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A Study on the Vulnerability of Fruit Crop Growers to Climate Change in Kalyana Karnataka Region

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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

Vulnerability of fruit crop growers due to climate change can be defined as the degree to which the growers are susceptible to or unable to cope with the adverse effects of climate change. An ex-post-facto research design was used for the study. The study was conducted in the Koppal and Bidar districts of Kalyana Karnataka during the year 2022-23, to analyse the climate change vulnerability of fruit crop growers. The total sample consisted of 80 fruit crop growers, comprising 40 mango growers and 40 guava growers from both districts, respectively. A well-structured interview schedule and the Climate Change Vulnerability Index (CVI) was used for

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the study, which comprised three components: exposure, adaptive capacity and sensitivity to climate change. The overall CVI was found to be 0.124, which indicated a moderate level of vulnerability of growers to climate change. The CVI of Koppal district was 0.144, and that of Bidar district was 0.105. This indicated that the growers in Koppal district were more vulnerable than those in Bidar district to climate change factors. It can be concluded that the socio-demographic and socio-psychological attributes of the farmers might have been influenced variably.

Keywords: Vulnerability; climate change; fruit crop growers.

1. INTRODUCTION

India is bestowed with several agro-ecological regions which provides ample opportunities to grow a variety of horticultural crops which form a significant part of total agricultural produce in the country comprising fruits, vegetables, root and tuber crops, flowers and other ornamentals, medicinal & aromatic plants, spices, condiments, plantation crops and mushrooms. India is the second largest producer of fruits and vegetables in the world. Only 17 per cent of arable land is being utilized for the cultivation of horticultural crops (27.2 million ha) and produced 329.86 million tonnes in 2020-21 with 2.05 per cent higher than the previous year and 8.5 per cent higher than the previous five years. The total production of fruit was 102.76 million MT with an average productivity of 14.51 MT/ha and vegetable production was 196.27 million MT with an average productivity of 17.11 MT/ha [1].

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer [2,3]. It refers to any change in climate over time, whether due to natural variability or because of human activity. Climate change would likely lead to food shortages, and increased loss of life and infrastructure from coastal inundation and riverine flooding. Crop production is primarily determined by soil moisture, temperature, sunlight, and soil fertility. Over the course of this century, climate change is expected to lead to higher average global temperatures, changes in annual and seasonal precipitation patterns, and increases in the frequency and intensity of extreme weather events. These factors will fundamentally alter crop yields and the distribution of agricultural or horticultural production.

Vulnerability is defined as the degree to which a system is susceptible or unable to cope up 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 its adaptive capacity [4]. This definition has been generally accepted by the academic community [2].

Fruit crop growers of India are particularly exposed to the climate change. Limited landholdings, dependence on rain-fed agriculture, and a lack of access to resources like irrigation and drought-resistant seeds leave them ill-equipped to weather the storms of climate change. The burden of debt, often incurred for essential agricultural inputs, adds another layer of fragility, pushing them further into a perilous spiral of vulnerability [5]. And their vulnerability is a tapestry woven from factors beyond their control. Lack of financial buffers and limited access to crop insurance leave them teetering on the edge of ruin after a bad season. Further complicating matters, rising input costs and fragmented markets squeeze their already meagre profits.

The vulnerability of fruit crop growers in Kalyana Karnataka to climate change is influenced by several factors. First and foremost, the region's semi-arid climate makes it highly susceptible to variations in precipitation and temperature. Rising temperatures, coupled with erratic rainfall patterns, can result in prolonged dry spells, heat stress, and increased evapotranspiration, which can adversely affect fruit crops. Furthermore, extreme weather events such as cyclones and unseasonal rains can lead to physical damage to orchards and fruit losses [6]. In addition to climatic factors, socio-economic factors also play a significant role in determining vulnerability. Many fruit crop growers in the region are small land holding farmers who rely on rain-fed agriculture. They often lack access to modern farming technologies, resources, and financial support systems. Limited access to information and education further compounds their vulnerability to climate change impacts. Furthermore, the lack of diversified livelihood options leaves these farmers heavily dependent on fruit crop production, increasing their susceptibility to climate-induced losses.

