

Juxtaposing Farmers' Suicides and Climate Change Vulnerability: An Empirical Analysis of Indian States

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Abstract

India's overall ranking on the Global Climate Risk Index has been deteriorating in recent years, making it more vulnerable to climate risks. It has been indicated in the literature that climate change is also associated with agrarian distress. However, empirical analyses are scanty on this, especially in the Indian context. In this analytical exercise, we tried to explore the association between farmers' suicides and climate change vulnerability across Indian states. Using data from various sources, we arrive at an Agrarian Vulnerability Index and juxtaposed that with farmers' suicide data between 1996 to 2015 collected from the National Crime Records Bureau (NCRB). We noted a strong association between climate change vulnerability and farmers' suicides. The essence of this analysis is to indicate and understand the broad trends and associations. This research, in the process, informs and presses for a systematic, more comprehensive study with an agenda at micro and meso levels to understand the nuances of this association.

Keywords: Climate Change Vulnerability; Farmers' Suicides; Agriculture; India

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Introduction

It is a well-known fact that climate change is a challenge for agriculture and food security (Verschuuren, 2016). The lives of millions are hinged on the performance of the sector, especially of the poor and vulnerable groups. Agriculture in India is historically vulnerable to climate as nearly 60 per cent of the population depends on it for livelihood. Food security and livelihoods depend on sustainable agriculture (Dev, 2011), added to that the recent trends in climate change indicators may worsen the situation. Problems of climate change are complex and varied. Climate change is visible in unpredictable weather, rise in average temperature, unseasonal and uneven distribution of rain, untimely increase in frequency and intensity of extreme weather patterns, melting glaciers and snow, unprecedented floods and snowfall and rise in sea levels (Rudiak-Gould, 2013; Hertel and Rosch, 2010). All of this affects the natural ecosystem and disturbs the ecological balance, throwing out of gear the historically developed culture of agriculture, besides impacting forestry, water resources and fisheries as productive resources (Herrmann et al., 2005).

Such frightening changes are posing serious threats to livelihood and food security, health and human settlements. Experts equate ecological imbalance with poverty (Brine et al., 2004) and express a growing concern and consensus that climate change will take a deepening toll on poor and marginalised communities due to the vulnerability and lack of fall-back work, coupled with insufficient adaptive capacity due to lack of access to required resources (Herrmann et al., 2005). The adverse impact of climate change on the value of agricultural grain production indicates a food security threat to the small and marginal farming households. A state-wise food security analysis by Kumar and Sharma (2013) revealed that the food security index is adversely changed due to climatic fluctuations. In the Indian context, there is a significant correlation of wheat yield with temperature changes and, more recently, with

winter rainfall (Jha and Tripathi, 2011). Climate change and variability are also linked with the social and economic development of the region (Varadan et al., 2015). Districts with better infrastructure and economic growth are less vulnerable to climate change. Carleton (2017) found that the temperature during India's foremost agricultural growing season has a strong positive effect on annual suicide rates. Using state-scale panel data for 1967–2013, the author suggests that an increase in 1°C temperature in a single day can cause 70 suicides (Carleton, 2017). Swaminathan report (2006) on farmers distress submitted to the government of India suggests that farmers needed assured access and control over resources such as land and water, bio-resources, credit and insurance, technology and knowledge management, and markets to fight against the climate change-induced vulnerability.

Vulnerability to climate change is manifested in three constituents: exposure, sensitivity, and adaptive capacity. Based on a review undertaken in previous studies (for a detailed review, see Sridevi et al., 2014) an attempt is made to identify the association between climatic vulnerability, agrarian distress and farmer suicides across different states in India. We have constructed a vulnerability Index based on predominant components available from secondary data. A comprehensive scale of vulnerability is captured through the Index by including many indicators that serve as proxies. Specifically, we considered five different sources of vulnerability: demographic, agricultural, occupational, climatic and common pool resource factors. A systematic ranking of the vulnerability of Indian states is thus evolved in order to combine and arrive at the Index.

