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Vulnerability of Farmers to Climate Change in Central Dry Zone of Karnataka

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Changing climatic parameters will have a huge effect on life and nature. Climate change will be best viewed through the increase in temperature, melting of ice and rapid rise in sea level. Such changes causes severe problems to human beings and other forms of life. Vulnerability to climate change is intimately related to poverty, as the poor are least able to respond to climatic stimuli. Further, certain regions of the world are more harshly affected by the effects of climate change than others. With this background the present study was carried out know the vulnerability of farmers to climate change in the Central Dry Zone of Karnataka with exposure, sensitivity and

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adaptive capacity as the dimensions. The study was conducted in the Central Dry Zone (Zone - IV) of Karnataka, India. Tiptur and Chiknayakanahalli *taluks* from Tumakuru district, Kadur from Chikmagalore district, Arsikere from Hassan district and Challakere from Chitradurga district were selected purposively for the study. The data was collected from 150 respondents. To exposure of farmers to climate change, rainfall and temperature were selected and the majority of farmers were severely exposed (0.822) and sensitive (0.894) to climate change with lower adaptive capacity (0.576) between the year 2013-2017. It shows that, 0.186, 0.226, 0.224, 0.220 and 0.241 was the Climate Vulnerability Index (CVI) of Arsikere, Kadur, Tiptur, Chiknayakanahalli and Challakere *taluk,* respectively. The overall CVI value of all *taluks* was 0.218. As per the result, all *taluks* were severely vulnerable to climate change.

Keywords: Climate change; vulnerability; farmers.

1. INTRODUCTION

Climate change has become a major ecological problem affecting the future survival and the expansion of mankind and it has involved extensive attention of governmental organizations and academic community in the world. Agriculture is one of the sectors most sensitive to climate change and any degree of climate change will bring likely or significant impact to agricultural production and related processes. Climate change has impacted the agriculture of India considerably and it will certainly have a huge impact on agricultural production in the future. Even though the impact will changes by locations, as a whole it mainly leads to adverse effects [1]. Estimation of climate change vulnerability is still a comparatively new field of study. IPCC developed a suitable research program specifically for measurement of climate change research work for indicating possible methods to evaluate (especially in a quantitative way) different natural structures, human systems. Since the 1990s, with the intensified research on climate changes impact on agriculture and adaptation, the vulnerability of agro-ecosystems and agricultural production to climate change has become the focus of attention for concerned scientists around the world.

The term vulnerability is broadly used in different disciplines, because of the differences in their study objects and knowledge conditions, understanding and description of vulnerability can be very different. The vulnerability was originally used in the field of disaster studies to correspond to the extent of the injury. Later, with the growing pressure of climate change issues, the concept was introduced to the field of climate science and the IPCC provided a preliminary elaboration of it. In 1996, the IPCC Second Assessment Report defined sensitivity and vulnerability. In 2001, the IPCC Third Assessment Report clearly defined the relationship between climate change sensitivity and adaptation and vulnerability with Equation as below.

Vulnerability = f (Exposure; Sensitivity; Adaptive capacity)

Exposure refers to the degree and the characteristics as a system exposed to significant climate variability; **sensitivity** refers to the degree of influence as a system stimulated by climate-related factors, including the adverse and beneficial effects**; adaptive capacity** refers to the ability to make protection and avoiding loss as the natural and man-made system affected by actual or expected climatic stimuli and their impacts. **Vulnerability** is defined as the degree to which a system is susceptible or unable to cope with adverse effects of climate change and it is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and adaptive capacity [2]. This definition has been generally accepted by the academic community [1]. The IPCC Fourth Assessment Report used the definition in the Third Report and provided a comprehensive explanation of the latest knowledge of climate change vulnerability and mitigation acquired by the international scientific community.

