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Livelihood Vulnerability Among Tribal Communities In Tribal-Sub Plan Blocks Of Odisha, India

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Abstract
Extreme climatic events affect the economy, society and environment, and even make tribal livelihood more vulnerable to those living in mountain regions and forest ecosystems. The paper examines the livelihood vulnerability in the Tribal Sub-Plan area and compares it across the northern and southern districts in Odisha. Moreover, the livelihood vulnerability index is computed based on the IPCC framework by incorporating adaptive capacity, exposure, and sensitivity. The overall LVI score is 0.623 and LVI-IPCC score is 0.09. This indicates climate vulnerability has less impact on overall vulnerability. The livelihood vulnerability index is more prevalent in the northern districts (0.536) of the TSP area in Odisha than in the southern districts (0.368), but the southern districts have low adaptive capacity. Less adaptive southern districts were Koraput, Kandhamal and Gajapati. Adaptive factors contributing to vulnerability were fewer primary schools, a percentage of households with less access to pension and MGNREGA. Similarly, more sensitivity factors in both northern and southern districts were illiteracy, crop not irrigated and population density.
Therefore, the policy should focus on the enhancement of literacy, the provisioning of proper irrigation facilities, primary schools, and ensuring the inclusion of more tribes in government schemes to reduce vulnerability and region-specific policy should be emphasised.

Keywords: *Climate Change, Livelihoods Vulnerability, IPCC framework and Tribals.*

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I. Introduction

Climate change (CC) has several consequences on society, the economy, and the environment (Sujakhu et al., 2019). There have been growing concerns among policymakers and academics across the globe about the livelihood impact of climate change. The unpredictable climate events such as cyclones, floods, heat waves and droughts severely affect the livelihoods of a large number of people, mostly in India, Bangladesh, Pakistan and Sri Lanka. CC mostly affects tribal and marginalised people who depend on agriculture and natural resources (Kumar & Mohanasundari, 2025). This has significantly affected rural livelihood systems, agricultural output, fishing and food availability. Tribal communities living in environmentally sensitive areas such as mountain regions and forest ecosystems are more vulnerable due to their low adaptive capacity (Hahn et al., 2009; Sujakhu et al., 2022).

Moreover, climatic events affect their farming practices, socio-economic status, and disrupt the water and food security, as well as access to health (Kumar & Mohansundari, 2025). The tribal often faces health problems, water scarcity, food problems, inadequate housing conditions, and lower adaptive capacity, along with infrastructure and financial challenges, making them more vulnerable to livelihood (Datta et al., 2024). Extreme events affect mostly all sectors such as health, water resources, agriculture, livestock, aquaculture, and forestry (Sethi et al., 2025). Odisha witnessed many extreme weather events over the last decade. These events not only affected coastal people but also non-coastal people. Odisha, one of the Indian states, is home to the highest number of PVTGs (13). A total of 62 tribes are found in Odisha, and they speak 74 vernaculars. The majority of tribes live in proximity to the forest and hilly mountain regions.

In this context, this paper investigates the livelihood vulnerability in the Tribal Sub-Plan area and compares it across the northern and southern districts in Odisha. This is the rare study that applied the LVI-IPCC framework in the Tribal Sub-Plan area, which possesses the novelty of the study. This study will not only help the researcher, policy maker and practitioner to reduce vulnerability among the indigenous communities within country but also in the world.

Review Of Literature

The literature reviewed here focuses on livelihood vulnerability among tribes across different parts of the country. Authors like Kumari and Mohansundari (2025) conducted a study in Madhya Pradesh, highlighting that factors such as food security, housing structure, and climate events were major contributors to climate risk.

Additionally, income, education, natural resource dependency and effective governance also affect vulnerability (Kumar, Devi and Mohansundari, 2025). In the eastern part, like Odisha, climate change affects tribal livelihoods (Behera et al., 2024). Tribals are more vulnerable due to being engaged in low-paid work and suffering from chronic poverty and multiple deprivations (Pothal, 2024). They were more vulnerable to health due to limited access to health care services, traditional health practices, exposure to community diseases and nutrition deficiency (Bhoi and Acharya, 2024). Tribal households are still deprived of basic amenities such as landholding, food security, income and overall development (Dungdung and Pattanaik, 2020). The non-timber forest product and social welfare schemes acted as a support system for PVTGs, but landless tribals were more vulnerable in Jharkhand and Odisha (Behera et al., 2024).