One of the most concerning issues confronting the policymakers in India is the increasing unabated trends in farmers' suicides. Ten thousand two hundred eighty-one persons involved in the farm sector ended their lives in 2019 (Sengupta, 2020). We attempted first to grasp the spread of the suicides and then analysed the farmer suicide scenario across

Indian states. Given the diversity of Indian agriculture and the conditions under which the farmers operate, it would be difficult to identify a single or significant contributing factor to farmers' suicides. However, many researchers have pointed out indebtedness as a significant factor (, Mishra, 2006; Sengupta, 2006; Sainath, 2013). But indebtedness emerges from an inequality where the increasing 'cost of cultivation' is confronted with 'value of output' not keeping pace with this increase. This causes the shrinking net income flow and the inability of the farmer to service the borrowings. Some studies have also identified that multiple risk factors feed each other and reinforce each other (Deshpande and Shah, 2010; Sainath, 2010). It is evident that many farmers across the states have shifted from traditional rain-fed crops to non-food cash crops, like cotton, oilseeds and chillies, whose prices are governed by global commodity markets. This is another theoretical trait available in the literature that underscores the inequality between farmers' expectations to reach an income level, and the prices of produce or income generated falling far short of that expectation. These bellied expectations cause distress.

This apart, farmers have growing pressure to meet basic social needs like expenditure on health and education. An increased number of suicides has been occurring in high and medium growth States articulated by the scholars as to the demonstration/imitation effect (Rao 2004; Kennedy and King, 2014). High aspirations for upward mobility in the absence of public policy support is seen as a significant cause for suicides in the backward areas of medium growth states (Rao, 2004; Vaidyanathan, 2006). By the late 1990s, many states such as Karnataka, undivided Andhra Pradesh, Madhya Pradesh, Maharashtra and Punjab reported farmers' suicides. These are the states that have readily adopted high-yielding technology in the first instance coupled with a rapid pace of commercialisation. The increasing costs of production combined with the decline in farm credit is putting an unbearable debt burden on farmers pushing farmers to suicide. According to Shiva (2004), biodiversity is being rapidly eroded, and food,

the very source of health and nutrition, has become a major source of health hazards caused by toxic chemicals in factory farming and new genetically engineered foods and crops. Though indebtedness is the root cause for farmers' suicides in all these states, it is crucial to understand what factors raise expectations on the rise of income and expenditure. The genesis of expected income and agricultural failure attributed mainly to climate change could be one of the plausible reasons for increasing indebtedness that leads to suicide. Lack of irrigation facilities and price volatility of cotton have been found responsible in the case of Maharashtra (Mishra, 2006).

Mono-cropping, whose fortunes are highly sensitive to price fluctuations in the international market, is another primary reason found responsible for farmers' distress in Kerala, particularly in the Wayanad region (Johnson, 2010). Indebtedness, exploitatively high interest rates, exorbitant expenditure on digging bore wells, seeds, fertilisers, pesticides, and crop loss due to pests and natural calamities have burdened cotton, chilli, and groundnut farmers with economic hardships and debt traps, eventually compelling them to suicide. Similar phenomena are subtly spread among horticultural farmers (Nancharaiah and Jagadeesh, 2015). Thus, the major causes of the agrarian crisis include unfinished agenda on land reform, quantity and quality of water, technology fatigue, access to resources and institutions, adequacy and timeliness of institutional credit, and opportunities for assured and remunerative marketing. Adverse meteorological factors add to these problems (Government of India, 2006; Dnyandev, 2020). The multiple factors, including debt, higher tenancy cost to small landholding farmers and complete breakdown of institutional support, are the main reasons for farmers' suicide (NHRC & NIRD, 2019). Literature and analysis on the relationship between farmers' suicides and climate change are largely focused on identifying the relationship between temperature rise and farmers' suicide. For example, according to the study published in the science journal PNAS (Carleton, 2017) using nationally comprehensive

panel data over 47 years, the author demonstrates that fluctuations in climate, especially temperature, significantly influence suicide rates, and the author estimated that warming over the last 30 years is responsible for 59,300 suicides in India. Most of the studies used rising temperature and change in rainfall pattern as indicators of climate change. However, that leaves a gap between climate change and its manifestation in inducing vulnerability in the agricultural sector and among the farmers. In this context, the present study explores climate change vulnerability and farmers suicides across states in India. Our research tries to consider multiple sets of variables that reflect vulnerability in the agricultural sector. A vulnerability index is drawn across the states, which is then used to identify the association between vulnerability and farmers' suicide.

