Understanding Livelihood Vulnerability in Dry Regions: Insights from Karnataka

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Abstract

In arid regions like India, sustaining livelihoods is challenging due to climate change impacts. Rural-urban migration persists due to limited manufacturing growth and scarce rural opportunities. Vulnerability, as per Inter-governmental Panel of Climate Change, depends on sensitivity, exposure, and adaptive capacity, affecting water scarcity, food insecurity, and poverty. Adaptive capacity, influenced by education, assets, and information access, is crucial for climate adjustment. This study focuses on livelihood vulnerability in highly vulnerable districts in northern Karnataka, selecting 237 households via multi-stage proportionate random sampling, categorized by Literate Household Heads and Illiterate Household Heads. Key results of data analyses lead to policy implications, such as, enhancing literacy, crop insurance access, income diversification, increased rural development budget, and constructing vulnerability indices for targeted interventions in Karnataka state.

JEL Classification Code: *Q22, R3, O130, A100*

1. Introduction

Inhabitants of arid and semi-arid regions around the world, especially developing countries like India face unique challenges in sustaining their livelihoods. These regions, often characterized by limited and erratic rainfall, extreme temperatures and fragile ecosystems, are particularly vulnerable to the impacts of climate change and environmental degradation. As the global climate continues to evolve, the issue of livelihood vulnerability in dry regions has gained increasing attention from researchers and policymakers. In India, livelihood pattern is very diverse and highly connected with the natural resources due to dependency on agriculture and allied sectors. Livelihood have five capitals (assets); human capital, financial capital, physical capital, social capital and natural capital (Datta and Sharma, 2008). These capitals are interlinked each other, and give livelihood sustainability to the household or community. As a result of majority of people living in rural area, growth of manufacturing sector is low and livelihood opportunities for them scares (Khan, 2017), they move towards cities and employed in low paid occupations.

Vulnerability is a situation of a system which easily susceptible to the uncertain happenings. Inter-governmental Panel of Climate Change (IPCC) defined vulnerability as a function of sensitivity, exposure and adaptive capacity (Rao et al., 2017). Sensitivity is the degree to which a system is affected, either adversely or beneficially by climate related stimuli. It is determined by demographic and environmental conditions of the region concerned. Exposure is the nature and degree to which system is exposed to significant climatic variations. Adaptive capacity is the ability of a system to adjust to climate change including climate variability and extremes. Adaptive capacity is determined by education, asset possession, access information, skills, management capacity etc. The vulnerability encompasses a broad range

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of interconnected factors, including but not limited to water scarcity, food insecurity, poverty and the degradation of natural resources. It reflects the complex relationship between the environment, society and economic systems in these challenging environments. Around 35 percent of the population lives in the dryland area (CIESIN, 2004 via Patnaik, 2010). Dryland is defined as situation of soil's moisture which fails to grow vegetation, and lead to low organic matter and productivity.

The review of literature (Datta and Sharma, 2008; Bhattacharjee, 2010; Rao et. al., 2017) reveals that most of the studies have focused on livelihood patterns in dry regions, drought impact on livelihoods, household conditions, especially household asset ownership, agriculture vulnerability and coping strategies. But very few have linked climate variability, livelihood vulnerability, coping up mechanisms and government intervention at the household level, especially the asset-poor households. Hence, the present study seeks to address the nature and extent of livelihood vulnerability of people in dry regions; understand the reasons for livelihood vulnerability in dry regions; and evaluate the adaptation and mitigation strategies of the households to minimize livelihood vulnerability, especially drought vulnerability between IHHs (Illiterate Headed Households) and LHHs (Literate Headed Households) in Karnataka State.

2. Methodology

Kumar et. al. (2016) note that three-fourth of the districts of northern Karnataka are categorized under very high degree of vulnerability. Therefore, the present study concentrates on northern districts of Karnataka state, particularly selected Rona taluk of Gadag district and Kushtagi taluk of Koppal district as these districts are classified as highly vulnerable districts (KSNDMC, 2017). Further, two villages for each taluk are selected for the primary data collection, namely; Lakkalakatti and Kalliganoor villages from the Rona taluk (now these villages are located in newly formed taluk named Gajendragad) and Jahagir Gudadur and Paramanahatti villages from the Kushtagi taluk. According to respective taluk revenue officials, these villages were severely affected by the drought and many people migrated for their livelihood. The present study used multi-stage proportionate random sampling technique for selection of households in the study area and listed poor, landless, migrated, women and IHHs in each village and 16 percent of households in each village are chosen as sample households. This sample size is in proportion of rural poverty rate in 2009-10 in Karnataka State (Prabhavathi and Naveena, 2014). Thus total sample is, 237 households. By adopting lottery method, the data is collected from these households. The primary data is collected during the month of August, 2021 (Kampli, R. S., 2021)

In addition to descriptive tools, Socio-Economic Index (SEI), Integrated Livelihood Index (ILI) and Drought Vulnerability Index (DVI) are constructed using the UNDP-HDI methodology as illustrated in Annexture 1. For positively related variables, the index is calculated as (actual - minimum) / (maximum - minimum); for negatively related variables, it's (maximum - actual) / (maximum - minimum). Correlation and regression analyses are used to estimate the impact of livelihood capitals (human, financial, physical, social, and natural) on reducing vulnerability.