Similarly, in states like West Bengal, water scarcity, food shortage, health issues and inadequate housing conditions were sensitive to livelihood vulnerability. Main challenges faced by communities were deforestation, climate change, human-wildlife conflict and limited access to crucial livelihoods (Datta et al., 2024). Factors influencing vulnerability among tribals were family size, poverty, agricultural income and distance to market (Das and Basu, 2020). Rural livelihoods were vulnerable owing to heavy exposure to floods, cyclones, riverbank land degradation, and inadequate access to basic amenities, as well as a low level of adaptive capacity among indigenous communities (Das and Sharma, 2024). A similar study in Himachal Pradesh highlighted that topographical location, educational status, household income, livelihood diversification, and agricultural activities affect the livelihoods (Kumar et al., 2023).

A study by Basavarajaiah et al. (2020) in western India, Karnataka, found that the major problems identified in the study area were inadequate safe drinking water, malnutrition and food insecurity. Another study conducted in Nigeria, Basiru et al. (2022), found that women were vulnerable in six categories, including livelihoods strategies, water, social networks, food and nutrition, health, natural hazards, and climate. In Nepal, Sujakhu et al. (2019) found that the vulnerability components were natural resource dependency, a lack of financial assets and a weak social network. Moreover, these studies also suggested that better adaptive capacity, better infrastructure, crop diversification, access to government schemes and climate information are crucial to reduce the climatic vulnerability of livelihoods among tribals and also promotion of agriculture, skill development, petty business, digital literacy, and internet access and broadcasting and communication can enhance their adaptability (Kumar and Mohansundari, 2025). Policy intervention is required to reduce vulnerability through protection and management of forests, better health infrastructure, food security and education (Das and Basu, 2020). Basavarajaiah, et al. (2020) suggested that training should be for animal husbandry, cattle, piggery, goats, apiculture, sheep, and beekeeping for better livelihood diversification. Similarly, a study by Venus et al. (2022) emphasised the construction of better housing facilities, training, livelihood diversification and agricultural conservation. Other suggestions are on quality education and improved access to land, which enhance the livelihood diversification among tribal (Vatta et al., 2017).

Research Gap

The review of literature listed here focuses on the tribal communities and livelihood vulnerability using the IPCC framework, including adaptive capacity, exposure and sensitivity and how different factors influenced their livelihoods. Tribals depend on different sources of livelihoods, and common property resources make their living; their livelihoods improved through agricultural diversification. Some studies have found significant differences in vulnerability between men and women. Moreover, other studies discussed how they are deprived of basic amenities and facilities, and no access and inadequate resources increase sensitivity, and the rehabilitation scheme affects their livelihoods. Better adaptive capacity will reduce vulnerability, and access to welfare schemes can reduce vulnerability. It can be inferred from the literature review that scant studies focus on tribal vulnerability in livelihood in the Tribal Sub-Plan area in Odisha. Hence, this paper examines the vulnerability of livelihood among tribes in the TSP area in the state.

II. Methodology

This study used secondary data. The adaptive capacity and sensitivity data were collected from the SCSTRI, Government of Odisha, 2014. The recent statistical handbook on Tribal Sub Plan block is not published. Therefore, this study used the data up to 2014. The exposure data, such as temperature, minimum and maximum temperature and precipitation, were extracted from the NASA Power website from 2005 to 2014. The present study used the livelihood vulnerability index of the Intergovernmental Panel on Climate Change (LVI-IPCC) framework to estimate the exposure from 2005 to 2014.

LVI-IPCC Framework

CC is a function of adaptive capacity, exposure, and sensitivity in the vulnerability context of IPCC (2001, as cited in Hahn et al., 2008). The climate hazard assessment is carried out with the IPCC-Sixth Assessment Report (AR6) framework. The IPCC-AR6 enables the separation of the indicators into adaptive

capacity, hazards, exposure, and sensitivity, and systematically analyses how these indicators significantly contribute to vulnerability (Kumar and Mohanasundari, 2025).