2. METHODOLOGY

The research design is the integral part of agricultural extension research. Keeping this in mind an ex-post facto research design was used for this study. This design was considered appropriate because the phenomenon had already occurred. It is a systematic empirical study in which the researcher does not have any control over variables as their manifestations has already occurred or as they are inherent and not manipulable. Thus, inferences about relations among variables were made without direct intervention from concomitant variation of variables. The study was conducted in Bidar and Koppal districts of Karnataka during the year 2022–23. From these districts Bidar and Humanabad taluks of Bidar district, Kushtigi and Yelburga taluks of Koppal district were purposively selected for conducting research, as shown in Fig 1. From each selected taluk, ten growers of mango and guava crops were selected randomly using the simple random sampling method. Twenty respondents from selected taluks of the district were selected at random in different villages. In total, the study's sample size comprised 80 respondents. By using a detailed constructed interview schedule, the data was collected by employing the personal interview method and the growers were asked about climate change experience over the past five years. A scale developed by Shankara (2023) [7] was used for the study with suitable modifications. The scale comprised of statements and these statements were administered to respondents along with five-point continuum representing 'Strongly Agree (SA)', 'Agree (A)', 'Undecided (UD)', 'Disagree (D)' and 'Strongly Disagree (SDA)' with weightage of 5,4,3,2 and 1, respectively. The vulnerability score of a respondent was worked out by adding the scores obtained from him/her on all final statements considered for the measurement. The collected data was analysed and tabulated using the scale on the vulnerability of growers to climate change with exposure to rainfall and temperature; their sensitivity and adaptive capacity were worked out with an index formula.

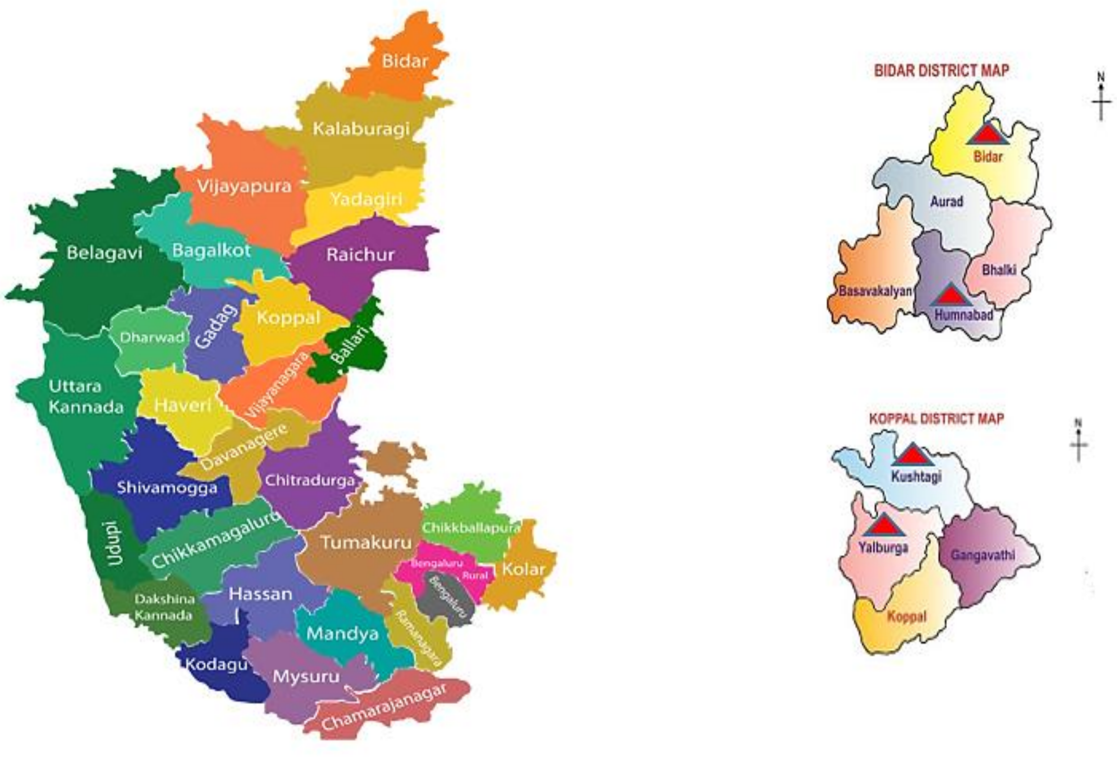

Fig. 1. Map of Karnataka showing selected study area

3. RESULTS AND DISCUSSION

3.1 Exposure Index

The Exposure Index (EI) value was determined by assessing respondents' scores on individual statements related to rainfall and temperature changes. The index ranges from 0 to 1, where a value close to 0 indicates a low level of exposure to climate change, specifically with respect to rainfall and temperature changes. Conversely, a value closer to 1 signifies a high level of exposure among farmers to these climate factors.