3. Analysis of Results

Livelihoods in an area depends on two main factors; internal and external (Datta and Sharma, 2008). Internal conditions include demographic settings which include literacy level, occupational condition, agriculture etc. Outside or external conditions include environmental condition (rainfall, temperature, land, waterbodies etc.), market condition, policies, demand condition etc. Briefly, internal conditions enable the household or the region to face any exacerbated circumstances by their own capacity. On the other hand, external conditions help farmers to withstand with

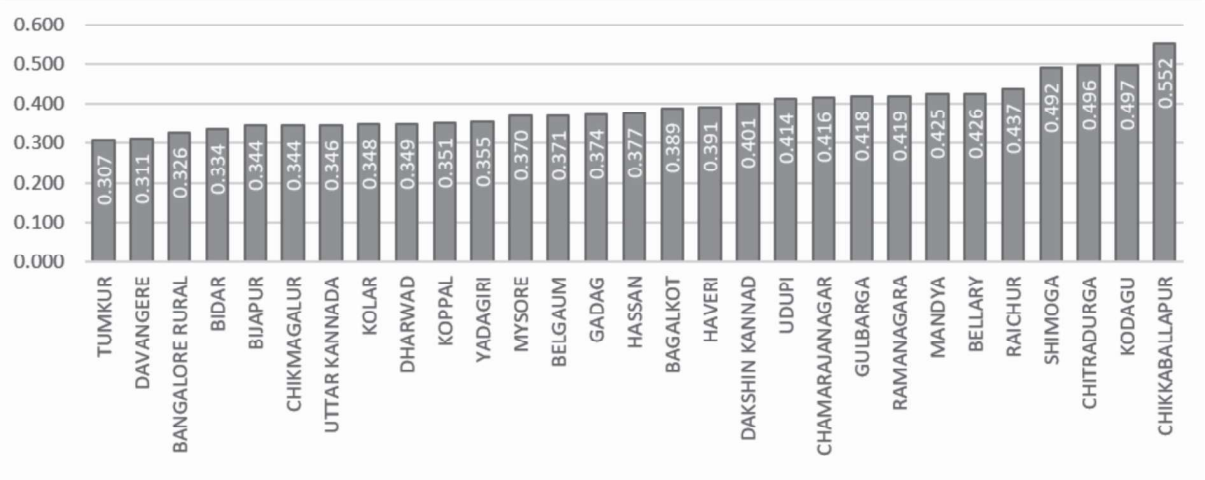
external circumstances. Hence, socio-economic conditions of the study area, adaptive capacity of the households' livelihood conditions and drought vulnerability are essential to our analysis.

3.1. Socio-Economic Condition of the Study Area

The Figure 1 explains the Socio-Economic Index (SEI), which is constructed with key variables to reflects the socio-economic condition of the region. The essential factors encompassed in this assessment include the agricultural status of the districts, having livestock, literacy level, the composition of the working population and average rainfall experienced in each district.

The district-wise SEI of Karnataka reveals a diverse levels of development, ranging from 0.307 to 0.552. Notably, Chikkaballapur, Chitradurga, and Kodagu exhibit higher SEI values or better in socio-economic conditions, while Tumkur, Davangere and Bangalore Rural potential socio-economic challenges with lower SEI values. The varying indices emphasize the need for selective interventions and policy approaches. For instance, more than half of total districts scored less than 0.400 in SEI. Parameters like agriculture, literacy and working population are the major contributors in this index, and their poor performance contribute to lowering the score. Gadag and Koppal districts (which are selected for the primary survey) score 0.374 and 0.351 respectively, indicating that the weak socio-economic performance of the districts makes them easily susceptible to uncertainties. People in such places are vulnerable and their livelihoods are unsustainable.

Figure 1: District wise Socio-Economic Index (SEI) of Karnataka



Source: Authors' construction.

Thus, primary data collection survey is conducted in Gadag and Koppal district and 237 total sample households. Here we bifurcated the data based on condition of literacy of a family (household) head as illiterate and literate. Because a head of a family plays a vital role in decision making and influence household livelihood condition and sustainability (Vatta et al, 2017) and leads a major role in household coping up strategy (Suan et al, 2020). Based on this reason, we explore how education of the family head influence on livelihood sustainability and withstand with the vulnerability.

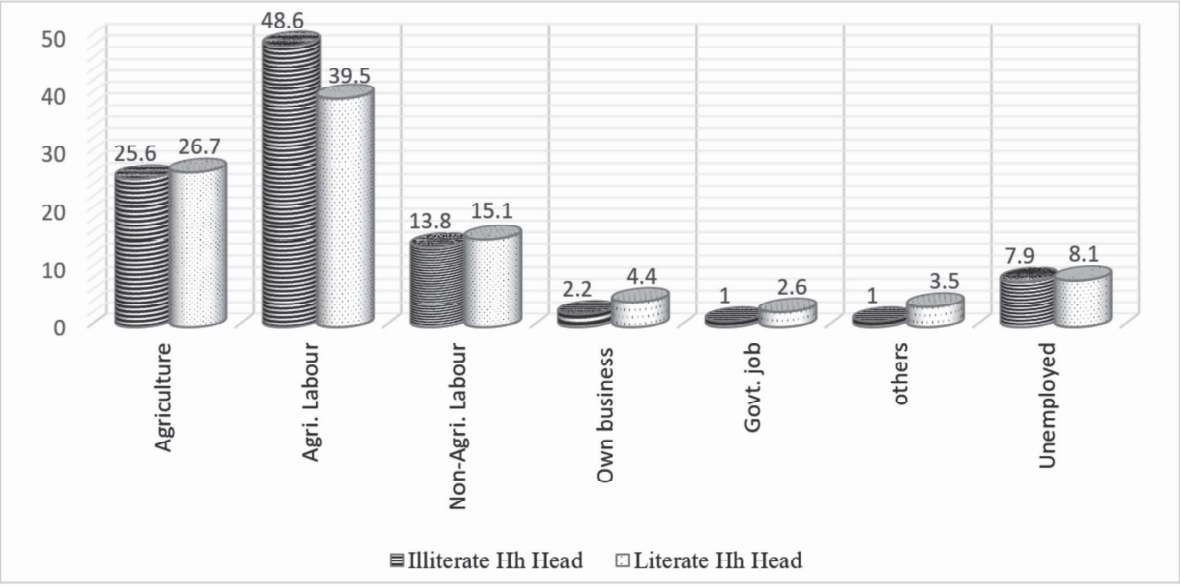
Educational qualifications of household members, categorized by the literacy status of a