Vulnerability assessment elucidates the various methods systematically designed to examine the interconnectedness between human, social and physical environment (Hahn et al., 2009). Many researchers follow the IPCC framework of vulnerability as a function of adaptability, exposure, and sensitivity (IPCC, 2001, as cited in Hahn et al., 2009). Exposure means the extent and magnitude of weather-related exposure to a community, like floods, drought, cyclones, and sensitivity means the degree to which a system is impacted by exposure. Adaptive capacity is the ability and strategies of a community to recover from a climatic event (Ebi et al., 2006, as cited in Hahn et al., 2009). LVA is a powerful tool for strengthening the adaptive capacity of the community and lessening climate risk (Das & Sharma, 2024).

The following vulnerability index is used in this paper.

Vulnerability Index

The livelihood vulnerability index is computed based on the IPCC framework by including adaptive capacity, exposure, and sensitivity. We employed the normalisation method (Iyengar and Sudarshan, 1982). The sub-indicators are to be estimated with various units, such as count, ratio, and per cent, and are to be normalised as follows.

$$\textbf{Index}_{si}=\frac{X(a)-X(min)}{X(max)-X(min)} \qquad \textbf{----------(1)}$$

SI represent the value of sub-indicators or components, X(a) is the actual value, X(min) is the minimum value, and X(max) is the maximum value of each component.

In the second step, an equal weight will be assigned to all 22 sub-components and averaged to calculate the major indicators (Bahinipati, 2014; Balica and Wright, 2010; Eakin and Bojorquez-Tapia, 2008; Kantamaneni et al., 2020).

$$M_{si}=\sum_{i=1}^{n}\frac{Indexsi}{n} \qquad \textbf{-----(2)}$$

Where n is the number of sub-components or indicators, and $Index_{si}$ is the normalised value of sub-indicators, the index of sub-indicators is represented by M_{si}.

In the next step, the contributing factors will be computed using the following equation.

Where, CFmc = IPCC defining contributing factors (sensitivity, adaptation and exposure)

Wi is the weight of each indicator

Msi is the index value of major components.

LVI-IPCC will be calculated by using the following equation.

LVI-IPCC= (Emi-Ami) * Smi

Where LVI-IPCC is the LVI using the IPCC framework. LVI-IPCC value will be 0 to 1 (from least vulnerability to high vulnerability)

VI (vulnerability index) will be calculated using the following equation.

$$VI=\frac{\sum_{i=n}^{n} wiEcf \sum_{i=n}^{n} wiScf}{\sum_{i=n}^{n} wiAcf} \qquad \text{----------(3)}$$

Ecf measure Exposure, Scf measure sensitivity and Acf measure adaptive capacity.

III. Result And Discussion

The present study was conducted in the Tribal Sub-Plan area of Odisha, which covered 12 districts. These are Sambalpur, Sundergarh, Keonjhar, Mayurbhanj, Balasore, Gajapati, Kandhamal, Kalahandi, Rayagada, Nowrangapur, Koraput and Malkangiri (Ota et al., 2014). In this section, we have estimated the livelihood vulnerability index in the Tribal Sub-Plan area. while comparing between northern and southern districts I have did not calculate LVI score for Balasore (northern district) and Kalahandi (southern district) because of inadequate data.

In adaptation capacity, we have taken nine sub-components such as, including ST-female workforce participation rate, Total workforce participation rate, Literacy rate, Village with electricity, Ratio of primary school, Upper primary high school, access to pension, and MGNREGA. In the tribal Sub-plan area, high adaptive capacity is evident in the total ST workforce participation rate, percentage of villages with electricity, and literacy rate. Access to pension and MGNRGEA are low adaptive capacity. The sensitivity Score is 0.359, quite similar to the adaptive capacity score. We have covered the nine sensitivity sub-components. Highly sensitive factors were the crop not irrigated and more illiterate people, contributing more to the vulnerability. Low sensitivity is seen in terms of doctor availability. This component has little impact on vulnerability (Tables 1 & 2).

