Farmer's sagaciousness on climate change and adaptation strategies in Agriculture. A case study in Hyatimundaragi village of Koppala District of Karnataka, India

Abstract

Climate change is recognized as one of the leading challenges affecting the performance of agriculture and the livelihood of people. Farmers are the hardest hit as they have to continuously respond to climate variations. In order to know farmers' perception of climate change and its impacts and to identify adaptation needs semi-structured questionnaire surveys were carried out in Hyatimundaragii village of Koppala district, Karnataka. Farmers have faced climate variability and noticed increasing temperature, delayed onset of rainfall, intermittent rainfall, prolonged drought conditions, depletion of the water table, untimely filling of water bodies, increased incidence of pests and diseases, livestock diseases, and decreasing soil moisture as the critical factors affecting their cultivation, decrease yield and quality of crop produce. Some of them have started to adapt to these changes by soil conservation measures like the construction of graded bunds, mulching, green manuring and sorghum+pigeonpea intercropping, crop rotation, cultivating drought, pest and disease resistance short duration varieties, providing lifesaving irrigation to crops.

Keywords: **Climate change, Farmer's Sagaciousness, Adaptation Strategies**

1. Introduction

The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC 2007[a]) confirms that the global average temperature has increased by 0.74 °C over the last 100 years and the projected rise in warming by 2100 is about 1.8 °C - 4 °C. Global warming and the resultant climate change are expected to increase the occurrences and intensity of extreme weather events, such as floods, drought, and severe cyclonic storms (IPCC 2012[a]). IPCC's assessment report 5 (AR5) also indicates that climate change is likely to reduce agricultural productivity in the tropics and impose threats on human security due to its direct and indirect impacts manifested on water resources, coastal areas, agriculture, and resource-dependent livelihood, especially in Asian countries (IPCC 2013). Due to global warming, the frequency of droughts in several tropical countries has increased and food production has been disrupted due to flooding in some other parts (IPCC 2007[b]).

Worldwide observed and anticipated climatic changes for the twenty-first century and global warming are significant global changes that have been encountered during the past sixty-five years. Climate change (CC) is an inter-governmental complex challenge globally with its influence over various components of the ecological, environmental, socio-political, and socio-economic disciplines (Feliciano *et al*. 2022). Climate change is characterized based on the comprehensive long-haul temperature and precipitation trends and other components such as pressure and humidity levels in the surrounding environment. Besides, the irregular weather patterns, the retreating of global ice sheets, and the corresponding elevated sea level rise are among the most renowned international and domestic effects of climate change. Throughout human history, farmers have adapted to changing environmental, social, and economic conditions Nonetheless, it is not clear if agricultural producers will be able to keep up with the unprecedented speed at which climate is expected to change in the coming years (Jones *et al*., 2012). The negative effects of these changes will be higher for agricultural producers who practice rain-fed agriculture, as well as for those with limited access to credit and insurance and those who are disconnected from regional or national markets. In that sense, the perception that farmers have about climate change not only informs their planting decisions but also determines the adoption of adaptation measures. Therefore, understanding farmers' perceptions of climate change can be seen as a condition for the design and successful implementation of adaptation policies in agriculture (De Matos Carlos *et al*., 2020). Cultivating crops in open fields can be greatly challenging due to low night temperatures, high rainfall, energy constraints, frost, elevated relative humidity, cold winds, and waterlogging. An

effective alternative involves using poly or plastic tunnels. These protected structures act as barriers and play a pivotal role in integrated pest management by preventing the spread of pests, insects, and viruses. Research indicates that cultivating crops under such protective environments, akin to playhouses, not only results in improved yields and more favourable economic returns but also reduces susceptibility to diseases. This practice is particularly significant for mitigating the adverse effects of climate change on agriculture (Singh *et al*., 2011). The current study aims to understand the climate change patterns in the study area, both in its present state and as compared to conditions twenty years prior. Furthermore, the study seeks to assess the impact of climate change on agriculture, livestock, and human health. It also investigates the various government initiatives designed to address climate change issues and examines any adaptive measures adopted by farmers in response to these challenges.

2. Methodology

2.1 Demography, ecology and population dynamics of Hyatimundaragi village, Koppal (T), Koppal (D)

Hyatimundaragi in Karnataka, India, falls under village location code 601782 and is situated in Koppal (T) of Koppal (D). It is positioned 9 km away from the district and sub-district headquarters at Koppal. The total geographical area of the village is 1952.86 ha with coordinate's 15.2670°N Latitude 76.9195°E Longitude (Fig.1).