In the next section, we discuss the materials and methodology used in this research. Section three and four analyse the climate change vulnerability and farmers' suicide scenario across the states of India respectively. In section five, we bring out a plausible explanation synthesising farmers' suicide with climate change vulnerability. Section six concludes the paper.

Materials and Methods

Twenty-two indicators have been considered in this study in the construction of the Climatic Vulnerability Index for a particular year, that is, 2011, based on the methodology used by Sridevi et al. (2014). Of the twenty-two indicators, nine are related to socio-demographic vulnerability,

Step 1: The dimension index for each of the indicator for each construct(x_i) is computed as

$$X_{ij} = \frac{X_{ij} - \text{Min}X_i}{\text{Max}X_i - \text{Min}X_i} \quad (1)$$

Whenever an indicator has negative relationship with vulnerability then the Index is calculated

as:

$$X_{ij} = \frac{\text{Max} X_i - X_{ij}}{\text{Max}X_i - \text{Min}X_i} \quad (2)$$

Where, X_{ij} is the normalised value of vulnerability indicator, X_{ij} is the value of i^{th} vulnerability indicator in the j^{th} block, 'Min X_i and 'Max X_i ' denote to the minimum and maximum value of the i^{th} vulnerability indicator across the state.

five indicators linked to occupational vulnerability, four variables cover agricultural vulnerability, and the remaining four are on common-pool resources (CPR) vulnerability attributes.

The secondary data, related to various indicators, namely socio-demographic, occupational, and agricultural, are collected and compiled from different sources, including the Census of India, 2011 and the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare, Government of India. Rainfall data is taken from the India Meteorological Department (IMD). For farmers' suicides between 1996 to 2015, data has been collected from the National Crime Records Bureau (NCRB), Ministry of Home Affairs, Government of India. From this, average annual suicides and standard deviations are computed across the states to rank the states on the farmers' suicide rate.

Indices Development for Climate Change Vulnerability

The following procedure has been used in this study for the estimation of a composite index. The choice of this method over other possible methods is described in Sridevi et al. (2014).

The Normalisation of Indicators using Functional Relationship

It is important to note that the normalisation procedure is adopted for adjusting indicator values to take the values between 0 and 1 using the following formula:

Step 2: Calculate an average index for each of the five sources of vulnerability vis-a-vis socio-demographic, climatic, agricultural and occupational, CPR vulnerability. This is done by taking a simple average of the indicators in each category.

$$\text{Average Vulnerability Index (AVI)}_i = [\text{Indicator 1} + \dots + \text{Indicator J}] / J \quad (3)$$

Step 3: Aggregate all the sources of vulnerability by following the formula below:

$$\text{Composite vulnerability index (CVI)} = \frac{[\sum_{i=1}^n (\text{AVI}_i)^\alpha]^{1/\alpha}}{n} \quad (4)$$

Where 'n' is the number of sources of vulnerability and $\alpha = n$.

Functional Relationship of Indicators with Vulnerability

Table 1 demonstrates the functional relationship between the indicators and vulnerability.

Further, states and UTs have been classified based on degrees of vulnerability on the basis of mean and S.D of composite vulnerability indices. The classification is as follows:

- High Vulnerability: States with composite indices greater than or equal to (mean + SD).
- Medium Vulnerability: States with composite indices in between (mean) and (mean +SD).
- Low Vulnerability: States with composite indices less than or equal to mean.

Floods and drought-like conditions increase the risk of crop failure, leading to higher rural poverty levels and farmer distress. Many studies and resultant reports (referred to in Table 1) have pointed out that changing patterns of land holdings, cropping patterns from food grains to cash crops and liberalisation policies are not farmer-friendly (Shiva,2004; Jagadeesh, 2013). Such policies have resulted in a heavy dependence on high-cost, paid-out inputs, market vagaries, lack of remunerative prices, indebtedness, and neglect of agriculture on the

policy front and a decline in public investment. Such adverse results have equal responsibility for farmers' distress and farmers' suicides.