Table 1 Sub-indicators of Adaptive Capacity

Sub-indicators	Values
ST Female Workforce Participation Rate	0.252
ST Workforce participation rate	0.593
Literacy Rate	0.464
Percentage of villages electrified	0.5
Ratio of primary school/1000 population	0.18
Percentage of Upper Primary School/1500 population	0.314
Percentage of High School/1500 population	0.336
Percentage of households' access to pensions	0.41
Percentage of Households' Access to MGNREGA	0.164
Average	0.357

Source: Author's calculation

Table 2 Sub-indicators of Sensitivity Index

Sub-indicators	Values
Population ST	0.37
Percentage of Female	0.224
Percentage of Children	0.059
Population Density	0.386
Percentage of Illiteracy	0.535
Percentage of agricultural land to total land	0.363
% Crop not irrigated	0.86
Net area sown (Acres)	0.289
Doctors per 5000 population	0.145
Average	0.359

Source: Author's calculation

Interestingly, the exposure score is 0.62 higher than sensitivity and adaptive capacity. Temperature and maximum temperature are the most severe climate events contributing to vulnerability in the study area. LVI Score is 0.623, which indicates higher vulnerability, and LVI-IPCC score is 0.09. This indicates that the climate vulnerability has little impact on vulnerability (Table 3). The sensitivity factors, such as the crop not being irrigated and more illiterate persons, are contributing more to the vulnerability. Similarly, there is less adaptive capacity in terms of access to some government schemes, such as access to pension and MGNREGA. The sensitivity and less adaptive capacity are more responsible for vulnerability.

Table 3 The last 10 years of climatic events (Sub indicators)

Sub-indicators	Values
Av. Temperature	0.78
Maximum Temperature	0.63
Minimum Temperature	0.27
Precipitation	0.8
Average	0.62

Source: Author's calculation

I have also compared the vulnerability between the northern and southern districts of Odisha. The northern districts of the community face more vulnerability than the southern tribal. LVI was 0.536 in the northern district of Odisha and 0.368 in the southern districts. LVI-IPCC score was more in southern districts (0.09) than northern districts (0.057).

Livelihood Vulnerability in Northern Districts

Northern districts are more exposed to extreme weather events than southern districts. Mayurbhanj, Sambalpur and Sundergarh districts are more vulnerable to climatic events. Keonjhar, Balasore, is less affected by climate events. Climatic events like maximum temperature are the extreme events in Sambalpur and Keonjhar districts.

Table 4 Major components in Northern districts

Major Components	Exposure			
Sub-Components Districts	**Sambalpur**	**Sundergarh**	**Keonjhar**	**Mayurbhanj**
Av. Temperature	0.61	0.72	0.21	0.79
MaxT	0.68	0.54	0.69	0.73
MinT	0.66	0.53	0.64	0.19
Precipitation	0.63	0.76	0.23	0.89
Av-	0.65	0.64	0.44	0.65
Information Skill And Infrastructure	**Adaptive Capacity**			
FWPR	0.43	0.62	0.54	0.44
WPR	0.42	0.56	0.55	0.43
Literacy rate	0.39	0.67	0.65	0.5
% villages electrified	0.58	0.5	0.63	0.54
Social Network				
Ratio of P.School/1000	0.44	0.39	0.54	0.46
% UPS/1500	0.58	0.52	0.55	0.39
%HS/1500	0.58	0.52	0.58	0.54
% Households access to Pension	0.35	0.34	0.73	0.24
% Household access to MGNREGA	0.46	0.43	0.45	0.49
Av	0.47	0.51	0.58	0.45
Sensitivity				
Population ST	0.56	0.44	0.47	0.37
Percentage of Female	0.33	0.43	0.42	0.49
Percentage of Children	0.55	0.39	0.43	0.4
Population Density	0.61	0.37	0.98	0.5
Percentage of Illiterate	0.61	0.33	0.35	0.49
Percentage Agr to TL	0.41	0.39	0.55	0.42
% Crop not irrigated	0.48	0.81	0.65	0.69
Net area sown (Acres)	0.55	0.54	0.72	0.55
Doctors per 5000P	0.36	0.23	0.55	0.37
Av-	0.5	0.44	0.57	0.48

Source: Computed

Sundergarh and Mayurbhanj districts were affected by precipitation. Adaptive capacity varies across the northern districts. Mayurbhanj district has the least adaptive capacity among the northern districts, and % household access to pension is the least adaptive capacity component. Less adaptive components in Sambalpur are household access to pension and literacy rate. In Sundergarh district, the low adaptive components are % household access to pensions and the ratio of primary schools. Access to MGNREGA is a less adaptive component in Keonjhar district. Keonjhar and Sambalpur districts have the highest sensitivity score among northern districts. Population density, net area sown, and % crop not irrigated are more sensitive in Keonjhar district. Population density, percentage of illiterate and ST population are more sensitive in Sambalpur district (Table 4).