Hyatimundaragi has a total population of 2314 in number, out of which the male population is 1164 while the female population is 1150. The literacy rate of Hyatimundargi village is 61.11% out of which 68.64% of males and 53.48% of females are literate. There are about 399 houses in Hyatimundargi village. The pin code of Hyatimundargi village locality is 583238.

Table 1: Demography Hyatimundaragi (V)

Particulars	Number (Unit)
Area	1952.86 ha
Latitude	15.2670°N
Longitude	76.9195°E
Altitude	526 meters
Population	2314
Literacy rate	61.1 %

Fig.1: Google map of Hyatimundaragi (V), Koppal (D)

The ecology of Hyatimundaragi village of Koppal district is characterized by its semi-arid climate, diverse vegetation, wildlife adapted to dry conditions, agricultural practices and the influence of human activities. The Tungabhadra reservoir, situated at Munirabad and bordering Hyatimundaragi village, serves as a primary water resource for nearby villages and tube wells are a major source of water needs for both agriculture and livestock. The region experiences an average annual temperature of 27.0 $^{\circ}$C, receives around 587 mm of rainfall annually over 30-40 days, maintains an average annual wind speed of 5.18 meters per second, and sustains an average annual pressure ranging between 1008-1010 mbar (Table 2).

The major soil type of the village is red loamy soil, with major agricultural crops like maize, sorghum, sugarcane, red gram, black gram, and green gram, and groundnut, vegetable crops like tomato, gourds, and crucifers.

Farming constraints experienced by households in the village were lower fertility status of the soil, wild animal menace on farm fields, low price for the agricultural commodities and lack of marketing facilities in the area was the constraint experienced by 71.43 % of the households, frequent incidence of pest and diseases (77.14 %), inadequacy of irrigation water and inadequate extension service (48.57 %), high cost of fertilizer and plant protection chemicals and high rate of interest on credit (62.86 %), Lack of transport for safe transport of the agricultural produce to the market (54.29 %), less rainfall (20 %) and Source of agri technology information (17.14 %) (Source: NBSS & LUP, Bengaluru).

Table 2: Ecological, Soil type, and cropping pattern of Hyatimundaragi village

Particulars	Number (Average) /Type/ Crops (units)
1. Annual Temperature	32.8 °C
2. Annual Rainfall	548.00 mms
3. Annual Rainfall days	30-40 days
4. Annual Wind Speed	6.85 mt/sec
5. Average Annual Pressure	1010 mbar
6. Soil type	Red loamy
7. Irrigation type	Rainfed and Irrigated (Tube wells and lift irrigation)
8. Major crops	Maize, Sugarcane, Sorghum, Pigeon pea, Black gram, Green gram, Cowpea, and Groundnut

2.2 Research gap and research questions

To eliminate the climatic adverse effect, many potential agricultural adaptation alternatives have been suggested likewise potential adaptation measures and adopted in practice. It is assumed few adaptation strategies for climate change impact analysis, although the adaptation process itself remains unclear. It is urgently need to understand what kind of adaptation is possible, and feasible during adverse weather conditions; who will be responsible for implementation; and what is needed to facilitate or encourage their development or acceptance. The purpose of this study was to investigate farmers' perceptions of agriculture adaptation strategies and their constraints on them in relation to climate change. Throughout the research study, we will be finding the answer to the following questions in the surveyed area: (1) General information of the respondent farmers (2). Knowledge of climate change (3).Climate change impacts on livelihood and agriculture (4). Climate change impact on food security and human health (5). Factors influencing climate change adaptation (6). Climate change adaptation and mitigation strategies

3. Results and Discussion.

3.1 Climate Change, Impact, and Mitigation Strategies Adopted in Hyatimundaragi (V)

A survey was conducted in Hyattimundargi village on climate change patterns, the impact of climate change on agriculture and livestock, and the mitigation measures adopted by the farmers. A total of eleven farmers were interviewed with an age group of 42 to 82 having education from

illiterate to high school level. Major questions asked were knowledge of climate change, the reason for climate change, whether have they experienced climate change in their life, cropping patterns, livestock, consequences of climate change on pests and diseases, mitigation strategies adopted, and governmental schemes that took initiatives to mitigate the climate change. Major climate change vulnerabilities identified in the village: Erratic rainfall, drought, heat waves, loss of biodiversity, and pollution.

