ISBN:978-81-954744-3-1

Identification of Climate Change Vulnerable Areas in Karnataka

- Suresh Kumar
- A. Raizada
- H. Biswas
- S. Srinivas
- A.S. Morade
- B. Mondal

ICAR - Indian Institute of Soil and Water Conservation (IISWC)
Research Centre, Hospet Road, Cantonment Ballari - 583 104 (Karnataka)

ISBN:978-81-954744-3-1

Identification of Climate Change Vulnerable Areas in Karnataka

Compiled by

- Suresh Kumar
- A. Raizada
- H. Biswas
- S. Srinivas
- A.S. Morade
- B. Mondal

ICAR - Indian Institute of Soil and Water Conservation (IISWC)

Research Centre, Hospet Road, Cantonment Ballari - 583 104 (Karnataka)

Correct Citation

Kumar, S., Raizada, A., Biswas, H., Srinivas, S., Morade, A.S. and Mondal, B. 2022. Identification of Climate Change Vulnerable Areas in Karnataka, IISWC, RC, Ballari, Karnataka. ISBN:978-81-954744-3-1

Reviewed by

S.S. Shrimali

Design & Layout

Matish Chandra

Published by

Director
ICAR-Indian Institute of Soil and Water Conservation (IISWC)
218- Kaulagarh Road, Dehradun- 248 195 (Uttarakhand)

Foreword

ICAR-Indian Institute of Soil and Water Conservation (IISWC)
218-Kaulagarh Road, Dehradun - 248 195, Uttarakhand (India)
Telephone: (O) 0135 2758564, 0135 2754968 (R)
Fax: 0135 2754213, 2755386
Email: directorsoilcons@gmail.com, director.iiswc@icar.gov.in

Dr M. Madhu
Director

The assessment of climate change hazards are of utmost importance to ensure sustainable production and growth in agriculture. Climate change has enormous influence on the hydrology as well as on rainfall pattern and that in turn results in intense rainfall and related flooding in some areas and drought in others. Of late, Karnataka has witnessed extreme weather events both in terms of frequency and intensity across the state. The recurrences of floods and droughts are proving detrimental to the overall wellbeing of agriculture scenario.

In pursuance of generating information on different aspects of climate change this document has been prepared. The document discusses the various components of vulnerability index *viz*, production loss, sensitivity, exposure and adaptive capacity, district wise. The details given in the document are simple to comprehend and convenient to compute vulnerability index.

Based on the composite index of indicators, district Kolar is the most sensitive whereas Gulbarga is most prone to production losses and Koppal has the highest level of exposure to change in climate. Overall Gulbarga is the most vulnerable district in the state.

I hope the information generated and presented in the document will be of great service to the planners, Karnataka State Government and all other stakeholders to execute diversified interventions to mitigate impact of climate changes more effectively.

January, 2022
Dehradun

(M. Madhu)

Contents

Introduction

India is highly vulnerable to climate change. Among the different sectors, agriculture, particularly rainfed area, is most vulnerable to the adverse impacts of climate change. Extant studies show that there will be a dramatic consequences on rural communities who depend directly on climate sensitive livelihoods options such as agriculture, fisheries and animal husbandry. Vulnerability to climate change has been defined as the extent to which a system or society is prone, or at risk to, and unable to deal with the negative effects of climate change and variability (IPCC, 2007). Vulnerability assessment is a tool for policy response to climatic variability since it helps identifying vulnerable regions/section of society. For this, use of a set of indicators is most common method since this facilitate combining of socio-economic and biophysical factors of vulnerability for making a composite index. Vulnerability index can facilitate decision making and helps setting targets and priorities as it provides a single-value which is easy to comprehend, and facilitates monitoring and evaluation of progress of vulnerability status. Vulnerability assessment can act as an entry point for understanding and addressing the processes that cause and exacerbate vulnerability. Keeping this in view, an attempt was made to develop a district-wise vulnerability index for Karnataka which is one of the most drought prone states in India.

Material and Methods

In India, Karnataka has the second highest arid land after Rajasthan. Of the net cultivated area, 66% is rainfed which is highly vulnerable to climate change. District-wise time series data on crop production (2000-01 to 2009-10) collected from the Directorate of Economics and Statistics, Karnataka and Ministry of agriculture, Government of India. Other required data were collected from Central Ground Water Board, Government of India, Planning, Programme Monitoring and Statistics Department and Rural Development and Panchayathi Raj Department, Government of Karnataka. For preparing vulnerability index, following four sub-indices were used. (1) Crop production loss index (CPLI) was constructed using data from three major crop groups viz., cereals (wheat, rice, sorghum, pearl millet, maize and minor millets), pulses (chickpea, horse gram, red gram, black gram, green gram, and some other minor pulses and oilseeds (groundnut, sunflower, safflower, niger, rape seed, mustard, castor, soy bean, linseed and sesame). At first step, the data were de-trended, and then the potential loss were estimated, and segregated into 'area deviation effect (ADE)', 'yield deviation effect (YDE)' and 'interaction deviation effect (IDE)'. (2) Sensitivity Index (SI) was computed using a battery of indicators: per cent rainfed area, percent population facing drinking water problems, level of groundwater exploitation, per cent degraded area; population density and per cent small and marginal farmers in a particular district. (3) Exposure index and rationale for choosing its indicators. Exposure is defined as the degree to which a particular system is exposed to frequent drought a major threat and common feature of rainfed areas.