All northern districts under TSP have more or less similar LVI index. The most vulnerable is Keonjhar, followed by Sambalpur and Sundergarh. In terms of vulnerability index, Mayurbhanj and Sambalpur districts are more vulnerable to climatic events. But the Keonjhar is negatively affected by climatic events (Table 5).

Table 5 Livelihood Vulnerability Index (LVI) and Vulnerability Index (VI)

Name of the District	Exposure	Sensitivity	Adaptability	LVI	VI
Sambalpur	0.65	0.5	0.47	0.52	0.09
Sundergarh	0.64	0.44	0.51	0.51	0.06
Keonjhar	0.44	0.57	0.58	0.55	-0.08
Mayurbhanj	0.65	0.48	0.45	0.50	0.10

Source: Computed

Livelihood Vulnerability in Southern Districts

The southern districts mostly affected by climate exposure are Malkangiri, Gajapati and Nowrangpur. Malkangiri district is severely affected by precipitation. Gajapati is affected by temperature, and the minimum temperature is in Nowrangpur. Less adaptable districts are Koraput, Kandhamal and Gajapati. Koraput has fewer upper primary schools.

Table 6 Major components of Southern districts

Major Components				**Exposure**		
Sub components Districts	**Gajapati**	**Kandhamal**	**Raygada**	**Nowrangpur**	**Koraput**	**Malkangiri**
Temperature	0.78	0.84	0.76	0.34	0.21	0.58
MaxT	0.65	0.41	0.48	0.51	0.16	0.56
MinT	0.36	0.31	0.44	0.78	0.26	0.55
Precipitation	0.43	0.49	0.36	0.43	0.62	0.61
Av-	0.56	0.51	0.51	0.52	0.31	0.58
Information Skill And Infrastructure Adaptive Capacity						
FWPR	0.54	0.16	0.34	0.59	0.45	0.53
WPR	0.56	0.59	0.32	0.47	0.42	0.57
Literacy rate	0.59	0.57	0.38	0.43	0.39	0.48
% villages electrified	0.38	0.34	0.55	0.41	0.4	0.52
Social Network						
Ratio of P.School/1000	0.58	0.29	0.46	0.36	0.38	0.46
% UPS/1500	0.43	0.31	0.66	0.63	0.18	0.33
%HS/1500	0.34	0.51	0.61	0.97	0.47	0.6
% Households access to Pension	0.29	0.52	0.39	0.48	0.38	0.58
% Household access to MGNREGA	0.33	0.36	0.57	0.45	0.47	0.46
Av	0.45	0.41	0.48	0.53	0.39	0.5
Sensitivity						
Population ST	0.39	0.34	0.35	0.43	0.39	0.45
Percentage of Female	0.58	0.27	0.61	0.37	0.49	0.34
Percentage of Children	0.49	0.14	0.5	0.48	0.37	0.35
Population Density	0.38	0.34	0.33	0.72	0.53	0.33
Percentage of Illiterate	0.41	0.42	0.61	0.57	0.84	0.52
Percentage Agr to TL	0.54	0.5	0.32	0.49	0.59	0.57
% Crop not irrigated	0.7	0.61	0.61	0.75	0.77	0.74
Net area sown (Acres)	0.3	0.44	0.31	0.41	0.44	0.54
Doctors per 5000P	0.43	0.18	0.48	0.34	0.42	0.47
Av-	0.47	0.36	0.46	0.51	0.54	0.48

Source: Computed

Kandhmal has a lower female worker participation rate and fewer primary schools. In the Gajapati district, % of households have less access to pension and MGNREGA. More sensitivity scores were found in the Koraput and Nowrangpur districts. Illiteracy and % crop not irrigated were more sensitive in Koraput. In Nowrangpur, % crop not irrigated and population density were more sensitive (Table 6).