A semi-structured questionnaire survey was employed to generate information on the perception of the farmers on climate change and variability. The survey encompasses 11 farmers of which 85.50 % had farming experience of more than 30 years. Among the respondents 90.90 % were in the age group of 50 years, followed by 45.45 % illiterate farmers, 36.30 % primary education, and 9.09 % PUC, respectively (Table 3).

Table 3: Demographic features of respondent farmers in Hyatimundargi (V)

Variables	Respondents (%)
1. Age Group	
20-30	0.00
30-50	9.09
50 and above**.**	90.90
2. Education Level	
Illiterate	45.45
Primary	36.36
High school	0.00
PUC	9.09
Graduation	0.00
3. Family size	
1-5	18.18
5-10	36.36
10-15	45.45
15-20	0.00
>20	9.09
4. Type of Land	
Dryland	18.18
Irrigated land	54.54
Both (Irrigated+ Dryland)	27.27
Fallow land	0.00

3.2 Farmers' general perception of knowledge of climate change

The findings on the general perception of knowledge of climate change patterns constituted 90.90 % followed by 72.27 % of the farmers agreed on climate change patterns, 90.90 % of farmers knew the climate change information from mass media and surrounding people and they have accepted the climate of their village is mitigating from past 20 years (Fig. 2).

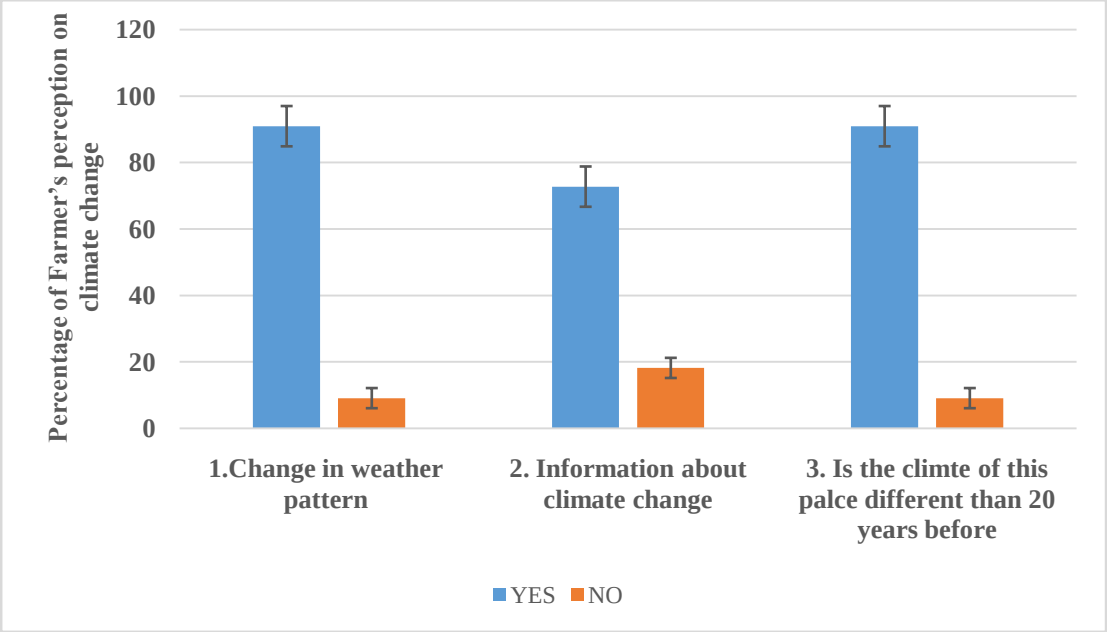

Fig. 2: General Perception knowledge of climate change

3.3 Assessing farmers' awareness and perceptions about climate change

Examining the current climate change necessitates a historical perspective, as much as possible, and framing a baseline climate data is important for establishing a reference point to assess climate change (Khan *et al*. 2014). The findings from the farmers' perceptions regarding changes in the climate are presented in Table 4. The results revealed that the majority of the farmers in the village are experiencing aberrations in climate change as they have been farming there for many years. Hundred per cent of the farmers revealed that the temperature is increasing and has become unbearable, especially in the summer months. There was uniformity in their opinion (90.90 %) decrease in rainfall and prolonged dry spells during the cropping season which

resulted in dry spells. Because of the decrease in rainfall no flood conditions in that village, almost all farmers have the same opinion of continued drought conditions in one or the other years. Apart from this, educated farmers' perceptions of the frequency of climate change events, like 90.90 % of the farmers noticed frequent changes in rainfall and thunderstorms, followed by drought, heat waves, loss of biodiversity and hailstorms equally constituted 81.81 %, Soil erosion and dry spells with 72.72 % only. Framers rarely observed the changes in climate events like forest fires, floods, cold waves and cyclones and never knew the landslide-like events in their village (Table 4 and Fig. 3).