household head. It details education levels from illiterate to postgraduate and professional courses. Overall, Illiterate Household Heads (IHHs) have higher illiteracy rates. Education levels decrease as we move towards higher education. IHHs have fewer members with primary or professional education compared to Literate Household Heads (LHHs). IHHs also have fewer literate members per household. Vatta et al. (2017) note that illiterate household heads contribute to household vulnerability due to their limited decision-making capacity and awareness.

In the same way, occupational status also contributes to livelihood vulnerability. Unsustainable occupations, which are influenced by external (as well as internal) fluctuations, are easily susceptible to changes. For instance, agriculture and related works are influenced by weather-related conditions, unorganized sectors, and private businesses influenced by local governance policies, etc. Generally, rural people are largely dependent on agriculture and related activities for their livelihoods (Gondwe, 2019), which are highly vulnerable climatically (Arora and Birwal, 2017).

In our sample, a higher number of households derive their livelihoods from agricultural labor compared to other occupations (48.6 percent for IHHs and 39.5 percent for LHHs as shown in **Figure 2).** Following agricultural labor, occupations in non-agricultural labor are the next most common. About 4 percent of households are engaged in their own businesses, and 2.6 percent have government jobs in LHHs. Approximately 8 percent of households have unemployed members in both IHHs and LHHs. This illustrates that the majority of households rely on agriculture and related activities for their livelihoods, making them more susceptible to changes in weather conditions, especially in IHHs.

Figure 2: Occupation Status of the people of sample households (in percent)



Source: Authors' calculation using data from the Field Survey.

In the same way basic household status like house condition, size, marital status, getting government facilities etc. are important to the household sustainability. Table 1 gives basic data on household status by these indicators.

Table 1: Basic Indicators Household Status

Household status			IHHs	LHHs	Total
% Households (Hh) having Ration card			98.4	92.6	95.8
Average Household size (no. of members per Hh)			4.8	5.0	4.8
% of female members			48.6	47.4	48.0
% of Pakka Households			48.8	72.2	59.5
Average rooms per household			2.3	2.5	2.4
% of Households having electricity connection		Connection through Bhagya Jyoti	60.5	57.4	59.1
		Personal Connection	39.5	42.6	40.9
Cooking Fuel	% of Hh using Wood only		45.7	43.5	44.7
	% of Hh using Gas only		10.9	9.3	10.1
	% of Hh using both fuels		43.4	47.2	45.1
% of Hh having Toilet facility			58.9	63.9	61.2
Drinking Water supply	% of Hh having own tap		31.0	33.3	32.1
	% of Hh having public tap		62.0	63.9	62.9
	% of Hh having tanker supply		7.0	2.8	5.1
% of Hh having home appliances (more than 3 items)			43.4	60.2	51.1
% of Hh having Agriculture appliances			45.0	63.0	53.2

Source: Same as Figure 2.

Table 1 compares household characteristics based on the literacy status of the household head. IHHs rely more on government subsidies, have smaller average household sizes, and fewer rooms per household. They also exhibit lower access to electricity and modern cooking fuels. In contrast, LHHs enjoy better housing conditions, larger average household sizes, more rooms per household, higher access to utilities and ownership of home and agriculture appliances. The data highlights the significant impact of literacy on socio-economic condition and household well-being, emphasizing the importance of education in improving living standards.

Knowledge and skills are vital for improving the status of individuals, households, and communities. Skill acquisition enhances livelihoods by increasing employability, income (Harper et al., 2012), and adaptability to changing job markets. Conversely, school dropouts exacerbate livelihood vulnerability by limiting access to education and skill development, reducing job prospects and earnings, and perpetuating poverty cycles. Lack of education also hinders individuals' ability to cope with economic shocks and adapt to new technologies. Our sample highlights disparities in skill acquisition and school dropout rates, with LHHs showing higher skill acquisition and lower dropout rates compared to IHHs.

In rural areas, land ownership is crucial for securing livelihoods. It provides opportunities for agricultural activities, such as farming and

livestock rearing, which are primary sources of income for rural populations (Goldin, 2016; Vatta et al, 2017; Arora and Birwal, 2017). Additionally, land ownership offers a sense of stability and security, allowing individuals to invest in their land for long-term sustainability. Overall, access to land plays a fundamental role in sustaining rural livelihoods and encourage economic development in these communities. **Table 2** explains land holding status of sample households.

Table 2: Nature of Land Holding (in Acre)

Land	IHHs	LHHs	Total
Average Land	2.6	3.1	2.8
% of Irrigated Land	9.3	11.6	10.5
% of Dryland	85.8	79.9	82.7
% of Fallow land	4.9	8.4	6.8
Average Land distance (in Km) from village	1.5	1.8	1.6

Source: Same as Figure 2.

The table shows that IHHs have smaller average land holdings, with a higher percentage of dryland, compared to LHHs. LHHs have a larger land holdings and more irrigated land, suggesting better access to water resources and irrigation infrastructure. LHHs also have more fallow land, indicating strategic land management, but their land is farther from the village. Thus, addressing land access disparities and promoting sustainable practices can improve livelihoods and resilience in rural communities.