We computed exposure index (EI) with the help of long-term rainfall data in terms of indicators namely, annual average *kharif* season rainfall; per cent change in mean *kharif* season rainfall; variability in *kharif* season rainfall; annual average *rabi* season rainfall; per cent change in annual average *rabi* season rainfall; variability in *rabi* season rainfall; projected change in maximum and minimum temperatures, variability in maximum and minimum temperatures. (4) Adaptive capacity is the ability of a system to reduce to moderate levels, the potential ill-effects of climate change and variability by either taking advantage of existing opportunities or undertaking measures to deal with its consequences (IPCC, 2007). We estimated adaptive capacity index (ACI) of a district by combining the following indicators-per capita income, poverty incidence, education level, infant mortality rate, average size of landholding and per cent share of agriculture and allied sectors (fishery, animal husbandry and forestry) in the state's gross domestic product (SGDP).

Vulnerability index (VI)

Vulnerability index for J^{th} district can be computed by integrating a new crop production losses index, sensitivity index, exposure index and adaptive capacity.

$$VI_j=(EI_j+SI_j+CPLI_j)-ACI_j$$

A district with higher score of vulnerability index would be considered as more vulnerable to climate change and its variability.

Results and discussion

Davangere, Mysore and Haveri districts incurred the maximum losses in cereal production to an extent of 283.8, 276.1 and 223.8 thousand tonnes per annum. Segregation of cereal production losses show that with 64.2 and 73.0% YDE value, Davangere and Haveri are more prone to yield reduction, respectively whereas Mysore has been affected from losses due to higher year to year fluctuations in area under cereal crops as is evident by an ADE of 57.1%.

Figure 1: Degree of crop production losses

Dakshina Kannada, Bidar, Dharwad, Udupi, Uttara Kannada, Gadag and Chitradurga had YDE value of more than 80% implying their high susceptibility to reduction in yield due to climate variability. On the other side, Mysore, Bellary and Mandya are highly prone to change in cropped area due to climatic variability as is evident from higher value of ADE i.e. 50%. Top ranked six districts (Raichur, Bijapur, Tumkur, Chitradurga, Bagalkote and Koppal) accounts for more than half of the total losses in whole state. These districts, therefore, must be accorded priority for minimizing losses of oilseed production. In case of pulses, Gulbarga along with the second most affected district i.e. Bijapur, accounts for around 46% of the total loss of pulses production in the state. As per CPLI scores, districts were also classified into four groups: extreme, high, medium and low degree of losses (Figure 1).

Sensitivity index

Kolar was found to be the most sensitive district due to very high area under rainfed agriculture (85%), and alarmingly high abstraction of groundwater (170% stage of groundwater development) and around one thirds of the area is degraded.

On the other extreme, Shimoga district was rated as the least sensitive district. on the account of higher irrigated area (70%) with safe status of groundwater resources and a very little degraded area (11%). Kolar, Bellary, Belgaum, Bengaluru urban, Ramanagara, Davanagere, and Chikballapur were categorized as extremely sensitive districts of the state.

Figure 2: Degree of sensitivity

Exposure index

Average score of exposure index was 0.613 and, wide variations in exposure to climate variability are evident from the range of scores from 0.075 (minimum for Udipi district) to 0.861 (highest for Koppal district). Based on the exposure index scores, all the districts were grouped into four categories *i.e.* extreme, high, medium and low degree of exposure to climate change and variability. Districts like Koppal, Raichur, Bijapur Gulbarga, Gadag, Bagalkote and Bellary were grouped under extreme degree of exposure. The factors responsible for very high level of exposure are: kharif and rabi season rainfall are almost half (103 mm/annum) and two thirds (94 mm/annum) of the state's average seasonal rainfall, respectively.

Moreover, during last decade, a five and six percent decline in seasonal rainfall kharif and rabi season was observed for these districts. Further, for these districts, projections show that there will be increase in maximum and minimum temperature to the tune of 2.1 and 2.30C, respectively, which are higher than the state level projections. On the other side, Hassan, Shimoga, Chikmagalur, Kodagu, Uttara Kannada, Dakshina Kannada and Udupi districts were grouped under low level of exposure on the account of receiving high seasonal rainfall with lower variation in rainfall and temperature.

