of Jharkhand, Source: FSI, Dehradun

Trends of Jharkhand Forests

The Forest Survey of India (FSI) regularly assesses the status and trends of forest in India and publishes the data in the State of Forest Reports (SFRs) since 1987 in a biennial manner. Change in forest resources between two successive assessments is an important indicator of the gain or loss of forests in the states and the country as a whole. Due to innovative measures in the conservation and protection of forests and a strong policy framework, especially after the enactment of the Forest Conservation Act, 1980, and the Godavarman judgment of the Hon'ble Supreme Court of India (1996), the deforestation rate is almost negligible in India. The forest cover in Jharkhand is 23.72 lakh hectares (2021) and there was an increase at the rate of 0.47% compared to the previous year. This increase is mainly due to the afforestation programmes of the state like CAMPA, plantation under Plan schemes in forest areas, and other schemes on non-forest areas. However, the existing forests are deteriorating in the quality of forest cover as well as their productivity in the state. With the data cumulated from the ten ISFRs (2003 to 2021), we have calculated the trends of the three categories of forests i.e. Very Dense Forest (VDF), Moderately Dense Forest (MDF), and Open Forest (OF), hereby graphically represented (Table 1 & Fig. 2).

All the components of forest cover have recorded an increase as in 2021 compared to the year 2003. However, the Moderately Dense Forest (MDF) was maximum in the year 2011 with 9.9 lakh hectares and decreasing gradually to 9.6 lakh hectares in 2021. If the data of the aforementioned three categories are compared from the year 2007 till 2021, there is negligible change in Very Dense Category, there in a decrease of forest cover in Moderately Dense Forest and there is a significant increase in open forest from 1.0 Mha to 1.1 Mha. The forest cover in Jharkhand state increased over some time, the one main accelerant is due to plantation done under various schemes, the forest cover increase was mainly observed in the category of open forest which was 10.23 lakhs hectares in 2007 to 11.43 lakh hectares in 2021. But, the assessment of forest cover by FSI using satellite imagery is often criticized by several authors like Puyravavd *et al.,* 2010, as it fails to distinguish native forest from tree plantations, which are often monocultures of exotic species that have limited value for endangered biodiversity (Gorain and Malakar, 2020). Several authors have claimed that the increase is due to exotic tree plantation such as Eucalyptus and Acacia having absolutely no value to conserve the native forest ecosystems. In Jharkhand state, as per the FSI report 2021, the relative abundance of *Acacia auriculiformis* was found to be 8.25% (in TOF) which includes block plantations etc.

Table 1: Category of Forests in various density classes, Jharkhand

Category of Forest	2003	2005	2007	2009	2011	2013	2015	2017	2019	2021
VERY DENSE FOREST (V.D.F)	254400	254400	259500	259000	259000	258700	258800	259800	260300	260100
MODERATELY DENSE FOREST (M.D.F)	913700	907800	989200	989900	991700	966900	966300	968600	968700	968900
OPEN FOREST (O.F)	1103500	1096900	1023500	1040500	1047000	1121900	1122700	1126900	1132000	1143100
SCRUBS	80700	73300	0	68300	68300	67000	0	66900	68800	68400

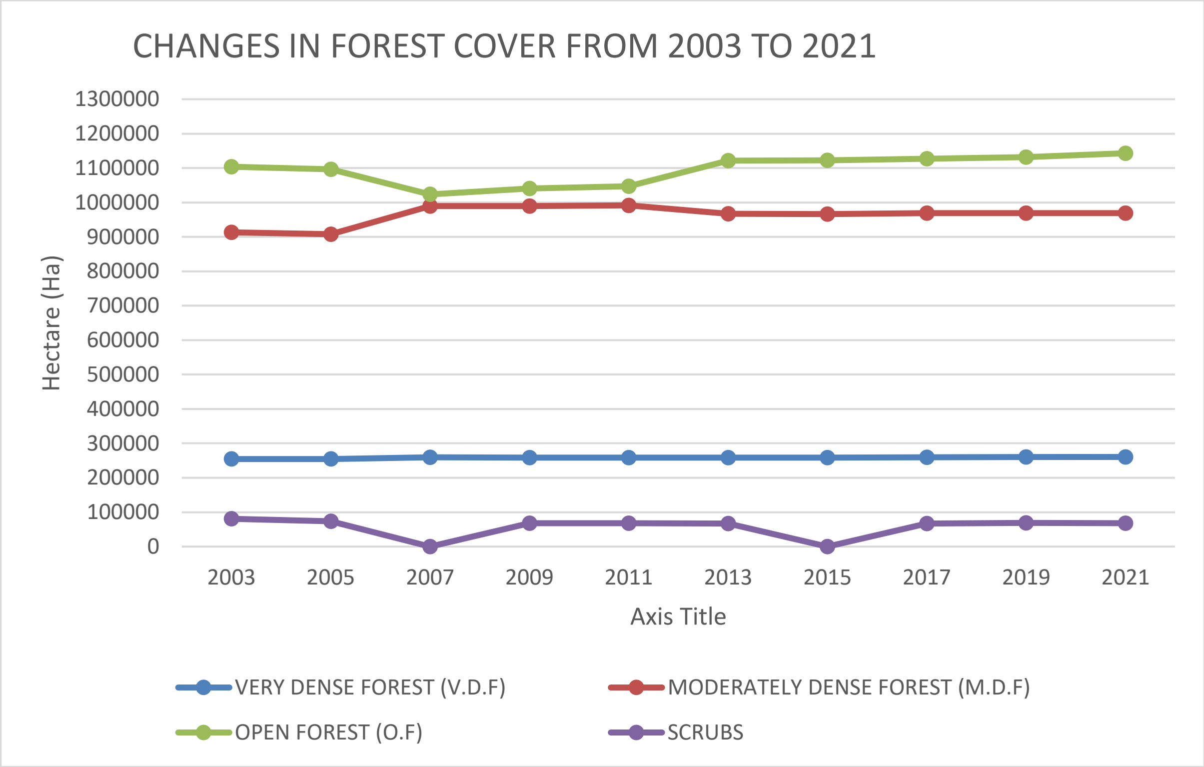


Fig 2: Graph showing the change in forest density classes

a) Growing Stock

However, there is no significant change in forest canopy density since the year 2007, the change matrix was negligible, in fact the area under Moderately Dense Forest has reduced. For further clarity the status of growing stock was analysed for Jharkhand state. In the year 2009 it was 103.78 MCM, and reached highest in the year 2017 to 117 MCM and declined to 100.8 MCM in the year 2021. A trendline for growing stock suggests that the growing stock would reduce gradually till the year 2040. But in ideal conditions the potential growing stock should have been much higher. The potential growing stock in the recorded forests of Jharkhand was calculated to be 178.9 MCM in 2021 as compared to the present figure 100.8 MCM (as calculated in SFR, 2021). And in the year 2040 the actual growing stock would be 112.36 MCM, which is significantly less as compared to the potential growing stock of 203.94 MCM, provided the forest management practices and other interventions are improved. For the sake of calculation of the potential growing stock, the rate of increase between the year 2013 to 2015 was considered as there was significant rate of increase in GS during that period (*Fig. 3 & 4*).