Table 3: Agriculture Production, Expenditure and Yield in Kharif and Rabi Seasons

Category	Seasons	IHHs	LHHs	Total
Average cultivated land (in acre)	In Kharif	2.2	2.3	2.3
	In Rabi	1.4	1.6	1.5
Expenditure per Acre (in Rs)	In Kharif	8,520	7,746	8,129
	In Rabi	7,158	5,747	6,418
Yield per Acre (in Quintal)	Kharif(N)	2.8	3.5	3.1
	Rabi(N)	3	2.9	2.9
	Kharif(D)	1	1.3	1.2
	Rabi(D)	1.4	1.2	1.3

Source: Same as Figure 2.

Note : N: Normal Year, D: Drought Year.

Table 3 compares agricultural production, expenditure and yield between IHHs and LHHs during Kharif and Rabi seasons. While both groups cultivate similar land sizes, IHHs incur higher expenditures (Rs. 8,520) per acre. Despite this, LHHs consistently achieve a higher yields per acre in both normal and drought years, indicating potential advantages in farming knowledge and adaptive strategies. Addressing literacy disparities and providing support for agricultural education could help narrow productivity gaps and enhance resilience among rural households facing

climatic uncertainties, contributing to sustainable agricultural development.

On the other hand, income from agriculture and allied activities, non-agriculture laboring and own businesses are vital sources of livelihood for many households, especially in rural areas (Goldin, 2016). However, these sources of income are vulnerable to fluctuations, such as market instability (Bhattacharjee, 2010), environmental factors and policy changes. Dependence on a single income stream can amplify vulnerability, as fluctuations in one sector can significantly impact overall income. Banerjee and Duflo (2007) argued that multiple occupations are stronger in rural area.

Table 4: Per capita (Rs) Household income per year by sources in Normal days and Drought situation

Income sources	IHHs		LHHs		Total	
	Normal days	Drought situation	Normal days	Drought situation	Normal days	Drought situation
Agriculture	3,922	1,441	4,709	1,777	4,289	1,598
Agri. Labours	11,938	2,642	9,104	1,709	10,615	2,207
Dairying	1,525	514	1,585	460	1,553	489
Non agri. Labours	3,922	2,866	3,000	2,424	3,492	2,660
Own Business	1,464	1,192	3,733	2,938	2,523	2,007
Government job	2,078	2,078	4,198	4,198	3,067	3,067
Other	276	207	1,403	1,377	802	753

Source: Same as Figure 2.

Table 4 depicts income sources among households led by illiterate and literate heads during normal days and drought situations. Agriculture remains a primary income source, with slight variations and situations. Additionally, non-agricultural labour, own businesses and government jobs contribute more or less stable household incomes. Drought situations generally lead to reduced incomes across all sectors except government and some privet sector jobs. However, LHHs tend to earn more consistently across income sources compared to IHHs during both normal days and drought situations. Drought impacts on agriculture and related (agriculture labouring and dairying) incomes. Therefore, drought make these households vulnerable.

Drought not only reduces household income but also impacts livestock, crucial for many small and marginal farmers' additional income (Arora and Birwal, 2017). During drought, feeding livestock becomes difficult (Rurinda et al., 2014; Mphande and Annie, 2016), leading to the sale of animals as a coping strategy (Joshi, 1999). Our study shows a reduction in livestock per household, indicating asset loss due to drought.

Apart from this, the study constructs socio-economic index (SEI) based on parameters **(Table 5)** which influence socio-economic status of sample households. SEI is invaluable for households in dryland regions, where agricultural productivity and access to resources are often constrained. It enables these households to assess their economic and social status accurately, helping them identify areas for improvement and prioritize their needs. For instance, by considering indicators like per capita income, asset possession and access to irrigation, households can understand their vulnerability to drought and plan accordingly.

Table 5: Socio-Economic Index (SEI) for Households

Parameters	LHHs	IHHs
Percent of members literates in the household	0.707	0.455
Percent of members working in the household	0.590	0.612
Per capita income of the household in normal days (in Rs)	0.199	0.146
Percent of households having pakka house	0.722	0.488
Per Capita Value of Home Assets in The Household	0.163	0.181
Per Capita Value of Agriculture Assets in The Household	0.053	0.061
Percent of Households Having Tractors	0.037	0.047
Household average land holding size (in acre)	0.222	0.275
Household having irrigated land (in acre) % of irrigated land	0.151	0.096
Household having fallow land (in acre) % of fallow land*	0.947	0.985
Percent of members having various accounts	0.986	0.961
Per capita value of livestock	0.212	0.198
Percent of households having electricity	1.000	1.000
Percent of Hhs having Toilets	0.639	0.589
Average Distance of field of household from village (in km) *	0.853	0.765
Percent of members in household working in non-agriculture sector	0.481	0.434
Percent of members in household working in salaried job	0.083	0.031
Percent of Unemployed members in Hhs*	0.741	0.752
Percent of Households having membership in any social groups	0.000	0.008
Per capita loan taken by Hhs (loan per Member) *	0.165	0.127
Socio-Economic Index	**0.447**	**0.411**

Source: Same as Figure 2.

* These parameters are negatively related with SEI.

The table 5 provides a comprehensive overview of how literacy influences various socio-economic parameters, as reflected in the SEI. Comparing households with literate and illiterate heads, LHHs consistently exhibit higher SEI scores (0.447). They boast better education levels, reflected in higher literacy rates among members, and higher rates of employment in non-agricultural sectors and salaried jobs. This translates into higher per capita income and greater ownership of assets, including homes and agriculture assets. Moreover, LHHs have superior access to basic amenities like pucca houses, electricity, and toilets, indicating a higher standard of living. They also demonstrate a more active participation in financial systems, with higher percentages of members having various accounts.