2. RESEARCH PROGRESS OF AGRICULTURAL VULNERABILITY TO CLIMATE CHANGE

Research work in the quantitative measurement of agricultural vulnerability to climate change is premature. Such a study has gone through three stages: the first stage was studying the vulnerability of crop yield, growth period among other indicators to temperature, precipitation and other climate factors [3,4] ; the second stage was mainly on the adaptation capability, focused on the exploration of adaptation and response measures [5] and the third stage not only dealt with the sensitivity of agriculture to climate change and adaptability, but it also account the ability of climate change mitigation.

From above all suggestions the present study was conducted to develop a suitable scale to measure the vulnerability and applied in the Central Dry Zone of Karnataka to understand the farmers vulnerability due to climate change.

3. METHODOLOGY

Research design is the most significant and crucial aspect of research methodology. Keeping in view and nature of the study, the descriptive research design was adopted for conducting the study as this was considered as most suitable. Descriptive research design is a systematic empirical in which the researcher has focused on a detail description of the phenomenon that the beneficiaries were experienced. The study was conducted in the Central Dry Zone (Zone - IV) of Karnataka, India. Tiptur and Chiknayakanahalli *taluks* from Tumakuru district, Kadur from Chikmagalore district, Arsikere from Hassan district and Challakere from Chitradurga district were selected purposively for the study. Villages from each of the *taluks* were selected randomly and the list of the villages from each of the *taluks* so selected was collected from the Revenue Department and then the five villages from each of the *taluk* were selected randomly for the study. In each of the village so selected, 2 farmers belongs to marginal, 2 from small and 2 from big farmers were listed and then the respondents were selected by applying systematic quota sampling technique. Thus, a total of 30 farmers from each Taluk and a total of 150 respondents constituted sample for the study. The scale on the vulnerability of farmers to climate change with exposure to rainfall and temperature, their sensitivity and adaptive capacity was worked out with index formula and ANOVA technique.

4. RESULTS AND DISCUSSION

4.1 Exposure of Farmers to Climate Change

Exposure index value was calculated based on the Exposure Index (EI) formula using scores obtained by each respondent to the individual statements under Rainfall and Temperature changes. The index value is between 0 and 1. A value near to zero reflects the low level of exposure and towards one shows high exposure of farmers to climate change particularly Rainfall and Temperature changes. Data in the Table 1 reveals that, the mean exposure index value of farmers in all *taluks* was 0.822. An equal proportion of exposure index value was observed in Arsikere (0.823), Kadur (0.841), Tiptur (0.824), Chiknayakanahalli (0.813) and Challakere (0.812). This implies that, the majority of the farmers were highly exposed to changes in rainfall and temperature. ANOVA technique was used to understand the significant difference among the *taluks* to exposure, it shows that, there was a significant difference among the *taluks* to exposure of farmers to severe climate change (Rainfall &Temperature) with the ‘F’ value of 2.675 at 5% level of significance. Result are in line with studies of Diana and Adrià [6], they reported that, overall LVI (Livelihood Vulnerability Index) is 0.106 (-1 low vulnerability to 1 high vulnerability) and exposure index value 0.696 is the factor that contributes most to the vulnerability of the community.

4.2 Sensitivity of Farmers to Climate Change

Sensitivity index value was calculated based on the components wise scores obtained due to adverse effects of socio - demographic factors and other activities on crop production practices, livestock production and Human health. The index values obtained were presented in Table 2 and it implies that, the index value is between 0 and 1. A value near to zero reflects the low level of sensitivity and towards one explains the high level of sensitivity of farmers to climate change. Data in the Table 2 reveals that, the mean Sensitivity Index values for five *taluks* were 0.894 and the maximum Sensitivity Index value was observed in Kadur (0.951) followed by Challakere (0.933), Tiptur (0.923), Chiknayakanahalli (0.922) and Arsikere (0.742). This implies that, the majority of the farmers were highly Sensitive *i.e* adversely affected due to climate change. Among 5 *taluks* except Arsikere other four *taluks* are closely near to value one, which indicated that, they were severely affected by climate change. The ANOVA test result reveals that, there was significant variation among the *taluks* to the sensitivity of farmers to climate change with “F” value of 725.4 at a 1% level of significance.