Table 2: Growing stock in recorded forest area and their corresponding potential growing stock (2003-2040), in Million Cubic Meters (MCM)

Year	Growing stock in RFA (MCM)	Potential GS (MCM)
2003	96.93	96.93
2009	103.78	103.78
2011	116.3	116.3
2013	103.73	128.82
2015	112.65	141.34
2017	117	153.86
2019	96.22	166.38
2021	100.8	178.9
2030	110.83	191.42
2040	112.36	203.94

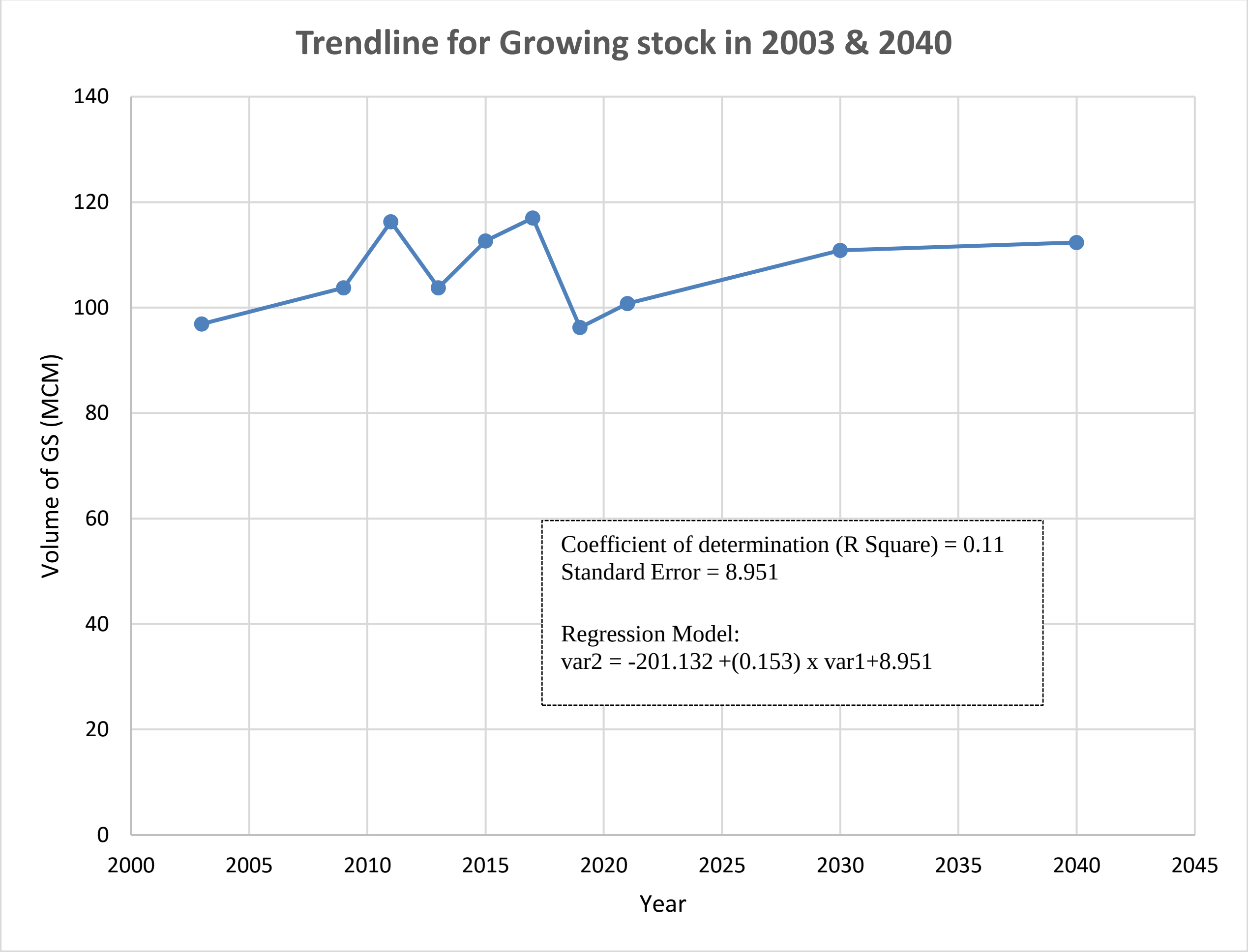


Fig 3: Graph showing the trendline of the volume of growing stock

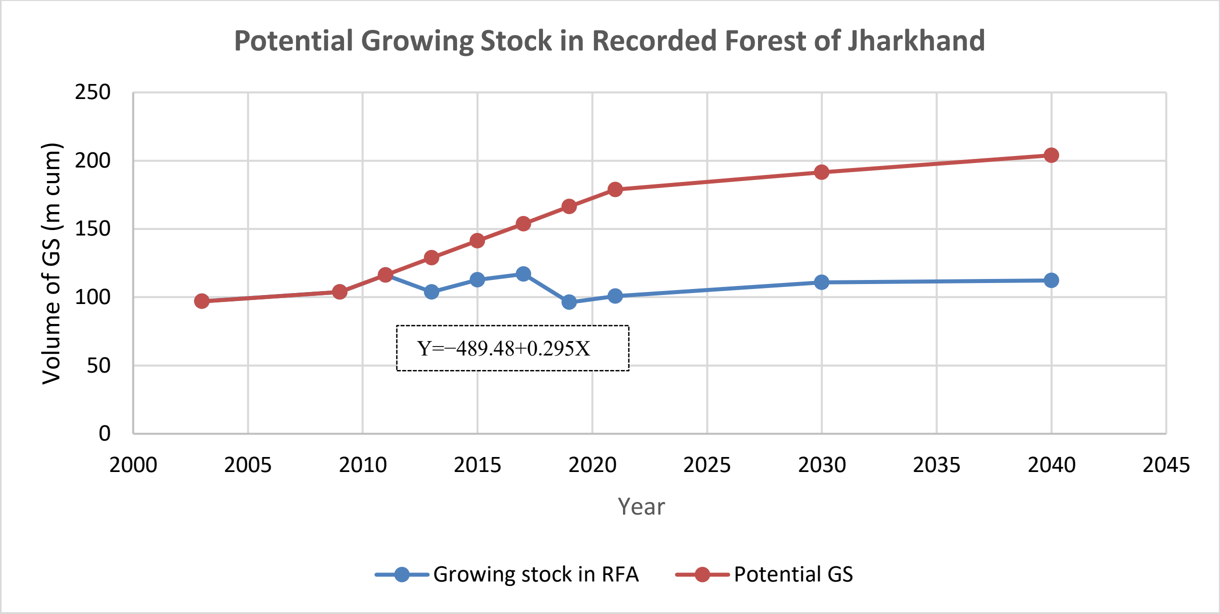


Fig 4: Graph showing the potential growing stock in the recorded forest of Jharkhand (2003-2040)