The data presented in Table 1 indicates that the average exposure index value for mango and guava fruit growers differed slightly between the Koppal and Bidar districts, with values of 0.784 and 0.761, respectively. Indicating that both the districts were moderately to highly exposed to climate change. It is depicted in Fig. 2.

The data presented in Table 2, shows that in Koppal district, the rainfall index was 0.794, while in Bidar district, it was slightly higher at 0.818. A higher rainfall index in Bidar indicates that this district experiences more significant variations in rainfall. Bidar district has a more intense rainfall pattern when compared to Koppal district. It was observed that both district farmers reported increased off-season rains. This contributed to these index values. And it shows that in Koppal district, the temperature index was 0.881, while in Bidar district, it was slightly lower at 0.779. Koppal districts' higher temperature index suggests they face more extreme temperature fluctuations compared to Bidar district, which can have a negative impact on fruit crops like mango and guava. The possible reason might be that the farmers in Koppal district observed more variations in temperature than those in Bidar district. It was observed that both district farmers were exposed to change in the seasons. This contributed to these index values.

3.2 Sensitivity Index

The Sensitivity Index (SI) value was determined by assessing respondents' scores on individual statements related to crop production practices, livestock production and human health changes. The index ranges from 0 to 1, where a value close to 0 indicates a low level of sensitivity to climate change, specifically with respect to crop production practices, livestock production and human health. Conversely, a value closer to 1 signifies a high level of sensitivity towards these climate factors.

Sensitivity to climate change, as it relates to the agricultural industry, describes how crops react to climatic shifts and how this negatively impacts crop development, production, and growth. Negative effects on livestock and human health are also included.

The data presented in Table 1 indicates that the average sensitivity index value for mango and guava fruit growers differed slightly between the Koppal and Bidar districts, with values of 0.733 and 0.728, respectively. Indicating that both the districts were moderately to highly sensitive to climate change. It is depicted in Fig. 2.

The information in Table 2 indicates that in Koppal district, the index value reflecting the adverse effects of socio-demographic factors on crop production was 0.740, while in Bidar district, it was marginally lower at 0.725. This was because various factors contribute to this component, like farming experience, most of the growers had medium farming experience. While the number of dependents in the household could also be the reason, they are dependent and are not contributing any assistance to the household.

The data in Table 2 reveals that in Koppal district, the index value representing the adverse effect of climate change on crop production was 0.737, while in Bidar district, it was slightly lower at 0.697. This suggests that both districts, with their mango and guava cultivation, are susceptible to the adverse effects of climate change, such as extreme weather events and temperature fluctuations. This was because of various factors, like heavy rainfall adversely affecting soil erosion and high temperatures adversely affecting the volatilization of nutrients in the soil. It also significantly effected the fruit crops like occurrence of increased pest incidence, change in the vegetation and flower induction pattern of the fruit crops. Thunderstorms adversely affect the quality of the fruit crop, and heavy rainfall along with high wind speeds causes damage to the mango and guava trees.

The data in Table 2 reveals that in Koppal district, the index value representing the adverse effects of climate change on livestock production was 0.729, while in Bidar district, it was slightly lower at 0.723. This was because climate change adversely affected the availability of fodder for the livestock. A few fruit crop growers also reported that milk yield was adversely affected due to a shortage of fodder. It was also observed that climate change had a significant impact on the health of livestock. This also caused the growers to sell their livestock to compensate for the losses they incurred. To support mango and guava growers, climate-resilient practices like improved water management, drought-tolerant forage crops, and livestock health measures are vital. These actions can enhance the overall resilience of agriculture in both districts, ensuring the sustainability of mango and guava cultivation alongside livestock farming.

The data in Table 2 reveals that in Koppal district, the index value representing the adverse effect of climate change on human health was 0.804, while in Bidar district, it was slightly lower at 0.719 than that of Koppal district. This was mainly due to the increased effect of climate change on human health. The growers were exposed to higher temperatures, causing dehydration, headaches, and other ill effects on their wellness. Climate change also increased the spread of vector-borne diseases such as dengue, malaria, meningitis, cholera, etc. These findings emphasize the need for region-specific interventions to safeguard the well-being of growers in both districts, including access to healthcare, safe drinking water, and climate-resilient agricultural practices to mitigate health risks associated with climate change.