These findings highlight the critical role of literacy of household head in shaping socio-economic outcomes, highlighting the importance of education as a catalyst for improving overall well-being and fostering less vulnerable within communities. On the other hand, IHHs scored 0.411 in SEI which is due to less irrigated land, per capita income, literates in the household etc. Overall, both households (LHHs and IHHs) scored less than 0.500 indicating that asset possession is poor in these households and highly vulnerable to the unexpected shocks in the system (Sahu, 2018) and their livelihoods become unsustainable.

3.2. Adaptive Capacity and Livelihood Conditions of the study Area

Households particularly in dryland employ adaptive strategies (Angels et al, 2011; Patnaik, 2010; Rao et al, 2017) to sustain livelihoods amidst uncertainties, which is defined as an ability of the system to withstand (or even adjust) with the uncertainty (Rao et al, 2017). These strategies are vital for mitigating risks posed by factors like drought, water scarcity and soil degradation, ensuring food security and economic stability. By diversifying income sources, conserving resources and encourage community cooperation, households enhance resilience, enabling them to withstand environmental challenges and maintain sustainable livelihoods in severe conditions. Table 6 provides important insight about adaptive capacity of the sample households, where we can notice that Adaptive Capacity Index (ACI) is higher for LHHs than the IHHs which demonstrate literacy plays a significant role in adaptive capacity.

Table 6: Adaptive Capacity Index (ACI) of the Sample Households

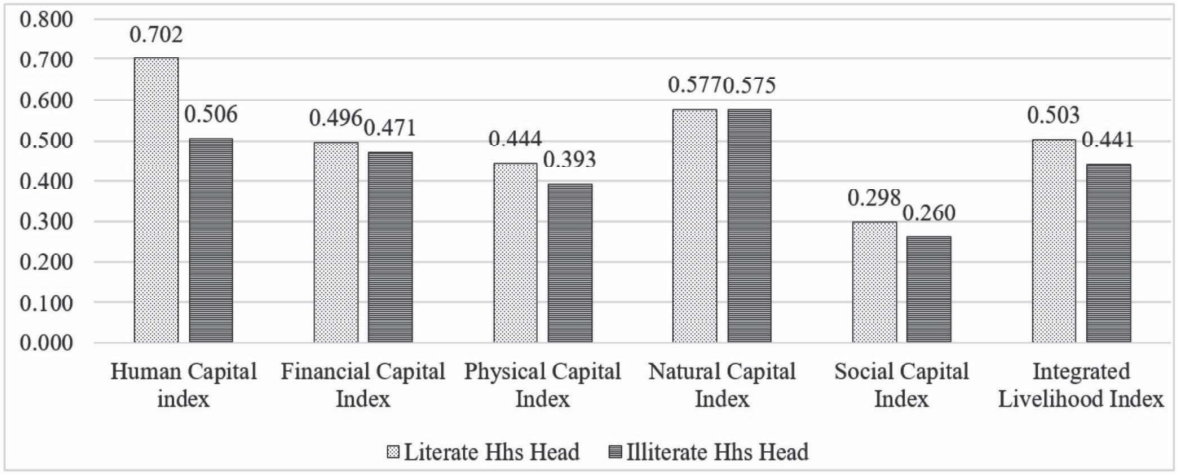
Parameters	LHHs	IHHs
Precent of Hhs having literate household head	1.000	0.000
Precent of Hhs members having vocational education (ITI, Diploma etc.)	0.231	0.101
Percent of working members in the household	0.590	0.612
Percent of non-agriculture workers	0.097	0.091
percent of Hhs heard about climate change	0.769	0.744
Precent of Hhs having information about drought before its occurrence	0.352	0.357
Percent of Hhs reduce cultivation land	0.389	0.318
Precent of Hhs use less water intensive crops	0.259	0.225
Precent of Hhs change sowing time	0.287	0.256
Precent of Hhs interest in mixed farming	0.250	0.240
Precent of Hhs construct farm ponds	0.139	0.124
Precent of Hhs taken crop insurance	0.574	0.434
Precent of Hhs start non-agriculture activities	0.694	0.705
Precent of Hhs postponed household functions	0.657	0.721
Precent of Hhs work in MGNREGs during drought	0.722	0.767
Precent of Hhs reported migration during drought situation	0.611	0.597
Precent of Hhs having any social securities	0.963	0.992
Precent of Hhs using old savings	0.796	0.899
ACI	**0.521**	**0.455**

Source: Same as Figure 2.

LHHs demonstrate good adaptability across parameters, boasting higher levels of awareness, education and engage in non-agricultural activities. They exhibit proactive measures such as taking vocational training, crop insurance adoption and land use adjustments (Patnaik, 2010). In contrast, IHHs rely more on traditional coping up mechanisms. Strengthening literacy

and education efforts can substantially strengthen adaptive capacity, ensuring households are better equipped to navigate climate-induced adversities and fostering resilience in vulnerable communities. Adaptive capacity is determined by asset possession (Vatta et al., 2017) of the households, which according to Rao et al., (2017), is a function of wealth, technology, education, information, skills, infrastructure, access to resources, stability and management capabilities. These livelihood capitals make household withstand with the uncertainty. The figure 3 displays Integrated Livelihood Index (ILI) based on five capitals.