Therefore, a similar method is also applied for the classification of farmers' suicides across different states and UTs in India. The states are mapped as high, medium and low in a matrix of vulnerability and farmers' suicides. The results obtained are discussed subsequently.

Climate Change Vulnerability Across Indian States

The state-wise vulnerability indices of India have been worked out for different states based on socio-demography, agriculture, occupation, CPR and climate indicators. The states have been ranked based on vulnerability indices. Table 2 presents all five axes of vulnerability indices among different states in India.

Table 3 exhibits the different levels of vulnerability among states in India computed based on mean and standard deviation. It shows that five states are in the highly vulnerable category, 13 are in the middle, and 14 are in the low vulnerability category. Small states and the UTs correspond with low vulnerability, which needs further investigation on a scale effect of the indicators considered in the indices.

Table1: Functional Relationship Between Indicators and Vulnerability

Indicators	Functional Relationship with Vulnerability	Supporting Literature for the Relationship
Socio-demographic Vulnerability Index		
a) Average HH Size (+)	Positive	Adger (1999)
b) Density of population (persons per sq. km) (+)	Positive	TERI (2003)
c) percentage of female (+)	Positive	ICRISAT (2009)
d) Growth of population (+)	Positive	Hahan et al. (2009)
e) Percentage of SC population (+)	Positive	Patnaik and Narayanan (2009)
f) Percentage of ST population (+)	Positive	Swain and Swain (2011),
g) Percentage of Literacy (-)	Negative	Hiremath and Shiyani (2013)
h) Sex ratio (Male- Female ratio) (-)	Negative	Raju et al. (2013)
i) BPL households (+)	Positive	Sridevi et al. (2014)
Occupational Vulnerability		
a) Percentage of marginal workers (+)	Positive	Palanisamiet al. (2009)
b) Percentage of non-Workers (+)	Positive	Gbetibouo and Ringler (2009)
c) Percentage of cultivators (Main and Marginal cultivators) (-)	Negative	Ravindranath et al. (2011)
d) Percentage of agricultural workers (+)	Positive	Raju et al. (2017)
e) Average number of human days under MGNREGA (-)	Negative	Sridevi et al. (2014)
Agricultural Vulnerability		
a) Cropping intensity (+)	Negative	O' Brien et al. (2004)
b) Percentage of irrigation area (+)	Negative	Palanisami et al. (2009)
c) Percentage of fallow land (+)	Negative	Ravindranath et al. (2011)
d) Percentage of net sown area (+)	Negative	Rama Rao (2013)
		Raju et al. (2017)
Common property resources vulnerability		
Percentages of CPR to TGA (Total Geographical area) (-)	Negative	Senbeta (2009)
Percentage of animal livestock to CPR (+)	Positive	Sridevi et al. (2014)
Climate Change Vulnerability		
a) Rainfall variation (+)	Positive	TERI (2009)
b) Drought area (+)	Positive	Gbetibouo and Ringler (2009)
		ICRISAT (2009)