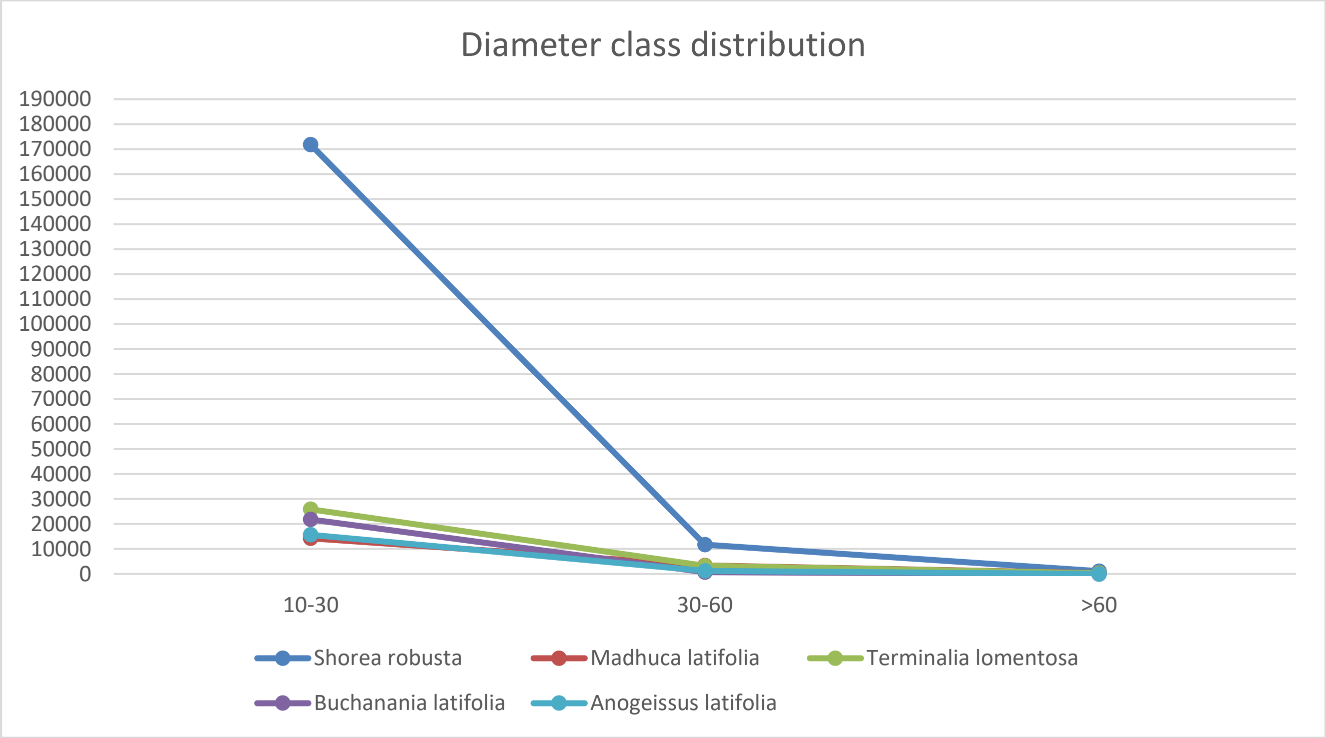


Fig 5: ND Curve of 5 dominant species of Jharkhand

b) The ND -Curve

The N-D curve for five dominant species i.e. *Shorea robusta*, *Madhuca latifolia*, *Terminalia lomentosa*, *Buchanania latifolia* and *Anogeissus latifolia* has been graphically represented (*Fig. 5*). The dominant species being *Shorea robusta* (sal), the enumeration data of diameter class distribution clearly shows that of total 1951 lakh Sal trees are in Jharkhand's forests of which 1818 lakh tree fall in the dia class 10-30 cms, 125 lakh trees in dia class of 30-60 and only 8.3 lakh Sal trees in dia class of >60 cms. Similar, trends have been observed in other species as well. In the case of *Shorea robusta* 93.1% fall in the diameter class of 10-30 cms. The ND curve ideally should have been inverse J-curve for uneven aged forests with a gradual curve, where the new recruits are continuously coming and there is a continuous shift of trees from one dia class to another. Many regeneration studies were conducted and it was observed that, the population structure of five dominant tree species decreased from young to old, and seedlings and saplings contributed to the highest density (98.21% of the total tree density). There was a decline in tree density with an increase in girth class in S. robusta, and mature trees with higher girth (>120 cm) were very few (9.3%) which signifies the ongoing natural regeneration, as well as both anthropogenic and natural disturbances in the studied Sal forest of Ranchi (Rahul Kumar and Purabi Saikia, 2017). Their study confirmed the enormous natural regeneration potential of S. robusta with a seedling density of 22071 individuals per hectare. They further confirmed that the degradation of forests is due to recurrent anthropogenic disturbances like felling, grazing, looping, fuel wood collection, forage removal, etc.

c) Carbon stocks

It is estimated by FSI that the total volume of growing stock (MCM) in Jharkhand state is 175.15 including TOF which is 74.35 MCM (which includes plantations etc). The total carbon stock of forest in the state including TOF patches that are more than 1 ha in size is 184.81 million tonnes (677.64 million tonnes of CO_2 equivalent) which is 2.57% of total forest Carbon of the country. The soil organic carbon is the largest part of forest carbon accounting for 59% followed by above-ground biomass (AGB) which is 27%, below-ground biomass (BGB) consisting of 10%, litter is 0.01% and dead wood 0.004% of total carbon, (FSI, 2021). As per the Global Forest Watch Report, between 2001 to 2023, forests in Jharkhand emitted 136 ktCO_2e/year and removed -2.19 MtCO_2e/year. This represents a net carbon sink of -2.05 MtCO_2e/year.

Status of Forest Land Degradation in Jharkhand

The terms land degradation and desertification, have a close relationship and several attempts to define and describe them have been made (UNEP 1991); (Conacher and Sala 1998, Oldeman *et al*.,1990). Desertification was redefined by (UNEP 1991), in the sense of considering it as 'the land degradation in arid, semi-arid and dry semi-humid areas resulting mainly from adverse human impact.' Land degradation accelerated during the twentieth century due to increasing and combined pressures for agricultural production and livestock production (overgrazing, forest conversion), urbanization, deforestation, and extreme weather events, such as drought and coastal erosion that cause soil salinity (Delang 2018, Janeckova *et. al*., 2023). Developing countries are more vulnerable to desertification and land degradation because they lack the infrastructure and capital to deal with these threats and implement land management in a sustainable manner (ELD Initiative 2013). So, a global initiative should be undertaken to raise awareness of the economic consequences of land degradation and promote sustainable land management. This initiative should aim at a global study on the economic benefits of land and terrestrial ecosystems. It also should provide a global approach to analyzing the economics of land degradation and should aim to make the land degradation economy an integral part of policy and decision-making strategies by increasing political and public awareness of the costs and benefits of land and land ecosystems.

The statistical summary and analysis of the land degradation of Jharkhand State reveal that 68.77% i.e. 5.48 Mha of the geographical area is undergoing desertification/land degradation (*Fig. 6*). The most significant process of desertification/land degradation in the state is water erosion (49.12%) followed by vegetation degradation i.e. 17.81% in 2018-19 (*Table 3*). Between the year 2011 to 2019 increase in degraded area was mainly due to manmade activities, and forest area/scrub land undergoing vegetation degradation. Forest degradation accounts for over 55 percent of the total economic loss due to vegetation degradation while water erosion accounts for about 14 percent of the total economic loss of desertification (Aarti Kelkar Khambete (India water portal), 2018). The annual economic costs of forest degradation was valued at 17,58,574 million (2014-15 prices) which is 2.08% of GDP (2014-15), (Pia Sethi, 2018). Overall forest degradation accounts for 40% of the costs of land degradation in the country and forest loss and forest degradation together account for 56.6% of the total costs of land degradation and land use change in the country. Unsustainable forest management results from deforestation, degradation, overgrazing, conversion to other land uses, forest fires, excessive fuel wood collection, and unsustainable harvest of non-timber forest products (Nachtergaele *et.al*, 2010, Meyfroidt and Lambin, 2011, GLASOD). The GLASOD (Global Assessment of Soil Degradation) assessment cites deforestation as the cause for 98% of areas affected by soil erosion as well as an important contributor to salinization.