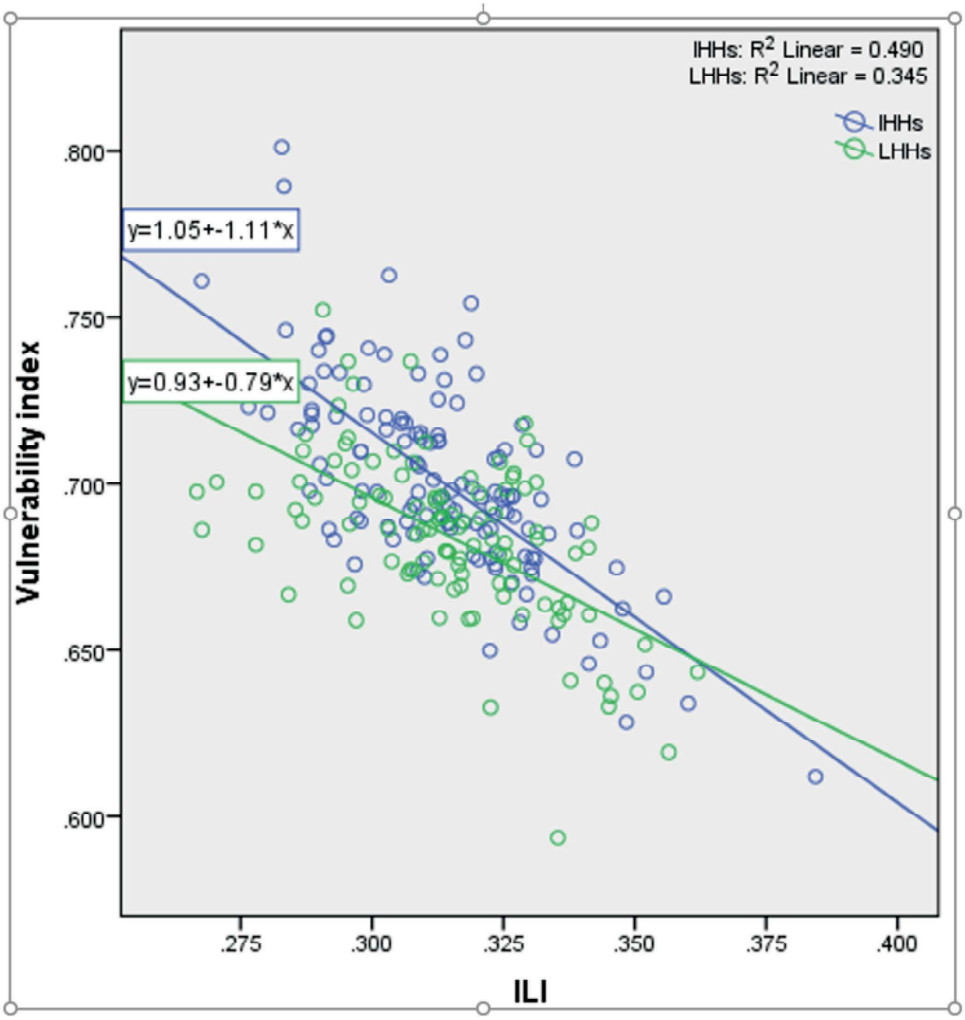
Figure 3: Integrated Livelihood Index (ILI)



Source: Same as Figure 2.

The figure compares ILI between LHHs and IHHs across various capitals. LHHs generally exhibit higher indices, indicating education's positive influence on livelihood. This trend is consistent across human, financial, physical and social capitals, suggesting literacy raises better access to resources and networks. However, both groups show similar levels of integrated livelihood concerning natural capital, implying its universal impact irrespective of literacy level of household head. Overall, compared to LHHs, ILI is lower for IHHs, illustrating that livelihood opportunities are more for well-trained, educated individuals than for those lacking these skills. This highlights the relationship between household livelihood and vulnerability (Figure 4), which reveals a negative correlation. Figure 4 indicates that improvements in livelihood factors tend to reduce vulnerability. As livelihoods strengthen, vulnerability decreases, signifying increased resilience to adverse circumstances.

Figure 4: Relationship between Livelihood and Vulnerability



Source: Calculated by Authors.

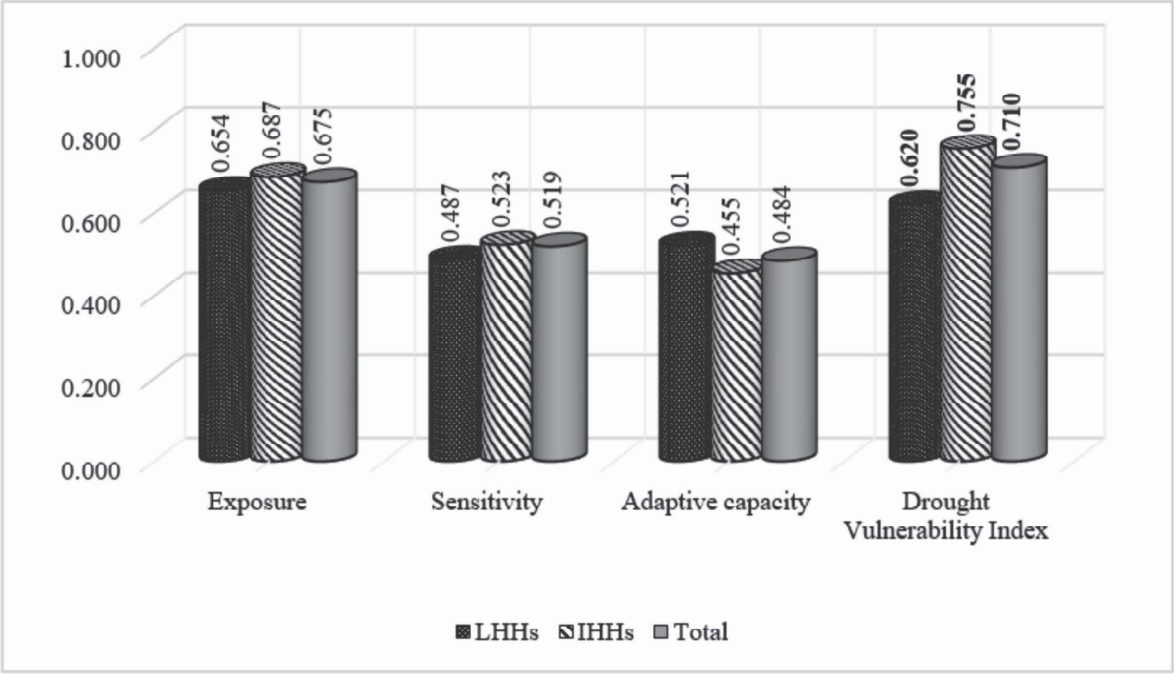
But this relationship varies between IHHs and LHHs where the trend lines intercepts and slopes are different. The intercept of IHHs trend line indicate that without livelihoods (0), their vulnerability is expected to be 1.05 which is higher than that of LHHs intercept (0.93). on the other hand, the vulnerability decreases more steeply with increasing livelihood for IHHs (-1.11) compared to LHHs (-0.79). This express that improvements in livelihood factors have a greater impact on reducing vulnerability for IHHs and initially, LHHs tend to have lower vulnerability than IHHs when livelihood factors are at their lowest.