Table 2: State-Wise Vulnerability Indices in India for the Year 2011

States	Socio-demographic Vulnerability		Agricultural Vulnerability		Occupational Vulnerability		CPR Vulnerability		Climate Vulnerability	
	Values	Rank	Values	Rank	Values	Rank	Values	Rank	Values	Rank
Andhra Pradesh(undivided)	0.31	19	0.1804	26	0.4133	6	0.653	5	0.470903	14
Assam	0.348	13	0.2737	23	0.3357	19	0.2563	13	0.675231	3
Bihar	0.41	5	0.3606	19	0.4993	2	0.3765	9	0.228657	27
Chandigarh	0.457	2	0.4315	15	0.2503	31	0.0001	30	0.349865	21
Chhattisgarh	0.349	12	0.2442	25	0.3899	8	0.3142	12	0.426024	17
Dadra & Nagar Haveli	0.325	15	0.4614	11	0.2853	26	0.0009	29	0.34503	22
Daman & Diu	0.405	6	0.1699	27	0.2516	30	0	31	0.5	12
Goa	0.31	20	0.6799	2	0.2611	28	0.0065	26	0.647925	5
Gujarat	0.307	21	0.5237	7	0.3415	16	0.4876	6	0.304145	24
Haryana	0.332	14	0.4914	9	0.3421	15	0.1237	17	0.058219	30
Himachal Pradesh	0.285	27	0.4179	16	0.3426	14	0.1216	18	0.483076	13
Jammu & Kashmir	0.318	17	0.5177	8	0.2992	24	0.2253	15	0.355112	20
Jharkhand	0.405	7	0.0903	29	0.3696	12	0.2546	14	0.510446	11
Karnataka	0.354	11	0.2786	22	0.375	10	0.4854	7	0.829888	1
Kerala	0.297	23	0.4393	13	0.2922	25	0.077	20	0.662157	4
Madhya Pradesh	0.284	28	0.6877	1	0.4318	4	0.7138	3	0.460029	15
Maharashtra	0.378	8	0.3588	20	0.3731	11	0.6862	4	0.63901	6
Manipur	0.291	25	0.256	24	0.326	21	0.0396	22	0.592993	9
Meghalaya	0.303	22	0.3698	18	0.3434	13	0.049	21	0.613967	7
Mizoram	0.173	31	0.0746	30	0.337	18	0.0352	23	0.613238	8
Delhi	0.44	4	0.6366	4	0.2534	29	0.0047	27	0.090708	29
Odisha	0.448	3	0.133	28	0.3959	7	0.3888	8	0.451959	16
Puducherry	0.296	24	0.5321	6	0.279	27	0.0014	28	0.119205	28
Punjab	0.324	16	0.474	10	0.339	17	0.1261	16	0.013487	31
Rajasthan	0.36	10	0.5509	5	0.4182	5	0.9201	1	0.356831	19
Sikkim	0.288	26	0.4111	17	0.3149	23	0.0129	25	0.686852	2
Tamil Nadu	0.264	29	0.0498	31	0.3853	9	0.3616	10	0.257723	25
Tripura	0.258	30	0.657	3	0.3249	22	0.0299	24	0.549482	10
Uttar Pradesh	0.569	1	0.3215	21	0.5972	1	0.8401	2	0.246403	26
Uttarakhand	0.314	18	0.4377	14	0.333	20	0.1176	19	0.361163	18
West Bengal	0.365	9	0.4451	12	0.4342	3	0.3458	11	0.308086	23

Source: The Authors' Calculations are Based on—1; Census of India, 2011; 2. Directorate of Economics and Statistics (DES); and 3. India Meteorological Department (IMD).

Table 3: Level of Vulnerability in Different States in India

Stages of Vulnerability	High Vulnerability	Middle Vulnerability	Low Vulnerability
States	Karnataka Madhya Pradesh Maharashtra Rajasthan Uttar Pradesh	Andhra Pradesh, Assam Bihar, Chhattisgarh Gujarat, Himachal Pradesh Jammu & Kashmir Jharkhand, Kerala Odisha, Uttarakhand, West Bengal	Goa, Haryana Manipur, Meghalaya Mizoram, Punjab Sikkim, Tamil Nadu Tripura, Chandigarh Dadra & Nagar Haveli Daman & Diu, Delhi, Puducherry

Source: Based on Authors' Calculations

Farmers' Suicides Across States Between 1996 and 2015

This section examines the trends in farmers' suicides and climate vulnerability across states in India. Agrarian distress in recent years has led farmers to commit suicide. Swaminathan Committee Report identifies the major causes of the agrarian crisis as unfinished agenda in land reform, quantity and quality of water, technology fatigue, access, adequacy and timeliness of institutional credit, and opportunities for assured and remunerative marketing along with the adverse meteorological factors (Government of India, 2006). The primary source of data for analysing the phenomenon of farmers' suicides in India has been the Accidental Deaths & Suicides in India (ADSI), an annual publication of the NCRB.

The NCRB has been publishing the ADSI, which contains data on suicides in the country, disaggregated by states and major cities, since 1967. Apart from providing data on the number of suicides, the ADSI also includes information on the causes of suicide. From 1995, the ADSI added another dimension of information and started publishing suicide data disaggregated by profession. This provides precise information on farmers' suicides. We computed the average and standard deviation of farmers' suicides between 1996 and 2015, as shown in Table 4.