Table 3: Drivers of land degradation in Jharkhand (%)

Causes for Land degradation	**2018-19**	**2011-13**	**2003-05**
Vegetation Degradation	17.81	17.3	16.4
Water Erosion	49.12	50.64	50.65
Manmade	1.2	0.66	0.62
Settlement	0.65	0.38	0.31
Total	**68.78**	**68.98**	**67.98**

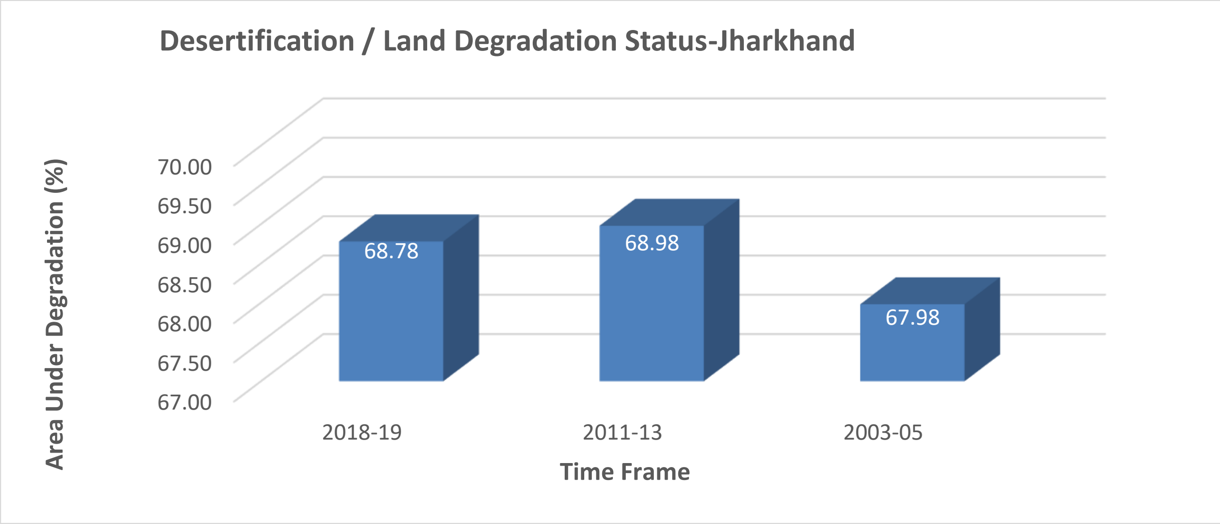


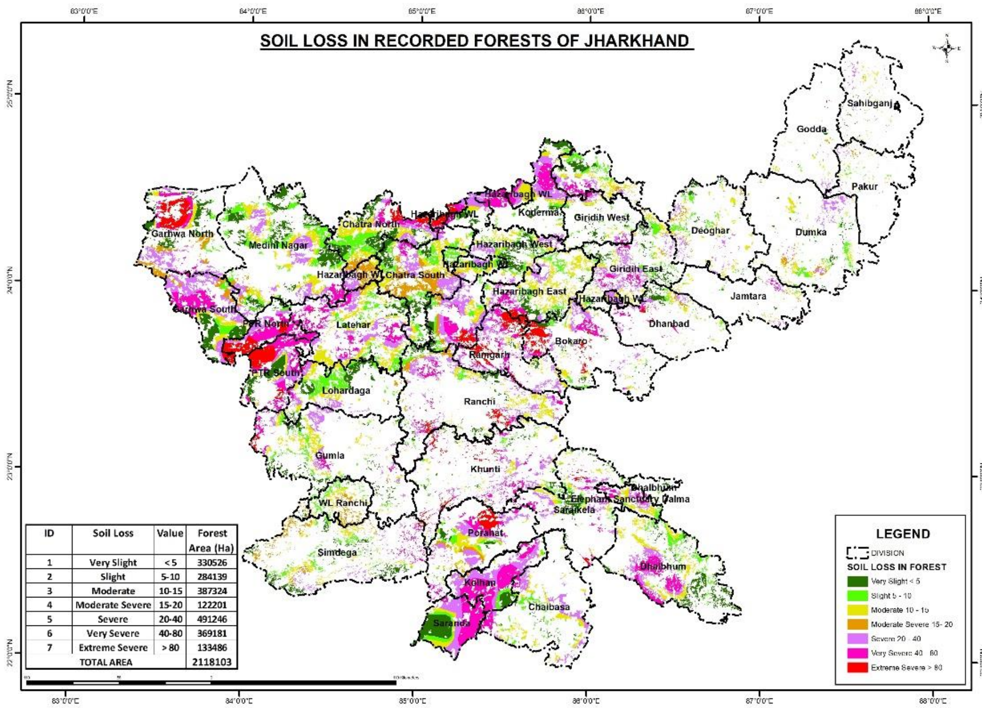
Fig 6: Area under degradation (%)

The vegetation health of Jharkhand between the periods 1982 to 2006 has been analyzed. The long term NDVI (1982-2006) map shows the negative trend in seven northwest districts of Jharkhand State. These are Hazaribagh, Ramgarh, Palamau, Lohardaga, Chatra, Garhwa and Latehar districts. The forest, as well as the agriculture of these districts lost their greenness during this time period (1982-2006). A similar identification of negative change assessment using long term NDVI was done by Chakraborty *et al*., 2018. The forests of these areas have deteriorated a lot over the long-term duration (Ahmad & Goparaju, 2017). Further the study by Ahmad and Goparaju (2017) revealed that the approximate forest percent calculated based on grid analysis for the year 1935 was 49% where as for the year 2015 it was 23% when compared with the total geographical area of Jharkhand. The driving factors of deforestation between the period 1935 and 2015 were industrialization, urbanization, mining activity and conversion of forest land to other land use purpose. Within the state, the losses of forest ecosystems are more pronounced in those area where population was high which resulted into forest loss by various anthropogenic activity. Roughly 53% of the forest area has been lost between these periods. The deforestation within the state of Jharkhand which is at such alarming rate is concern for forest policy/decision makers. (Ahmad and Goparaju, 2017). The forest degradation and fragmentation are directly affecting the wildlife habitat with increase in human animal conflict in the state of Jharkhand.

Causal Reasons for Forest land Degradation

a.) **Soil Erosion**

Jharkhand is the state with highest area under desertification/land degradation in the country with respect to state TGA i.e. 69.98% and is increasing at the rate of 1.01% since 2002-05. In the last few decades, immense human interference like industrializations, over exploitation of forest resources, settlement encroachment, heavy construction works, mining activities are some of the major causes of vegetation degradations and deforestation (Ren *et al*., 2021; Sonter *et al*., 2017) in Jharkhand. In the state of Jharkhand water erosion contributes for maximum land degradation which is 49.12% followed by vegetation degradation which is 17.81%. The soil loss in the recorded forest under different classes is presented below in the (*Fig. 7*). It indicates that about 330526 ha. area (15.6%) is under the very slight erosion class which is mainly covering the forest in the district of Medininagar, Chatra, Hazaribagh, Lohardaga, Latehar, Saranda etc. Moderate and moderately severe classes cover over 5,09,525 Ha. (23.9%) area restricted to hilly areas and extreme terrains of PTR North & South, North of Garhwa, Chatra and Hazaribagh Wild Life, Southern part of Hazaribagh district, Southern district of Porahat, Kolhan, North and Eastern part of Saranda etc. Very severe to Extremely severe soil erosion classes are found in Hazaribagh, Palamu, Ranchi, East and West Singhbhum and an approximate area 502667 ha of recorded forest area are affected under these classes.