3.3 Adaptive Capacity Index

An essential factor in the farming community's ability to withstand the negative consequences of climate change is the farmers' ability to adapt to it. Different growers have different levels of adaptive ability depending on how well they can handle technology and resources that are available, how well they can adjust to crop production challenges, how well they can manage animal and human health, and other socioeconomic factors. The value of the adaptive capacity index was computed using the component-wise ratings that farmers' adaptive capacity in crop output, livestock production, and human health yielded. Growers' high degree of climate change adaptation is explained by values that are closer to one than around zero, which indicates a low degree of adaptive capacity.

The data presented in Table 1 and Fig. 2 indicates that the average adaptive capacity index value for mango and guava fruit growers differed slightly between the Koppal and Bidar districts, with values of 0.588 and 0.618, respectively. It was revealed that both districts fall into the moderate level of the adaptive capacity index category.

The data in Table 2 revealed that Koppal district had an average crop production index of 0.597, which was slightly lower than Bidar district with an index of 0.657. This was because only a few growers practiced suitable post-harvest management practices. Very few growers have adopted borewell recharge technology. Most of the growers used non-formal credit sources for loans and had poor repaying capacity. Additionally, few growers used family labours to complete timely operations in the orchards. While few growers implemented drip irrigation technology to overcome the water shortage, Hence, the growers had a moderate crop production index.

The data in Table 2 reveals that Koppal district had an average livestock production index of 0.573, which was lower than Bidar district with an index of 0.632 for adaptive capacity. Both districts fell within the medium adaptive capacity index range. This was mainly due to the fact that most of the growers did not have any subsidiary activities other than one unit, whether it was animal husbandry or poultry. Very few growers had both. Only a few growers adapted timely vaccination measures to the livestock. The majority of the growers faced shortages of fodder during the off-season, creating stress on the livestock.

The data in Table 2 reveals that in Koppal district, the average index value of adaptive capacity in human health was 0.569, while in Bidar district, it was higher at 0.603 than that of Koppal district. This was because of higher temperature variations and potentially inadequate access to healthcare, leading to an increased risk of heat-related illnesses. Additionally, erratic rainfall patterns might have affected water supply and food security, further impacting human health. Potentially better healthcare services and water resource management could lead to reducing the health risks associated with extreme climate conditions.

Table 1. The Koppal and Bidar districts fruit crop growers index values of dimensions in the Climate Vulnerability Index (CVI) N=80

Sl. No.	Dimensions	Koppal	Bidar
1	Exposure Index	0.784	0.761
2	Sensitivity Index	0.733	0.728
3	Adaptive Capacity Index	0.588	0.618

Table 2. The table representing index values contributing to dimensions of Climate Vulnerability Index (CVI) of the Koppal and Bidar districts N=80

Sl. No.	Subcomponents	Koppal	Bidar
I	**Exposure Index**		
1	Rainfall	0.794	0.818
2	Temperature	0.881	0.779
II	**Sensitivity Index**		
1	Adverse effects of socio demographic factors on crop production	0.740	0.725
2	Adverse effects of climate change on crop production	0.737	0.697
3	Adverse effect of climate change on livestock production	0.729	0.723
4	Adverse effect of climate change on Human health	0.804	0.719
III	**Adaptive Capacity Index**		
1	Crop production	0.597	0.657
2	Livestock Production	0.573	0.632
3	Human Health	0.569	0.603