We categorised the states and the UTs on the number of farmers' suicides based on mean and standard deviation. Table 5 shows four states are in the high category, seven in the middle and 19 states, and UTs are in the low category with respect to farmers' suicides.

Table 4: Total Farmers' Suicides and Ranking of States between 1996 and 2015

States	Farmers Suicides 1996-2015	Average	Standard Deviation	The Rank of States based on Number of Farmers' Suicide
Andhra Pradesh(undivided)	36882	1844.1	722.9	3
Assam	4556	227.8	121.6	13
Bihar	1430	71.5	35.9	17
Chhattisgarh	15641	782.05	509.0	31
Chandigarh	5	0.25	0.5	7
D&N Haveli	263	13.15	7.9	24
Daman & Diu	6	0.3	0.5	30
Goa	147	7.35	5.4	27
Gujarat	10063	503.15	200.0	10
Haryana	3806	190.3	103.4	14
Himachal Pradesh	741	37.05	26.4	20
Jammu & Kashmir	241	12.05	8.5	25
Jharkhand	1193	59.65	52.2	18
Karnataka	39938	1996.9	749.1	2
Kerala	19875	993.75	511.5	5
Madhya Pradesh	29908	1495.4	553.4	4
Maharashtra	64367	3218.35	1441.8	1
Manipur	22	1.1	1.1	29
Meghalaya	160	8	4.8	26
Mizoram	87	4.35	5.7	28
Odisha	4664	233.2	110.2	12
Puducherry	1578	78.9	61.7	15

Punjab	1507	75.35	41.4	16
Rajasthan	9645	482.25	246.6	11
Sikkim	485	24.25	10.8	21
Tamil Nadu	14373	718.65	360.3	8
Tripura	994	49.7	38.2	19
Uttar Pradesh	11072	553.6	224.8	9
Uttarakhand	372	18.6	11.5	22
West Bengal	18400	920	406.8	6

Source: National Crime Records Bureau, Ministry of Home Affairs, Government of India

Table 5: Categorisation of States by Number of Farmers' Suicides

Level of Farmers' Suicides	High	Middle	Low
States	Andhra Pradesh Karnataka Madhya Pradesh Maharashtra	Chhattisgarh Gujarat Kerala Rajasthan Tamil Nadu U.P West Bengal	Assam, Bihar D&N Haveli Daman & Diu Goa, Haryana Himachal Pradesh Jammu & Kashmir Jharkhand, Manipur Meghalaya, Mizoram Delhi, Odisha Puducherry Punjab, Sikkim Tripura Uttarakhand

Source: Based on Authors' Calculations

Farmers' Suicides and Climate Change Vulnerability

We attempted to understand the association between climate change vulnerability and farmers' suicides by computing the rank correlation, juxtaposing the high medium and low categorisation of states with respect to climate change vulnerability and farmers' suicides. Table 6 provides the ranks and rank correlations. Besides, based on the formula suggested in equation (4), a composite vulnerability index (CVI) was computed. The CVI values are also given in this table.

Table 6 shows that there is a positive relationship between climate change vulnerability and farmers' suicides. As per the Spearman rank correlation, the coefficient being 0.733 is significant at 5 per cent.

We juxtapose climate change vulnerability and farmers' suicides with the help of a matrix. The matrix depicted in Table 7 shows states that appear diagonally follow a predictable relational

pattern. However, states off the diagonal need a deeper understanding of whether the association between climate change vulnerability and farmers' suicides is to be analysed at a meso level.

According to a recently released ADSI report, 10,349 farmers committed suicide in 2018. State-wise data on average farmers' suicides per million rural population per year for 1995-2016 shows that around 56 farmers' committed suicides occurred in Karnataka and Chhattisgarh. In Maharashtra, this figure stands at 54, followed by 49 in Kerala, 32 in Andhra Pradesh, and 31 in Madhya Pradesh. States such as Punjab, Uttar Pradesh, and Bihar have reported low average numbers of suicides. The most critical distress reasons are debts (39 per cent), followed by crop failure due to natural disasters (19 per cent), family problems (12 per cent) and illness (11 per cent). Apart from these reasons, inadequate irrigation facilities, changing cropping patterns, low return from the farm sector and poor marketing supply chain are also significant.