ID	Soil Loss	Value	Forest Area (Ha)
1	Very Slight	< 5	330526
2	Slight	5-10	284139
3	Moderate	10-15	387324
4	Moderate Severe	15-20	122201
5	Severe	20-40	491246
6	Very Severe	40-80	369181
7	Extreme Severe	> 80	133486
	TOTAL AREA		2118103

Fig 7: Map showing the intensity of soil erosion in recorded forests of Jharkhand

The soil loss tolerance determines the maximum limit of soil erosion that will permit tree or crop productivity to be sustained economically and indefinitely. Unlike field crops where organic and inorganic fertilizers are added to maintain soil productivity and improve crop production, no such application is done in natural forests, the nutrients are obtained from the soil pool. Considerable work has been done on this aspect and the tolerance limits ranged from 4.5 to 11.2 t ha^{-1} yr^{-1} (Mannering, 1981). Soil loss over 11.2 t ha^{-1} yr^{-1}, affects the effectiveness of water conservation structures. Nearly 70.79% of Jharkhand's forest come under this category where the annual loss of soil is more than 11.2 t $ha^{-1}yr^{-1}$. At this stage, the gully formation starts which in turn obstructs the cultural operations (Gurmel Singh, *et al*., 1981). In Jharkhand as per the soil erosion classes it is evident that moderate, moderately severe, severe, very severe and extremely severe classes covering and an area of 5.16 Mha (64.8%) have exceeded this their tolerance limit of 11.2 t ha^{-1} yr^{-1} (Anil Kumar Sahoo, Surendra Kumar singh, *et al*., 2014). The top soil erosion depletes the nutrient content of the soil (State of Environment, 2001), which also determines the growth of the forests. The annual soil specific erosion rates provided by the Central Soil and Water Conservation Research and Training Institute, ICAR shows that nearly 74 million tons of major nutrients loss due to erosion in India annually.

b.) Mining Activities

The drastic rise in the intensity of mining activities in the last two decades has led to massive vegetation destruction compared to the earlier period. The open cast mining activities are the main reason for forest degradations and forest fragmentations since most of the mining sites are found inside the dense, interior, and biodiversity-rich areas of the forests (Sonter *et. al*., 2017). The total forest land diverted since the 1980s till date in Jharkhand is approximately 28,000 ha (*Fig. 8*). The Karanpura coalfield is 1,420 sq. km including 425.37 sq.km forest cover (Central Mining Planning and Design Institute, 2019). The Damodar basin is known for its coal deposits, accounting for 46% of the country's coal reserve less than 20% of Damodar basin is under vegetation cover. The number of mines in the landscape has increased tremendously since the late 1980's (Oskarsson *et. al*., 2019) and expansion continues with allocation of new coal blocks resulting in the loss of forest cover and degradation in adjoining forests. An increasing number of projects has further contributed to excessive mining in the region which led to the devastation of the entire ecosystem with impacts on forests, hydrological regime, associated terrestrial and aquatic biota and loss of species diversity as endemic populations abandon their habitat. The Saranda Forest is dense forest in the hilly region of West Singhbhum district of Jharkhand. Under this pristine Sal forests lays one of the richest repositories of iron ore. Existing mines have already destroyed extensive swathes of Saranda. About 16 iron ore mines are working in 6526.369 ha of lease area. It is estimated that more than 1,100 hectares of virgin forest with over 80% canopy cover has been destroyed by mining. The total mining lease area including existing, closed and proposed is 15924.013 ha for iron ore mining. The mining and its allied activities are having direct impact on the degradation of forests in Jharkhand.

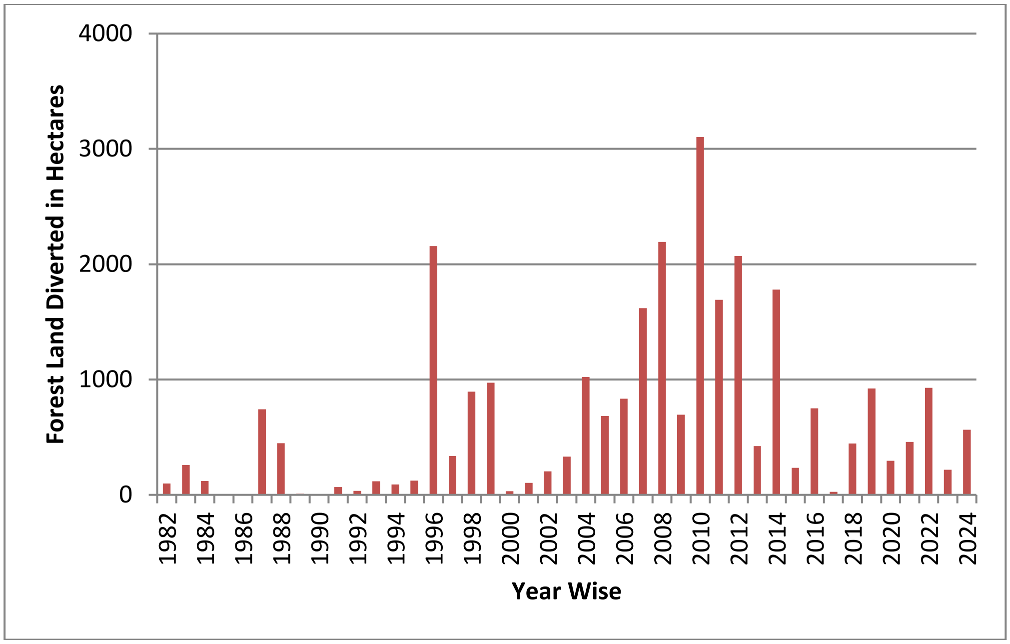


Fig 8: Graph showing forest land diverted (ha) since 1980 till date in Jharkhand

c.) Forest fire and Alien plant invasion

The other major cause for forest degradation in forest fire and plants invasion, they are inter-related phenomenon in major forest ecosystems which adversely affects the native biodiversity and causes deforestation and forest degradation. The types of vegetation and its density are the two most vital floristic factors interrelated to the ignition of forest fires (Danthu *et al*., 2003). Fire reduces the quantity and quality of forest produce including timber and non-timber forest products affecting the forest regeneration through killing dispersed seeds, seedling, and sapling damaging roots by heating surface and subsurface soil to enhance mortality (Balch *et al*., 2013). Climate change is exacerbating the dangers and losses of habitats that boosts the spread of invasive plant species and affect biodiversity by modifying species habitats abundance and distribution of species (Adhikari *et al*., 2019). The extent of biological invasions has increased rapidly over the past Century (McNeely *et al*., 2001). Invasive plant species can promote forest fires, creating new fire regimes by adding abundant fuel that are unsuitable for native species and lead to lower biodiversity and localized extinctions (D'Antonis and Vitousck, 1992; Brooks *et al*., 2004) For example, *Lantana camara* grow best in wastelands, rainforest edges and forest recovering from fire, logging or erosion and spread rapidly though root suckers and profuse Seedlings (Negi *et al*., 2019).