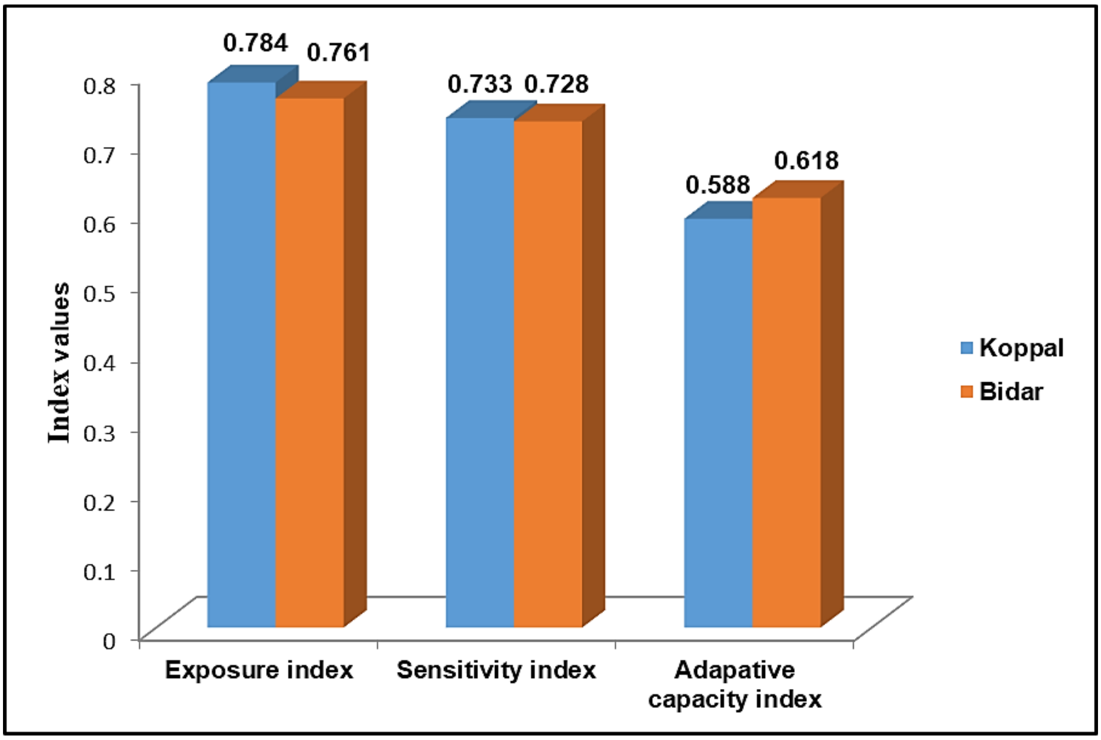

Fig. 2. The Koppal and Bidar district fruit crop growers index values of dimensions in Climate Vulnerability Index (CVI)

Table 3. Overall Climate Vulnerability Index (CVI) of Koppal and Bidar districts fruit crop growers. N= 80

Sl. No.	District	CVI
1	Koppal district fruit crop growers	0.144
2	Bidar district fruit crop growers	0.105
Overall CVI		0.124

3.4 Overall Vulnerability of the Growers

The climate vulnerability index value is between 0.05 and 0.20. An index value nearer to 0.05 shows that there is least vulnerability and a value greater than 0.20 indicates high vulnerability.

Finally, by using the index values of Exposure, Sensitivity and Adaptive Capacity of growers of each district Vulnerability Index were worked out and presented in Table 3. And it is evident from Table 3 that, both Koppal and Bidar districts were moderately vulnerable to climate change, with CVI values of 0.144 and 0.105, respectively. With an overall CVI value of 0.124, indicating moderate vulnerability to climate change. The moderate vulnerability to climate change in both Koppal and Bidar districts, as indicated by their CVI values, can be attributed to several climate-related factors. Koppal's slightly higher CVI was a result of factors like higher temperature fluctuations, erratic rainfall patterns, and potential socio-economic factors, which collectively increase its susceptibility. Bidar's lower CVI might be due to slightly milder climate impacts, with a relatively more resilient agricultural and socio-economic system. The overall CVI suggests that both districts share a similar level of moderate vulnerability to climate change, highlighting the importance of region-specific adaptation strategies required to address these challenges. Very few studies were found similar to the current study.

Shanabhoga et al. [8] The research revealed that Yadagir (0.64) district belonged to a very high degree of vulnerability to climate change whereas Ballari (0.58) and Bidar (0.50) districts belonged to high and medium level of vulnerability. It was also depicting that Kalburagi (0.45), Koppal (0.19) and Raichur (0.25) belonged to low vulnerability category.

Shanakara et al. [7] revealed that majority of farmers were severely exposed (0.822) and sensitive (0.894) to climate change with lower adaptive capacity (0.576). It showed 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.

4. CONCLUSION

The fruit crop growers in the study region were moderately to highly exposed to climate change and were severely affected by its negative effects but had a moderate adaptive capacity. Hence, the majority of fruit crop growers were moderately to highly vulnerable to climate change. Assessments of adaptive capacity and vulnerability indicate the need for focused interventions. Strengthening adaptive capacities through educational campaigns, targeted skill development programmes, and financial support schemes can reduce vulnerability to climate change.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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