Table 6: Spearman Rank Correlation between Farmers' Suicides and CVI.

States	Farmers Suicides	Rank	CVI*	Rank
Andhra Pradesh(undivided)	36882	3	0.3719	8
Assam	4556	13	0.3537	10
Bihar	1430	17	0.3635	9
Chandigarh	5	31	0.076	30
Chhattisgarh	15641	7	0.3384	11
D&N Haveli	263	24	0.105	28
Daman & Diu	6	30	0	31
Delhi	270	23	0.1249	27
Goa	147	27	0.1872	24
Gujarat	10063	10	0.3819	6
Haryana	3806	14	0.2093	22
Himachal Pradesh	741	20	0.2991	14
Jammu & Kashmir	241	25	0.3305	13
Jharkhand	1193	18	0.2812	17
Karnataka	39938	2	0.4313	5
Kerala	19875	5	0.287	15
Madhya Pradesh	29908	4	0.4882	1
Maharashtra	64367	1	0.4669	4
Manipur	22	29	0.2245	20
Meghalaya	160	26	0.2586	18
Mizoram	87	28	0.1566	25
Odisha	4664	12	0.3338	12
Puducherry	1578	15	0.094	29
Punjab	1507	16	0.1546	26
Rajasthan	9645	11	0.4865	2
Sikkim	485	21	0.2013	23
Tamil Nadu	14373	8	0.2161	21
Tripura	994	19	0.2462	19
Uttar Pradesh	11072	9	0.4686	3
Uttarakhand	372	22	0.2868	16
West Bengal	18400	6	0.3761	7
Coefficient of Rank correlation of farmers suicides and CVI	0.733			

Source: Computed by the Authors based on the Sources Mentioned Earlier.

* CVI: composite vulnerability index

Table 7: Matrix of Agrarian Vulnerability and the Farmers' Suicides Across States

Stages of Climate Change Vulnerability/ Farmers' Suicides	High Climate Change Vulnerability	Middle Climate Change Vulnerability	Low Climate Change Vulnerability
High Farmers' Suicides	Karnataka Madhya Pradesh Maharashtra	Andhra Pradesh (undivided)	0
Middle Farmers' Suicides	Rajasthan, Uttar Pradesh	Kerala, Gujarat, Chhattisgarh, West Bengal	Tamil Nadu
Low Farmers' Suicides		Assam, Bihar, Himachal Pradesh, Jammu & Kashmir Jharkhand, Odisha. Uttarakhand	Dadra & Nagar Haveli, Daman & Diu, Delhi, Goa, Haryana, Manipur, Meghalaya, Mizoram, Punjab, Delhi, Puducherry, Sikkim, Tripura

Source: Authors' Calculations

Farmers' suicides in a particular state/region are directly related to the vulnerability of that state's/region's exposure to weather events, such as droughts and floods. These extreme

climatic events increase the risk of crop failure. States like Karnataka, Maharashtra, Kerala, Andhra Pradesh, and Madhya Pradesh reported relatively higher numbers of farmers' suicides and higher climate vulnerability levels. With reference to the low incidence of farmers' suicides and low climate change vulnerability, there are 14 states and the UTs which are noted in low climate change vulnerability, of which 13 states and the UTs are also noted under the low incidence of farmers' suicides.

Conclusion

Our analysis shows the proximate association between climate change vulnerability and farmers' suicides. There is no doubt that climate change can lead to agricultural vulnerabilities. However, understanding how that manifests in the farmers' distress that eventually leads them to the extreme step of committing suicide needs deeper micro-level understanding. It is possible that the distress can be reflected in the form of crop failure or debt. What is important is to establish the root cause of that distress. If the reasons are identified in the commercialisation processes or input costs or degradation of land, it is vital to understand how extreme events and climate change increases the vulnerability of such groups of farmers. It is equally important to understand the factors contributing to resilience among farmers that can prevent extreme distress. While studies across different agro-ecological regions, cropping patterns, and communities would provide a better meso-level understanding, in-depth qualitative studies at the micro-level would help establish the root causes. Further studies can focus on those aspects.

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Conflict of Interest

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Author Contribution Statement

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