As per the ISFR, 2021, the major invasive species in the recorded forest area of Jharkhand is *Lantana camara* occupying 342 sq. km area. The studies done by Tiwari *et al*., 2022 indicate that in the future, about one-fifth of the geographical area of Jharkhand may contain an invasion of *Lantana camara*, which may have serious implications on the health of native ecosystems (Gorden *et al*., 2001). Approximately, 91% of the occurrence of *L. camara* was observed mostly in non-forest and open forest areas in contrast to moderately dense and very dense forests (8-9%). This endorsed the findings that it does not thrive under compact tree canopies of taller native forest species (Oosterhout *et al*., 2004; Negi *et al*., 2019). And also, that approximately 43% area of Betla National Park has been observed high to very high fire incidences (Kumari and Pandey, 2020) and is primarily affected by the invasion of *L. camara* (>75% area) (Priyanka and Joshi, 2013b). In the studies conducted by Gopuraju *et al*., 2018 showed that, the "tropical lowland forests, broad leaved evergreen forests" category occupied 3.7% of total geographical area and retained 19% of total Jharkhand fire events. Similarly, the "tropical mixed deciduous and dry deciduous forests" category occupied 23.4% of the total geographical area and retained 66% of the total Jharkhand fire events. The forest fire frequency event is more significant in the category of "tropical lowland forest, broadleaved evergreen, and in a serious concern (Chakraborty *et al*., 2018). The above-mentioned major reasons like anthropogenic pressure, changes in land use, forest fires, invasive species, etc. are the causes of the degradation of the forests. Such degradation can also be attributed to improper valuation of the forests and forest resources of the state.

Hence, appropriate valuation of the forest is necessary to achieve harmony between production and conservation in the forestry sector by way of proper planning by policy making and implementation of various schemes by the state forest department. Forestry and logging contributed about 2.2 trillion Indian rupees of agricultural gross value in fiscal year 2021. This production figure can further be uplifted to a greater value while conserving the forest ecosystems and biodiversity, if proper valuation of forests is done by the concerned authorities.

Methodology for valuation of degraded forests

Degradation of forests can be valued through several methodologies, but in practice, three methods are used rigorously to evaluate the forests i.e. (1) Total economic value (TEV), (2) Carbon Sink Method, and (3) Green Accounting Method. Of the three methods TEV approach was adopted by the Millenium Ecosystem Assessment (MEA 2005) and the same is used in this study to evaluate degradation in Jharkhand State's forests.

Total Economic Value (TEV):

The concept of TEV is the most complete measure and the most practiced methodology when it comes to forest valuation. As far as the TEV is concerned in general, the works of D. Pearee, J. Warfood and R. Turner should be mentioned. In the book "Economics of Natural Resources and the Environment", 1990, D. Pearee and R. Turner noted two types of values: instrumental and intrinsic. According to D. Pearee and R. Turner, the instrumental value is identical to the use value, while the intrinsic value is identical to the non-use value. TEV takes in almost both direct use and indirect use values during the valuation. It measures the ecological services provided by the forests in terms of economic values along with direct economic benefits generated by the forests. Forest produce like timber and non-timber products come under the tangible benefits exploited from the forests whereas mitigation of climate change and reducing greenhouse gas emission, regulation of the hydrological cycle, conservation of soil and gene pool, and carbon sequestration are some of the intangible benefits that can be received from the forests. TEV is calculated according to the following formula:

Where,

Use values = Direct use values +Indirect use values +Option value

And,

Non-Use values = Bequest value+ Existence value

Direct use values consider the direct economic return from the forests mainly through the consumptive use of timber or non-timber forest products and non-consumptive uses like recreation, tourism or research. Indirect use values are enumerated from the total ecological services provided by the forests. Option value can be explained as the future benefits of conserving the forests where as the Bequest Value measures the People's Willingness to Pay (WTP) for the conservation of forests. The existence value, on the other hand, takes into account the people's Willingness to Pay (WTP) for the aesthetic purposes derived from the forests. Total Economic Value is the most accurate economic enumeration tool for forests as it measures all the above values together. Mythilli and Goedecke (2016) used the TEV approach to estimate the costs of degradation across the country. For Jharkhand, the Gross Regional Product (GRP of that region) in 2009 was estimated to be 20.2 billion USD, and the annual costs of land degradation was estimated to be 218.7 million USD. And the share of land degradation cost in GRP was 1%. Similarly, the cost of action and inaction was analyzed for Jharkhand. The cost of inaction exceeded the cost of action and the ratio of action over inaction is 41% in Jharkhand. A recent global study attempted to value land degradation using the TEV approach and found that only about 46% of the global cost of land degradation is due to LUCC (land use/cover change) is borne by land users while the remaining 54% is borne by consumers of ecosystem services off the farm (Konya *et al*., 2016). Very few studies address the economics of forest degradation in India. To date, only six major studies have estimated the costs of forest degradation in India. Many of these form part of a larger assessment of the economics of land degradation in the country, and utilize different approaches. These include the study conducted by TERI (1998), studies conducted by Gundimeda *et al*., (2005), Kumar *et al*., (2006), a World Bank study (2013), and a recent assessment by Mythilli and Goedecke (2016). TERI (1998) carried out a study on land degradation in which they included the economic losses resulting from forest degradation. They studied the loss of provisioning services that result from forest degradation. In this study, they estimated the real forest area versus the recorded forest area using the following formula:

$$\textbf{Real forest area} = \frac{\text{Total growing stock}}{\text{Potential growing stock}} \times \text{ Recorded forest area}$$

$$\textbf{The real forest area of Jharkhand (2021) as}$$
$$\frac{100.8 \text{ m cu m}}{178.9 \text{ m cu m}} \times 25118\ sq.km \ = \ 14152.5\ sq.kms$$

Where the total growing stock is 100.8 MCM in Jharkhand's forests (FSI, 2021) and 178.9 MCM is the Potential Growing Stock of the state. Hence, 14152.5 sq. km (56 %) is the real forest area as compared to the recorded forest area (25118 sq. km). The remaining area of 10965.5 Sq km is unproductive forests which constitute 44% of the RFA in the state.

Gundimeda *et al*., (2005) determined the value of timber, carbon fuelwood, and Non-timber Forest Products in India's forests. They found an overall decrease of 168 MCM of timber accompanied by a net carbon release of roughly 58 Mt C. They estimated that a decrease in stock of timber was responsible for a wealth depletion of INR 380 billion (1% of GDP). The World Bank (2013) study assessed both degradation (static land use) and deforestation (land use change). They used various estimates to arrive at a deforestation figure of 0.6 Mha annually between 2006-09, and an estimate of degraded forest area in 2003 of 24.4 Mha. Using various estimates of use value, they valued the losses by assuming that degraded forest provide between 20 to 80% of the direct use values but none of the indirect values that are associated with dense forest functions. However, according to estimates provided by Gundimeda (2001), degraded forests are associated with a 20% loss of accumulated carbon in the range of 20-59 t c/ha in India, valued at a cost of carbon USD 20 per ton of CO_2. The losses are estimated at between 0.1 to 0.3% of GDP.