Livelihood vulnerability indices were higher in Nowrangpur and Malkangiri districts. In terms of vulnerability index, districts like Gajapati, Kandhamal and Malkangiri are mostly affected by climatic exposure. But very little climatic effect falls on the Koraput, Nowrangpur and Rayagada districts (Table 7).

Table 7 Livelihood and vulnerability index (LVI) and Vulnerability Index (VI)

Districts	Sensitivity	AC	Exposure	LVI	VI
Gajapati	0.47	0.45	0.56	0.48	0.05
Kandhamal	0.36	0.41	0.51	0.41	0.04
Raygada	0.46	0.48	0.51	0.48	0.01
Nowrangpur	0.51	0.53	0.52	0.52	-0.01
Koraput	0.54	0.39	0.31	0.44	-0.04
Malkangiri	0.48	0.5	0.58	0.51	0.04

Source: Computed

IV. Conclusion

The sensitivity and adaptive capacity index scores in the TSP area were quite similar, but the exposure index score was not. A total of 22 sub-indicators were analysed to estimate the vulnerability index. Indicators such as a crop not irrigated and more illiterate persons were contributing more to the vulnerability. Less adaptive factors were access to pension and MGNREGA. Exposure was not a major contributing factor to vulnerability. Sensitivity and low adaptive capacity were more contributing factors to vulnerability in the TSP area. LVI was more prevalent in the Northern districts of the TSP area in Odisha than in the southern districts, but the southern districts have low adaptive capacity. High sensitivity components were cropland not irrigated, net area sown and a larger female population.

Mayurbhanj, Sambalpur and Sundergarh districts were more vulnerable to climatic events among northern districts. Mayurbhanj was the least adaptive district. The least adaptive factors were the percentage of households with access to pension, literacy rate, ratio of primary schools and access to MGNREGA in northern districts. Keonjhar and Sambalpur districts were more sensitive to livelihood vulnerability. Sensitive factors were population density, net area sown, percentage of crop not irrigated, illiteracy and tribal population in northern districts.

The districts mostly affected by climate exposures were Malkangiri, Gajapati and Nowrangpur among the southern districts. Less adaptive districts were Koraput, Kandhamal and Gajapati. Adaptive factors contributing to vulnerability were fewer primary schools, a percentage of households with less access to pension and MGNREGA. More sensitive score districts were Koraput and Nowrangpur. Illiteracy, crop not irrigated, and population density were more sensitive factors in the southern districts.

Implications of the Study

This research has identified the high sensitivity sub-indicators and low adaptive capacity indicators contributing to vulnerability in the TSP area of Odisha. The vulnerability among tribal can be transferred from one generation to another as an externality causes market failure. A study by Behera and Mishra (2022) highlighted that there was a significant gap in irrigation, education, food security and socio-economic status between TSP areas. My study also found that there was a significant difference in the livelihood vulnerability index among northern and southern districts. Both southern and northern districts were less adaptive in access to pension and MGNREGA, with fewer primary schools. The northern district, like the Sambalpur district, was the least adaptive in literacy rate. Similarly, more sensitivity factors in both the southern and northern districts were illiteracy, crop not irrigated and population density. Apart from these factors, the net area sown and the tribal population were sensitive factors in Keonjhar and Sambalpur districts.

Therefore, the policy should focus on the enhancement of literacy, the provisioning of proper irrigation facilities, the provisioning of more primary schools and ensuring the inclusion of more tribes in government schemes to reduce vulnerability in Tribal Sub-Plan blocks in Odisha. Region-specific policy is needed to address the vulnerability. This study will not only help the researcher, policy maker and practitioner to reduce vulnerability among the indigenous communities in Odisha but also in other part of the world.

Limitations and Recommendations for Future Research

The vulnerability study mostly captures both primary and secondary data. Comprehensive vulnerability can be better understood from the primary data. This study estimates the vulnerability through secondary data. The inclusion of primary and current secondary data would have added more flavour to the present study; nevertheless, the study contributed to the present discourse.

Conflicts of interest

I have no conflicts of interest for the publication of this paper.

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