Result were similar to the studies of Mohan and Sinha [7], they used the LVI-IPCC approach to assess farmers' vulnerability to climate change in Uttar Pradesh. The results show that the LVI value was 0.072 and the sensitivity index value was 0.509. Diana and Adrià [6] reported that the sensitivity index value of Berambadi watershed livelihoods towards climate change impacts was 0.535. This value indicates a moderate sensitivity to climate variations.

4.3 The Adaptive Capacity of Farmers to Climate Change

Adaptive capacity index value was calculated based on the components wise scores obtained under the adaptive capacity of farmers in crop production, livestock production and Human health. The index value obtained was presented in Table 3 and it implies that, the index value is between 0 and 1. As value near to zero reflects the low level of adaptive capacity and towards one explains the high level of adaptive capacity of farmers to climate change.

Data in the Table 3 reveals that, the mean Adaptive Capacity Index value of the study area is 0.576 and the *taluks* Arsikere (0.572), Kadur (0.603), Tiptur (0.581), Chiknayakanahalli (0.574) and Challakere (0.554) have a more or less moderate level of Adaptive Capacity Index. This implies that the majority of the farmers are moderately adapted to the adverse effect of climate change even though they are highly exposed and severely sensitive to climatic variations. ANOVA test result shows that, there was a highly significant variation among the *taluks* regarding the adaptive capacity of farmers to climate change with “F” value of 4.311 at a 1% level of significance. Parallel studies were also conducted to know the adaptive capacity of farmers to climate change and they reported that, the LVI-IPCC approach to assess farmers' vulnerability to climate change in Uttar Pradesh, a state located in North India. The results obtained in this study gave an overall result of 0.072. The partial results for each contributing factor of the adaptive capacity score of 0.349 [7]. Suresh et al., [8] worked out the scores of ACI of all the districts and reported that, Bengaluru (Urban), Kodagu, Belgaum, Bengaluru Rural, Dakshin Kannada, Bellary and Udupi emerged as districts having high degree of Adaptive capacity with their Adaptive capacity scores being 0.768, 0.580, 0.579, 0.568, 0.559, 0.514 and 0.500, respectively. Bengaluru (urban) secured the first rank in terms of adaptive capacity on account of very high per capita income, which was the highest among all the districts, high literacy rate, substantially sound on health parameters coupled with higher life expectancy and lesser infant mortality rate than that other districts. A wide range of Adaptive capacity scores, ranging from 0.334 to 0.282, shows that, there are perceptible inter-district disparities among the districts. Uttar Kannada, Yadgir, Bidar, Mandya and Chamrajnagara were placed under the 'low adaptive capacity' category since all these districts scored an Adaptive capacity value of < 0.367 which was the minimum criteria value as per quartile analysis.

4.4 Vulnerability of Farmers to Climate Change

After assessing the Exposure, Sensitivity and Adaptive Capacity Index of farmers to marginal, small and big farmers, a cumulative index value for all farmers of each *taluk* on the above dimensions were worked out and presented in Table 4. It shows that, farmers of Arsikere had 0.823, 0.742 and 0.572, Kadur *taluk*: 0.841, 0.951 and 0.603, Tiptur: 0.824, 0.923 and 0.581, Chiknayakanahalli: 0.813, 0.922 and 0.574, Challakere: 0.812, 0.933 and 0.554 and in overall: 0.822, 0.892 and 0.576 of Exposure Index, Sensitivity and Adaptive Capacity Index, respectively. In a general sense, irrespective of *taluks*, all farmers had a more or less equal level of exposure, sensitivity and adaptive capacity Index. But to sensitivity the farmers of Arsikere had the Index value of 0.742, where, this value was less compared to over all and also *taluk* wise Sensitive Index value. And also in Adaptive Capacity, farmers of Kadur had 0.603 which is better than others marginally. These deviations in both taluks might be attributed to their level of adaptation strategies, resources, and socioeconomic factors that influenced their sensitivity and adaptive capacity to climate change. Farmers' vulnerability to climate change would reflect their level of Exposure, Sensitivity, and Adaptive Capacity to Climate Change.