Table 4: Farmers' perception of climate change over 20 years

Climate Variables	Increased (%)	Decreased (%)	No change (%)
1. Temperature	100.00	0.00	0.00
2. Rainfall	0.00	90.90	9.09
3. Flood	0.00	0.00	100.00
4. Drought	100.00	0.00	0.00

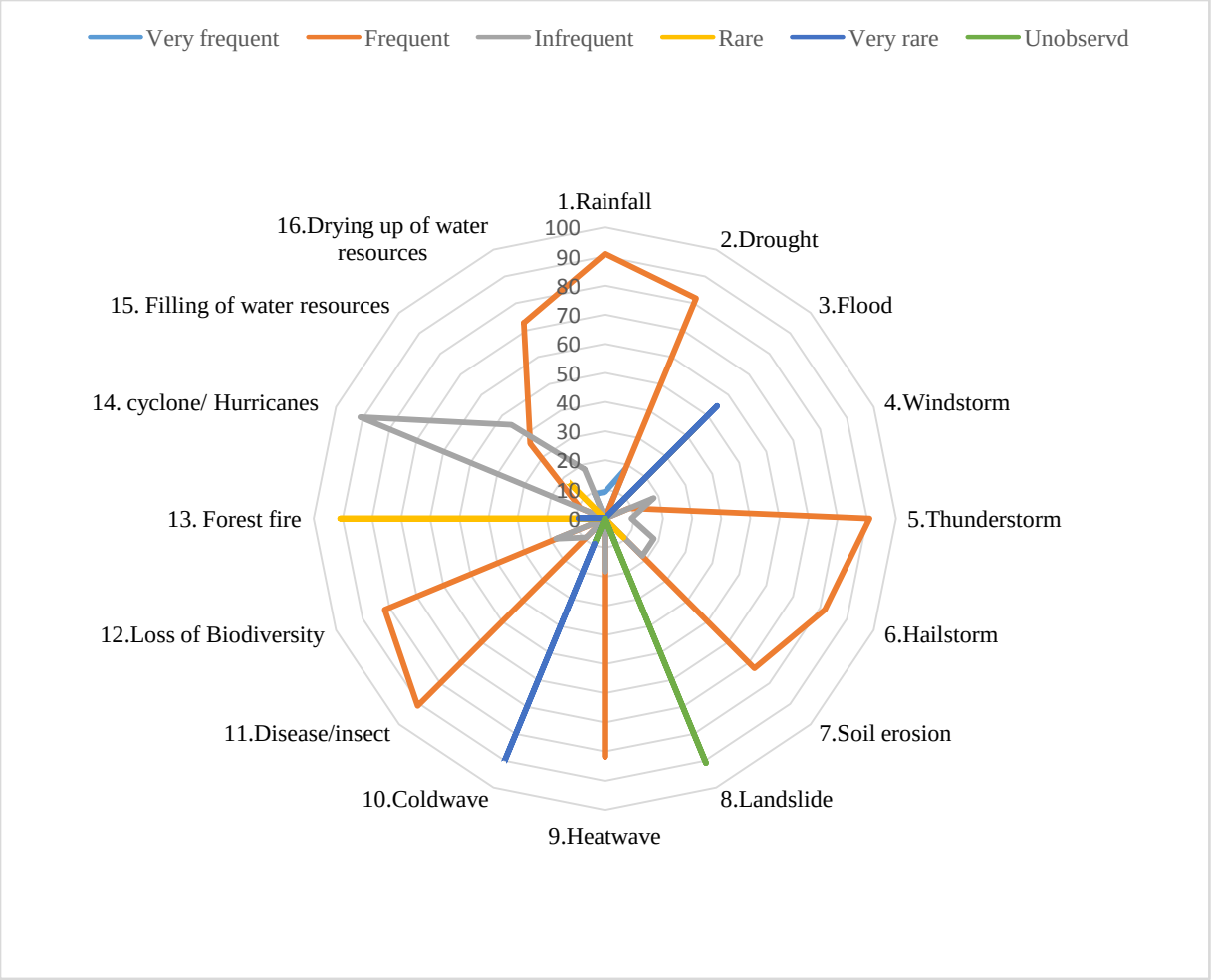

Fig. 3: Farmer's awareness and perception about climate change

3.4 Perception of farmers on climate change impacts on livelihood and agriculture

Farmers' perception of the effect of climate change impacts on livelihood and agriculture, 90.90 % of the farmers have said that for the past 20 years, they have facing water scarcity in their village followed by deterioration of water quality, lack of water hampers equally constituted 81.81%, 72.72 % of the farmers have expressed their unwillingness on water scarcity and 72.27 % of the farmers revealed that excess loss of crop due to moisture, and upping of fungal infection. Thereby, there is an increased incidence of pests and disease in crops as well as in livestock populations. Farmers have mentioned that all these consequences are the outcome of drastic transformation in climatic events over a period of time and they have experienced a novel incidence

of a pest called fall armyworm in maize has made havoc in maize production, and wilt disease in pigeon pea made a drastic crop loss. The main reason farmers quoted for the incidence of pest and disease use of pesticides, hybrids, and extensive farming practices made the development of new pest and disease incidences as compared to 20 years before. Farmers are facing gambling of monsoon during sowing season and hailstorms during harvest season. Hence, they are incurring a huge loss of yield at the harvest stage (Table 5).

Table 5: Farmers' Perception of climate change impacts on livelihood and Agriculture

Events	Respondents (%)
1. Quality of water deterioration over the years	81.818
2. Drying of water resources over the years	90.909
3. Faced water scarcity for crop production	72.727
4. Due to climate change susceptibility of crops/ livestock to pest/ disease attacks has increased	81.818
5. Have you noticed new disease incidence in the crops	81.818
6. Have you noticed new insects in crops	90.909
7. Have you noticed new diseases or parasites in livestock	63.636
8. Have you noticed any shifts in the flowering and harvesting period of crops	72.72
9. Have you noticed any quality deterioration observed in farm products	72.727
10. Have you noticed any losses in farm earnings	63.636
11. Incidence of illness due to any disease increased in your family	63.636

3.5 Perception of farmers on climate change impact on food security and human health