3.3. Drought Vulnerability

Drought vulnerability in Karnataka is a pressing issue, intensified by erratic rainfall, water depletion, deforestation and climate change. This vulnerability disproportionately affects rural areas, where agriculture is a primary source of livelihood. Farmers face crop failures, reduced yields and financial stress, while livestock suffer from water scarcity and fodder shortages. Rural communities bear water stress, impacting daily life and livelihood. Migration to urban areas in search of employment (Goldin, 2016) becomes a necessity, further straining social and economic structures. Thus, assessing vulnerability is crucial

for rural dryland area to mitigate effects of such uncertainty. Here an attempt is made (in the Figure 5) to analyze impact of drought on household vulnerability through a Drought Vulnerability Index (DVI). It involves computation of Exposure Index (EI),[3] Sensitivity Index (SI)[4] and Adaptive Capacity Index (ACI); and amalgamating these three into a single composite index called the DVI (Singh and Hiremath, 2008; Panda, 2013).

Figure 5: Drought Vulnerability Index (DVI)



Source: Calculated by Authors.

This figure presents a comparative analysis of the DVI among LHHs and IHHs. Notably, IHHs exhibit a higher vulnerability with a DVI of 0.755 compared to LHHs at 0.620. This suggests a correlation between education level and resilience to drought. Additionally, exposure and sensitivity scores align with this trend, showcasing higher values for IHHs, which indicate that compared to LHHs, IHHs possess less assets (livelihood capitals) and these two parameters positively associated with vulnerability. But overall, the data underscores that vulnerability is highest regardless of any category at 0.710 which is due to lack of asset possession and weak environmental conditions (dryness, less rainfall, high temperature etc.)

3.4. Regression Analysis

Estimated the determinants of Livelihood Vulnerability Index (LVI) with independent variables like human capital, financial capital, physical capital, natural capital, and social capital and model found to be statistically significant at 0.01 level. The results are given in Table 7 and Table 8 below.

[3] *Exposure is the nature and degree to which a system is exposed to significant climate variations.*

[4] *Sensitivity is the status of an assetlessness of households (Rao et al, 2017; Nogbri et al, 2016).It is the system which affect livelihood, either positively or negatively.*

Table 7: Determinants of Livelihood Vulnerability for IHHs – Estimates of Multiple Regression Model

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)*	1.529	0.122		12.535	0.000		
Human Capital	-1.065	0.444	-0.102	-2.398	0.018	0.948	1.054
Financial Capital	-0.476	0.032	-0.655	-14.856	0.000	0.876	1.141
Physical Capital	-2.272	0.434	-0.235	-5.231	0.000	0.842	1.187
Natural Capital	-0.139	0.031	-0.202	-4.491	0.000	0.838	1.193
Social Capital	-1.370	0.506	-0.114	-2.708	0.008	0.964	1.038
R		R Square		Adjusted R Square		Durbin-Watson	
	0.889		0.791		0.782		1.795

Source: Calculated by Authors.

* Dependent Variable is Livelihood Vulnerability Index (LVI).

Additionally, there are no autocorrelation issues detected in these models, as indicated by the Durbin-Watson test of 1.79 and 2.04 for IHHs and LHHs, respectively. Furthermore, the variance inflation factor (VIF) values suggest the absence of multicollinearity problems among the independent variables. With R2 values of 0.79 and 0.72 for both models, it is evident that a significant percentage of the dependent variable (LVI) can be explained by the independent variables.

Table 8: Determinants of Livelihood Vulnerability for LHHs –Estimates of Multiple Regression Model

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)*	1.145	0.108		10.572	0.000		
Human Capital	-1.129	0.393	-0.164	-2.875	0.005	0.843	1.186
Financial Capital	-0.406	0.039	-0.59	-10.435	0.000	0.859	1.163
Physical Capital	-1.013	0.377	-0.15	-2.684	0.008	0.882	1.133
Natural Capital	-0.177	0.033	-0.309	-5.308	0.000	0.812	1.231
Social Capital	-0.562	0.543	-0.058	-1.035	0.303	0.872	1.147
R		R Square		Adjusted R Square		Durbin-Watson	
	0.849		0.720		0.706		2.048

Source: Calculated by Authors.