Finally, by using the index value of Exposure, Sensitivity and Adaptive Capacity of farmers of each *taluk* Vulnerability Index were worked out and presented in Table 4. It shows that -0.186, 0.226, 0.224, 0.220 and 0.241 was the Climate Vulnerability Index (CVI) of Arsikere, Kadur, Tiptur, Chiknayakanahalli and Challakere *taluk,* respectively. The overall CVI value of all *taluks* was 0.218. As per the result, all *taluks* were severely vulnerable to climate change. Since, the index value was nearer to 0.25. Few studies are comparable to the current one.

Diana and Adrià [6], reported that, the overall of the Livelihood Vulnerability Index (LVI) for the studied Berambadi watershed villages was found to be 0,499 (in a range from 0 to 1 where 0 represents low vulnerability and 1 high vulnerability).

Suresh Kumar et al., [8], reported that, in Karnataka, nearly 51% of the state's geographical area has a 'high' to 'very high' degree of vulnerability.

Omid et al. [9] report on vulnerability assessment reveals that, the majority of small holder farmers are relatively or highly vulnerable to climate change. Highly vulnerable indicates the households which are sensitive and exposed to

Table 1. *Taluk* wise Exposure Index values (n=150)

Sl. No	*Taluks*	Exposure Index value	ANOVA test - "F" value
1	Arsikere	0.823	2.675*
2	Kadur	0.841	
3	Tiptur	0.824	
4	Chiknayakanahalli	0.813	
5	Challakere	0.812	
Mean		**0.822**	

** Significance level @ 5%*

Table 2. Sensitivity Index values (n=150)

Sl. No	*Taluks*	Sensitivity index value	ANOVA test - "F" value
1	Arsikere	0.742	725.4**
2	Kadur	0.951	
3	Tiptur	0.923	
4	Chiknayakanahalli	0.922	
5	Challakere	0.933	
Mean		**0.894**	

*** Significance level @ 1 %*

Table 3. Adaptive capacity index values (n=150)

Sl. No	*Taluks*	Adaptive capacity index value	ANOVA test- "F" value
1	Arsikere	0.572	4.311**
2	Kadur	0.603	
3	Tiptur	0.581	
4	Chiknayakanahalli	0.574	
5	Challakere	0.554	
Total		**0.576**	

*** Significance level @ 1 %*

Table 4. *Taluk* wise climate vulnerability (n=150)

Taluks	Total			
	Exposure Index value	Sensitivity Index value	Adaptive capacity Index value	CVI
Arsikere	0.823	0.742	0.572	0.186
Kadur	0.841	0.951	0.603	0.226
Tiptur	0.824	0.923	0.581	0.224
Chiknayakanahalli	0.813	0.922	0.574	0.220
Challakere	0.812	0.933	0.554	0.241
Total	**0.822**	**0.892**	**0.576**	0.218

CVI: Climate Vulnerability Index

climate change and do not have adequate adaptive capacity. Low vulnerable means that households which are in a vulnerable situation are still able to cope without external assistance. And also less vulnerable refers to those households which need urgent, but temporary external assistance to recover after a hard shock.

5. CONCLUSION

Farmers were highly exposed to changes in climate and adversely affected due to negative effects of climate change but had moderate to low levels of adaptive capacity. Hence, the majority of the farmers and taluks in the study area fall in the severely vulnerable category. This is a lightning call for policy makers and development departments to take necessary activities and suitable programes to build confidence among the farming community and to improve their status by making farming a profitable occupation.

CONSENT

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

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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