The public distribution system is a crucial one and has played a pivotal role in the distribution of food grains to the people for their consumption. For the past 20 years whereas the quality of food has been deteriorating over the years by employing chemical farming. Food consumption habits also have changed from roti to rice, dose, and idli there by immunity power has been deteriorating over time. Diseases such as dengue, malaria, typhoid, viral fever, *etc*. The major livestock diseases encompass Foot and mouth disease (FMD), LSD (Lumpy skin disease) in cattle, and Anthrax in sheep. These diseases were less frequently observed 20 years back.

3.6 Drivers of climate change adaptation

Most of the farmers have no information, as well as knowledge on climate change, timely non-availability of credit facilities for their input purchase, and lack of mitigating strategies on climate change equally constituted 72.72 % and they have agreed (Table 6).

Table 6. Factors Influencing Climate Change Adaptation

Events	Respondents (%)
1. Lack of information and knowledge on climate change acts as a barrier to climate change adoption	72.727
2. Credit accessibility influence take adaption measures	72.727
3. Using technology (like mobile, TV, radio, etc.) to influence and adopt adaptation measures	81.818
4. Government/NGO/others' support influences adopting adaptation strategies	72.727
5. Scarcity of water during the dry season influences to take adaptation measures	72.727
6. Outbreak of new diseases or food scarcity influence to take adaptation measures	72.727

3.7 Farmer's perception of climate change adaptation/mitigation strategies

In the village, the majority of farmers (72.72 %) lack knowledge about climate change mitigation strategies. However, 90.90 % have adopted intercropping and crop rotation. Water conservation through farm ponds is less prevalent at 36.36 %. Most farmers prefer desi cows (72.72 %) over crossbreeds, and only 18.18% use weather forewarning systems to monitor weather conditions (Table 7). The strategies that they have adapted encompass providing lifesaving irrigation when continuous dry spells are providing one or two irrigation to their crops since some of the farmers have borewells and lift irrigation facilities provided by the government. Additionally, soil conservation techniques like mulching, construction of graded bunds, application of green manuring, maize+cowpea intercrop system, and cereal-pulse cropping system for conservation of soil fertility. Farmers timely not get crop and livestock insurance due to climate change-related disasters, and are also not involved in community-based land and soil conservation measures.