* Dependent Variable is Livelihood Vulnerability Index (LVI).

A comparison of the regression results for IHHs and LHHs reveals distinct determinants of livelihood vulnerability. Physical capital, encompassing productive assets, significantly affects vulnerability. A one percent increase in physical assets reduces vulnerability by 2.27 percent for IHHs, compared to 1.01 percent for LHHs. Similarly, a one percent increase in human capital (reflecting education and health) results in vulnerability reductions of 1.12 percent for LHHs and 1.06 percent for IHHs. Financial capital emerges as influential for both groups. Natural capital's effect appears slightly higher for LHHs. Social capital notably reduces vulnerability for IHHs but less so for LHHs, indicating a greater reliance on social networks for IHHs. Overall, the models suggest that physical and social capital significantly contribute to reducing vulnerability for IHHs, while human and natural capital play a more prominent role in vulnerability reduction for LHHs.

3.5. Government Support

Government (central and state) has designed a number of interventions to help the vulnerable people to overcome the immediate stress, or to overcome the general poverty. Through targeted initiatives, such as livelihood training programs, access to microfinance and skill development schemes, the government aims to empower individuals to create sustainable livelihoods. Additionally, welfare schemes offering food security, healthcare and housing assistance ensure basic needs are met. By encourage community resilience and socio-economic development, these efforts strive to uplift vulnerable populations and mitigate the impact of environmental challenges in Karnataka's dry regions. We collected primary data by asking the sample households about the nature of central and state government schemes accessed (shows in the **Table 9**).

Table 9: Percentage of Households Availing Benefits from the Government Schemes

Schemes	IHHs	LHHs	Total
Old age pension	39.5	42.6	40.9
Disabled pension	7.8	8.3	8.0
Widow pension	15.5	8.3	12.2
MGNREGA	76.7	72.2	74.7
Housing scheme	17.1	5.6	11.8
Crop Insurance	33.3	46.3	39.2
Annabhagya Yojana	96.1	90.7	93.7
Kisan Samman Nidhi	30.2	42.6	35.9
Ayushman Bharat Yojana	22.5	21.3	21.9
Rashtriya Swastya Bhima yojana	9.3	10.2	9.7

Source: Same as Figure 2.

The table illustrates that IHHs have higher participation rates across most schemes, indicating potentially greater dependence on government support. Schemes like Annabhagya Yojana and MGNREGA exhibit notably high participation among both groups, emphasizing their importance in providing food security and employment opportunities. However, LHHs show higher participation in schemes such as Crop Insurance and Kisan Samman Nidhi, reflecting their likely engagement in agricultural activities and use government benefits. Overall, the data highlights the diverse support mechanisms provided by the government to address the needs of vulnerable

households. But since government schemes come as post-facto schemes, i.e., after the risk situation hit the regions (Choudhury and Sindhi, 2017; Jadhav, 2019), poor people may not be able to sustain their livelihoods.

4. Conclusion and Implications

Livelihood vulnerability in dry area of Karnataka exacerbated by climate related factors like erratic rainfall, water scarcity, temperature increase, flood etc. and socio-economic conditions of an area where the agriculture is predominating livelihood, where most of the land relies on rainfall. The reliance on rain-fed agriculture makes communities particularly susceptible to climate variability, leading to economic instability and food insecurity. Adaptive strategies, such as sustainable water management, diversification of income sources and government support programs, are essential to mitigate these vulnerabilities. Addressing these challenges requires a coordinated effort to enhance resilience, ensuring sustainable livelihoods and improving the socio-economic conditions of the affected populations in Karnataka.

In our sample, many households found livelihoods through agricultural laboring, followed by agricultural and non-agricultural labor. LHHs generally enjoy better living conditions, access to sanitation, pukka homes, agricultural appliances, and more permanent housing compared to IHHs. These differences underscore the critical role of literacy in enhancing socio-economic status and resource access. Additionally, LHHs possess more agricultural land with higher proportions of irrigated land compared to IHHs. The impact of drought is more severe on dryland compared to irrigated land, which is reflected in the quantity of agricultural production. LHHs generally have higher literacy rates, income, non-agricultural employment, home assets, and participation in social groups, contributing to their highest SEI. However, overall, SEI indicates that the sample households are socio-economically poor.

LHHs also show higher adaptive capacities with better vocational education, crop insurance uptake, and climate change awareness. They employ more agricultural adaptation strategies. In contrast, IHHs rely more on social securities and old savings and participate more in MGNREGS during droughts. Overall, LHHs demonstrate stronger resilience compared to IHHs. LHHs score higher in most livelihood capitals, highlighting the benefits of education, while natural capital impacts both groups equally. It is clear that access to livelihood capitals reduces household vulnerability. Physical capital and social capital are crucial for reducing livelihood vulnerability among IHHs, while human capital contributes more for LHHs. LHHs benefit more from crop insurance and Kisan Samman Nidhi, indicating better resource access. IHHs rely more on MGNREGA and housing schemes, indicating higher dependency. Widow pension uptake is notably higher for IHHs. Both groups use Annabhagya Yojana extensively. However, further policy efforts are needed to enhance literacy with adult education and vocational training, improve access to crop insurance and irrigation to mitigate drought impacts, strengthen social securities and diversify income sources through non-agricultural employment, increase budgetary support for rural development, irrigation and flood control and promote participation in social groups to build community resilience. These are some common policy suggestions, but more than these, constructing a livelihood vulnerability index, drought vulnerability index, and socio-economic index at the district level is crucial. This would help policymakers concentrate on targeted areas to mitigate such vulnerabilities.

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