Land degradation in the forestry context may refer to:

a) The conversion of forests to non-forests, i.e. the change in Land Use Land Cover (LULCC) (deforestation)

b) Degradation which refers to a shift from a more dense forest class to a less dense forest one (Static land use). The values of deforestation can be derived from the FSI change matrix over a period of time (2003-2021), forest degradation is assessed using the FSI data for 2021. The change matrix of Jharkhand's forest has been analyzed (2005-2021) and the change was not found to be significant. In Jharkhand context, forest degradation (decrease in forest quality) rather than deforestation is one of the major reasons for land degradation. So, in the present study, the cost of degradation due to land use change (deforestation) and degradation within the static use with a focus on forest will be conducted. In order to estimate the costs of forest degradation (shift from a higher forest density class to a lower value) the Millennium Ecosystem Assessment (MEA), 2005 definition of land degradation to the forestry context in India, and the Total Economic Value (TEV) approach will be applied to determine the value of forest degradation. (Nkonya *et. al*., 2016). The following steps were followed:

- The costs of forest degradation due to conversion from one density class to another was derived from the equation for cost of land degradation due to LUCC (as outlined in Nkonya *et al*., 2016) in the following way.

$$CF_{CD} = \varepsilon_i^K \Delta aij \times (Pi\text{-}Pj)$$

Where,

CF_{CD} = The cost of forest degradation due to change in forest density class.

aij = land area of forest density i being replaced by forest density class j, where i, j = i ………. K

Pi = The TEV per unit of area for forest density class i, the underlying assumption being that change in area from one density class to another can be valued by the difference in TEV values of these density classes under different levels of forest degradation.

The current situation of Jharkhand Forest is given below (Table 4), and some tenable assumptions would be made to estimate the costs of forest degradation for the Jharkhand state under two alternative scenarios, which will be discussed subsequently:

Table 4: Forest and tree cover of Jharkhand in 2021

Class	Area (in ha.)	Percent of Geographical area
Forest Cover		
Very Dense Forest	260100	3.26
Moderate Dense Forest	968900	12.15
Open Forest	1143100	14.33
Total Forest Cover	**2372100**	29.76
Tree Cover	286700	3.59
Total Forest & Tree Cover	**2658800**	33.35
Scrub	58400	0.73
Non-Forest	5254800	65.91
Total Geographical Area	**7972000**	

3. RESULTS

1. Degradation which refers to a shift from a denser forest class to a less dense forest class (Static land use).

Forest Degradation in Jharkhand– Scenario I

In this scenario, we include both open forest (11.43ha.) and scrub forest (0.58 lakh ha.) (That is forests of canopy density 40% within the category potentially degraded forest (total 12.01 lakh ha.) (FSI, 2021) and then consider the benefits lost from the current status (that is the cost of forest degradation resulting from the area of forests lying under scrub and open forests, rather than under moderately dense forest is estimated. In this scenario, we assume that the potentially degraded forest of this State should at least be in the moderately dense category. The figure of 12.01 lakh ha. is within the degraded forest of figure of 14.19 lakh ha. reported by SAC (2018-19). The FSI change matrix itself shows that it is dynamic and upgradation from open forest to moderately dense forest and very dense forest (and vice versa) indicating that this forest can and regularly achieve higher canopy. Hence, moderately dense forests (40-70% canopy density) should be converted to very dense category than that of open and scrub forests. In the State of Jharkhand as seen from the data in ISFR (2003-2021) all three categories of forests (VDF, MDF, OP) are mostly constant with insignificant change matrix from one category to another but the ideal condition would be that a significant part of Open forests should be converting to Moderate forests and the Moderate forests to Very Dense Forests.

Forest Degradation in Jharkhand – Scenario II

In this even more conservative scenario, we only consider open forests (11.43 lakh ha.) to be degraded (FSI, 2021) and then estimate the benefits lost from degradation. In this scenario we do not consider scrub forests to fall within the definition of forests, since they have less than 10% forest cover, hence it do not fall under the definition of forests, "an area with a minimum coverage of 1 ha, with at least 10% forest cover." (FSI, 2009). Moreover, the scrub forests can also include grassland areas (Anmol Kumar, 2017).

To estimate the cost of this forest degradation of the state of Jharkhand, the TEV of different density classes and estimated cost (or equivalent the benefits for gone), due to the forest being in the scrub and open density classes were compared rather than in the moderately dense class. Verma *et al*., (2014) assessed the TEV and rates of Net Present Value (NPV) applicable to different classes/categories of India's forest (Table 5). This was done for 14 different forest types (based on Champion and Seth's 1968 classification. The TEV estimates incorporate the goods and services comprising timber, bamboo, fodder, fuelwood, NWFP, carbon sequestration, soil conservation, etc.). The values for TEV provided by Verma *et al*., (2014) were used in the present study to calculate the economic costs. The figures used are, however, likely to be an underestimate, as they do not provide the TEV for bioprospecting and carbon storage. However, these values account for double counting and simultaneous delivery of ecosystem services.

Table 5: Total Economic Value of forests (after adjusting for double counting and simultaneous delivery of ecosystem services) as given by Verma *et al*., (2014)

Tropical Economic Value Rs/ha/yr	**VDF**	**MDF**	**OF**	**Scrub**
Tropical Wet Evergreen Forests-North East	178772	93991	81716	22988
Tropical Wet Evergreen Forests-Western Ghats	197052	138537	53832	27464
Tropical Semi-Evergreen Forests-North East	102971	80975	42447	24170
Tropical Semi-Evergreen Forests-Eastern Deccan	240290	195825	104140	93733
Tropical Semi Evergreen Western Ghats	159497	10536	63064	34818
Tropical Moist Deciduous Forests	147493	101457	57112	26102
Littoral & Swamp Forests	240606	161884	92650	63493
Tropical Dry Deciduous Forests	**107810**	**77390**	**46804**	**29565**
Tropical Thorn Forests	61365	54008	43238	29289
Tropical & Subtropical Dry Evergreen Forests	126952	91131	51781	21928
Subtropical Pine/Broadleaved Hill Forests	108322	83875	47420	17256
Montane & Moist Temperate Forests	165691	127735	63635	18541
Sub Alpine & Dry Temperate Forests	139036	114532	54901	13563
Alpine Scrub	120739	89210	41483	18038
Country Average	**149757**	**108276**	**60302**	**31528**

The forests of Jharkhand are classified as "Tropical Dry Deciduous Forests, Eco class III, so the change in TEV resulting from conversion from one density class to another class of lower density (in Rs/ha/year) corresponding to this category (Tropical Dry Deciduous Forests) of forests is calculated from Verma's TEV table. The difference in the values from a denser class to a less dense class is shown below in (*Table 6*) for the State of Jharkhand.

Table 6: Difference in the values from a denser class to a less density class, Jharkhand

VDF to MDF	**VDF to OF**	**VDF to Scrub**	**VDF to NF**	**MDF to OF**	**MDF to Scrub**	**OF to Scrub**	**MDF to NF**
30420	61006	78245	107810	30586	47825	17239	77390

The cost of forest degradation for the two scenarios was calculated as shown below:

Scenario- I

Costs of degradation (benefits foregone) resulting from forests in the scrub and OF categories rather than in the MDF category (Table 7). Considering that the Open forests (OF) and scrub should at least have been in the Moderate Forest category (MDF).