Table 7. Climate change adaptation/ mitigation strategies

Events	Respondents (%)
1. Received any skill development training program to cope with the impact of climate change	27.273

2. Changed in cropping pattern (crop rotation/intercropping/ new crop) over the past 20 years	90.909
3. Invested in farm ponds for irrigation purposes	36.364
4. Adopted improved seeds for cultivation	81.818
5. intensified the application of farm inputs	72.727
6. Reared livestock of a different breed than the earlier one over the past 20 years	72.727
7. Measures have you taken to improve soil properties	90.909
8. Using any forewarning systems to know about weather conditions	18.182

3.8 Major climate change mitigation strategies adopted by the farmers in the village

Adaptation measures: Blend of traditional and improved practices

1. Soil conservation practices
    a. Graded bunds, mulching, and green manuring with sun hemp, daincha.
2. Intercropping system (sorghum+ pigeon pea), (Maize + cowpea).
3. Crop rotation: Maize- chickpea (Cereal- pulse cropping pattern).
4. Drought-Disease-resistant varieties.

4. Conclusion

The study conducted in Hyatimundaragi village of Koppala district, Karnataka, reveals that farmers in the region are experiencing the adverse impacts of climate change, including rising temperatures, delayed rainfall, and increased incidence of pests and diseases. Farmers have responded with adaptive measures such as soil conservation, intercropping, and crop rotation. However, challenges remain, including limited access to climate change information and credit for inputs. The study highlights the need for government and NGO support, technology utilization, and comprehensive policies to assist farmers in adapting to climate change while ensuring food security and human health.

5. **Consent**
    We have recorded videos of each farmer with their clear and transparent consent, signifying their willingness to participate in activities involving their land and data, all in adherence to agreements ensuring transparency and respecting their rights and interests.

6. References

1. Castells-Quintana, D., Lopez-Uribe, M. D. P., and McDermott, T. K. J. (2018). Adaptation to Climate Change: A Review through a Development Economics Lens. World Development 104, 183–196. doi: 10.1016/j. world dev.2017.11.016.

2. De Matos Carlos, S., da Cunha, D. A., Pires, M. V., and Do Couto-Santos, F. R. (2020). Understanding farmers' perceptions and adaptation to climate change: the case of Rio das Contas basin, Brazil. Geo Journal 85, 805–821. doi:10.1007/ s10708-019-09993-1

3. Feliciano D, Recha J, Ambaw G, MacSween K, Solomon D., and Wollenberg E (2022) Assessment of agricultural emissions, climate change mitigation and adaptation practices in Ethiopia. *Clim Policy* 1–18.

4. IPCC. 2007[a]. Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the intergovernmental panel on climate change. IPCC. 2007[b]. Intergovernmental Panel on Climate Change, Geneva Working Groups contribution to the Fourth Assessment Report (AR4).

5. IPCC. 2012[a]. Available from: http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5Chap19_FGDall.pdf, FINAL DRAFT, Chapter 19 Emergent Risks and Key Vulnerabilities.

6. IPCC. 2013, Chapter 24. Intergovernmental Panel on Climate Change, Asia IPCC Working Group II contribution to the Fifth Assessment Report (AR5).

7. Jones, H. P., Hole, D. G., and Zavaleta, E. S. (2012). Harnessing Nature to Help People Adapt to Climate Change. *Nat. Clim. Change* 2 (7), 504–509.doi:10. 1038/nclimate1463.

8. Khan S, Ramachandran A, Malini P., and Palanivelu K. 2014. Climate portfolio of Pichavaram mangrove region of Tamil Nadu coast, India: an add-on information for adaptation policy planning. *J. Integr. Environ. Sci*. 11(3– 4):173 –186.

9. Michel D, Eriksson M., and Klimes M (2021) Climate change and security in transboundary river basins Handbook of Security and the Environment: Edward Elgar Publishing.

10. Singh A.K., Singh, B., and Gupta, R. 2011. Performance of sweet pepper (Capsicum Annum) varieties and economics under protected and open field conditions in Uttarakhand. *Ind. J. Agric Scien*. 81: 973-975.