Figure 3: Degree of exposure

Adaptive capacity index

Bengaluru (Urban), Dakshin Kannada and Kodagu secured first (3.680), second (3.016) and third (2.785) places in terms of adaptive capacity (Table 5), due to higher per capita income which was noticeably 214, 49 and 75% higher in these districts, respectively over the state's average (INR 58399) income (DES, Karnataka, 2011). Additionally, other factors namely, higher level of education, lower rate of infant mortality and poverty incidence helped these three districts in achieving better adaptive capacity status. In North Karnataka, around third-fourths of districts were placed under 'low to medium' category of adaptive capacity. Expectedly, around 60% of southern Karnataka's districts were found to exhibit 'high to very high' degree of adaptive capacity. A wide range in the values of ACI, ranging from a low of 0.902 for Koppal to a maximum of 3.680 for Bengaluru (urban), indicates the prevailing huge inter-district disparities in adaptive capacity.

Figure 4: Degree of adaptive capacity

Vulnerability index (VI)

Gulbarga district was rated as the most vulnerable district of the state (vulnerable index score, 1.495), on account of low adaptive capacity

(26th rank) coupled with high exposure level (6th rank) and CPLI (1st rank) scores. On the contrary, Dakshin Kannada was the safest district in terms of vulnerability with VI score of 0.217. In addition to Gulbarga, other districts, namely Koppal, Raichur, Bellary, Bagalkote, Bijapur, Belgaum, Devangere and Chitradurga were also grouped under 'extreme degree' of vulnerability with their scores of 1.48, 1.34, 1.30, 1.29, 1.28, 1.21, 1.17 and 1.15, respectively. On the contrary, district like Chikmagalur, Shimoga, Bengaluru urban, Uttara Kannada, Kodagu, Udupi and Dakshina Kannada were found to be exhibit low degree of vulnerability with their scores ranging from -0.217 to 0.436. Assessing the extent of population facing different level of vulnerability is considered a necessary step to assist in decision-making and to orient adaptation efforts. It is, therefore, necessary that to show that: how much agricultural area, human population, (especially rural population) and livestock population are expected to suffer with ill-effects of vulnerability caused by climatic variability and/or change. Our study concludes that almost 70% of the cultivated area, which supports 60 and 67% of livestock and rural population of the state are under the threat of 'extreme to high' level of vulnerability to climate change (Fig. 6).

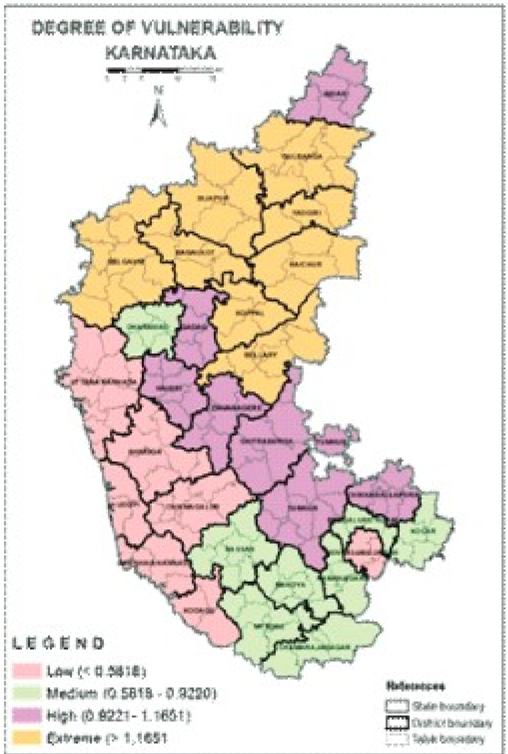

Figure 5: Degree of vulnerability

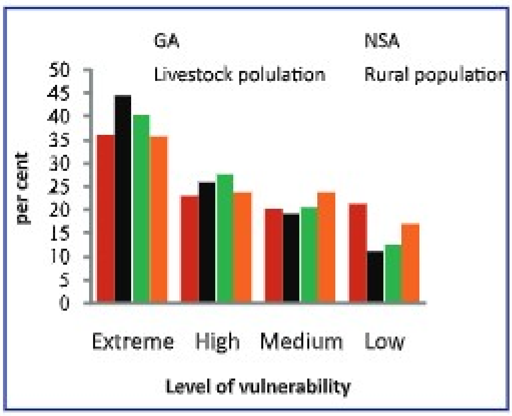

Figure 6: Percent of geographical area (GA), cultivated area (net sown area), livestock population and rural population under different degree of vulnerability

Conclusion

The study revealed that Gulbarga is most prone to crop production losses; Kolar is the most sensitive and Koppal has the highest level of exposure to climate change. Overall, Gulbarga is most vulnerable district in the state. There is need to implement more focused and targeted progarmme and schemes, particularly in the areas categorized under extreme to high level of vulnerability climate change, for sustaining livelihood to deal with challenges of climate change.

References

Kumar, S., Raizada, A., Biswas, H., Srinivas, S. and Mondal, B. 2016. Application of indicators for identifying climate change vulnerable areas in semi-arid regions of India. Ecological Indicators, 70, pp507-517.

IPCC, 2007 Climate Change 2007-the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, United Kingdom.

आज़ादी का अमृत महोत्सव

ICAR - Indian Institute of Soil and Water Conservation (IISWC)

Research Centre, Hospet Road, Cantonment Ballari - 583 104 (Karnataka)