Table 7: Costs of degradation in Scenario-I

Forest Category (Tropical Dry Deciduous Forests)	**VDF**	**MDF**	**OF**	**Scrub**	**Total**
TEV (Rs/ha/yr)	107810	77390	46804	29565	
Area of each class of forest (in ha)			1143100	58400	
TEV lost per ha for non-conversion to MDF			30586	47825	
Costs (in million rupees)			34962	2792	37754

Scenario- II

Costs of degradations (benefits foregone) resulting from forests in the OF category rather than in the MDF category. The scrub is not considered a forest hence the corresponding area was not taken into consideration, the costs of degradation are shown in *Table 8* below;

Table 8: Costs of Degradation in Scenario II

Forest Category (Tropical Dry Deciduous Forests)	**VDF**	**MDF**	**OF**	**Scrub**	**Total**
TEV (Rs/ha/yr)	107810	77390	46804	-	
Area of each class of forest (in ha)			1143100	-	
TEV lost per ha for non-conversion to MDF			30586	-	
Costs (in million rupees)			34962	-	34962

Depending on the scenario considered, the costs of degradation of Jharkhand forests range from 34962 million rupees to 37754 million rupees/year, which is the TEV lost by the forests of Jharkhand per year due to non-conversion to higher density classes.

1. Conversion of Forests to Non-Forests (Deforestation) or vice versa

To estimate the conversion of dense forest area to non-forest area, the forest cover change matrix (*as shown in Table 9*) resulting from the conversion of one density class to another between 2005 and 2021 was considered;

But along with forest degradation, forest cover is also upgrading simultaneously including conversion from non-forest and scrub to open forests, moderately dense forests and to very dense forests. Therefore, the net decrease or increase in area under forests from one density class to the next (or to non-forests) is calculated to obtain a picture of the costs of forest degradation/deforestation. Under this scenario, there is a possibility of Non-Forest (NF) being converted to MDF and VDF, in which case the gain or the value added is calculated taking the same TEV values.

Table 9: Estimate of net conversion to non-forests or dense forests from forests cover change matrix (2005-2015)

Forest cover change (in ha)	2005	2009	2011	2013	2015	2017	2019	2021	Total forests change from 2005-2021
VDF to NF	0	0	0	0	0	0	0	100	-100
NF to VDF	0	100	0	0	0	0	100	100	300
Net conversion of VDF to NF	0	100	0	0	0	0	100	0	200
MDF to NF	200	2300	1600	2600	0	0	600	2300	-9600
NF to MDF	0	1500	0	11000	200	200	700	2600	16200
Net conversion of NF to MDF	-200	-800	-1600	8400	200	200	100	300	6600
Net change									+6800

The change matrix of the density class was considered from the year 2005-2021.And significant change was observed in the conversion of MDF to NF in the years 2009, 2013, and 2021. This may be due to the forest land being diverted for mining purposes. Likewise, there was a significant spike in the year 2013, when 1100 ha NF was converted to MDF.

And the net change in the forest matrix was positive and there was a gain in 6600 Ha of the MDF category and 200 Ha of forests in the VDF category. The gain in TEV due to the conversion of NF to Dense Forest has been calculated in Table 10 below,

Table 10: Costs of conversion of non-forests to dense forests

Category of forest Tropical Dry Deciduous forests	VDF	MDF	OF	Scrub	Non-forest	Total
	107810	77390	46804	29565	0	
Costs of conversion (benefits resulting from non-forest to VDF and MDF						
TEV gained per ha for conversion from NF to VDF and MDF (rupees)	107810	77390				
Net conversion of NF to VDF (in ha.)						200
Costs of conversion from NF to VDF (in million rupees)						21.56
Net conversion of NF to MDF (in ha.)						6600
Cost of conversion from NF to MDF (in million rupees)						510.77
Costs of increase (in million rupees) (Total forest converted to dense forest)						532.33

The costs of the conversion from non-forest to dense forests are provided in the table. Using the annual TEV per hectare of VDF and MDF and assuming that TEV of non-forest land converted to VDF and MDF is negligible, the total economic gain due to net conversion of NF to VDF and MDF is estimated to be 532.33 million rupees per year due to conversion. Considering the scenarios of costs in forest degradation and the gain in forest density, the net gain is 532.33 million rupees per year and which is negligible to the cost of degradation which is 34962 million rupees per year (Scenario 2). The net cost of degradation is still much higher than the gains which is approximately 35000 million rupees (3500 Cr). Thus, the ratio of action to inaction is significantly higher, which is near to 40 percent.

4. DISCUSSION

The present study clearly establishes the fact that nearly 45% of the forests are unproductive and are in degraded condition. Forests in Jharkhand are not only important for creating livelihood security of the people but are more important in maintaining the hydrological balance and the biodiversity. But the present conservation and management practices adopted fall short in realizing the full potential of the tropical forests of the state. The quality and quantity of the forests are the two important characteristics that will add value to a biome. In the state of Jharkhand, for the past two decades, the quality of the biome is relatively unchanged, with no significant increase in the area under dense forests. Forests would have been in better condition if proper conservation strategies and protection activities were adopted. The costs of non-conversion to a higher density class are very high amounting to TEV values of 35000 million rupees per year. Besides this, the amount of money spent on increasing the productivity of forests is very little compared to benefits foregone. The present study identified that the potential growing stock in the record forests of Jharkhand is

178.9 MCM in the year 2021, as compared to the existing figure of 100.8 MCM. In other words, the annual increments which are put up by the existing forests are lost by illegal felling, deforestation and other anthropogenic factors.

The budgetary provision of the state for protection (including fire and Lantana eradication) and soil conservation activities is meagre compared to plantation and other activities. Since commercial exploitation by the way of extraction of timber is no longer practiced, the quality of forests should have been better but there is no significant improvement in the conditions of forests. The present interventions and management practices failed to achieve the objectives. The costs of inaction against forest degradation is very high in the state of Jharkhand, which is nearly 40 percent. The forests in Jharkhand are dominated by Sal (*Shorea Robusta*) which respond well to protection, hence closing the degraded forests physically and under the provisions of the Indian Forest Act,1927 should be considered by policymakers. Similarly, proper planning and allocation of a proportionate budget towards soil and water conservation activities should be considered by the State on a priority basis, failing which ecological security will be at great risk.

5. CONCLUSION

This paper will with its limited scope will act as a reference for understanding the TEV of forests in Jharkhand. This is following the fact that very limited studies have been conducted on divulging the TEV of tropical forests for decision-making purposes with regards to value of the biome due to its density classes. The economic valuation studies conducted clearly shows the losses or costs incurred due to the present state and the conditions of forests. This study will aid the forest managers and policy makers to revise their strategies and in turn can efficiently allocate the resources available at a particular site (Ahmad, 2011). Besides that, the government can utilize the findings from ecosystem valuation to justify conducting conservation programs pertinent to biodiversity conservation efforts in a particular site (Kumar, 2010). An identification of the TEV will definitely alert the concerned department and policy makers regarding the importance of conserving natural resources in the tropical forests of Jharkhand. Besides, this approach can be used by decision makers in the better implementation of the forest management activities. Furthermore, finding from the benefits of the TEV in the monetary value can be applied in cost-benefit analyses (CBA) of government and private projects (Matthew *et al*., 2019). This information will be useful to show the benefits from conservation of the forest resources as compared to the return from the alternative development projects. Furthermore, valuation is a must to arrive at the natural resource accounting to project the net present values of the resources (Kumar, 2020).

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