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Adapting Gujarat to Climatic Vulnerabilities: The Road Ahead

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Abstract

Climate change is expected to affect agriculture, following food security and farmers' livelihood. Though several international level interventions have taken a step forward, there is a need to carry out disaggregated analysis at the regional level, particularly, within the state in order to fine-tune the hot spot areas that need immediate interventions. Keeping this in view, and the fact that there exists a dearth of systematic literature with reference to climate change in Gujarat, the present study aims to assess the impacts of climate change particularly with reference to rainfall and temperature parameters notwithstanding the relationship between climate change and the vulnerability of people living in different districts of Gujarat. For Gujarat state as a whole, it could be concluded that the year 1987 was undoubtedly the driest year across the various agro-climatic zones during the entire period of study. The Northwest Arid Zone was the most vulnerable zone due to extreme deviations in rainfall pattern. The results of distribution of frequencies of clusters of below average rainfall years showed that in general, during the period 1978-2008, more than ninety per cent of the districts had more number of years with below average rainfall. The districts of Surat, Narmada, Patan, Gandhinagar and Amreli had more number of clusters of three years and above with below average rainfall and thereby, indicating a high variability of rainfall in these districts. The vulnerability indices constructed revealed that the variables pertaining to agricultural vulnerability were the major contributors in the overall vulnerability to climate change during the different periods. Next to the agricultural indicators, the occupational indicators were found to be the second largest contributors towards overall vulnerability. Keeping in view the vulnerability of different districts, investments in adaptation research capacity: particularly, in the development of climate proof crops, improvements in the agronomic practices of crops such as revising planting dates, plant densities etc, designing region-specific strategies particularly suited to drylands such as rainwater harvesting, livestock development and better techniques of dryland agriculture, income diversification and generating better employment opportunities in districts where out-migration is high as well as adopting resource conservation technologies emerged as the major suggestions of this study.

Keywords: Climate change, vulnerability, rainfall variability/deviations, adaptation.

Introduction

The dynamic patterns in climate started being observed since the mid-20th century and Gujarat is no exception to this. Initially, these changes were looked upon as cyclical changes but evidences pointed to what seemed like a trend, which could not be explained away as normal cyclical climatic changes.

Gujarat is a state with semi-arid zones and encompasses the longest coastline. These characteristic features make the state relatively more vulnerable to climate change. Agricultural growth, food security, human health, biodiversity, and overall development could be in jeopardy if the issue is not addressed upon in a timely and systematic manner. Western India is expected to receive higher than normal rainfall as temperatures continue to rise. This change in the quantum of rainfall and its time of occurrence will adversely affect agriculture in the state. Coastal areas are likely to be the worst hit as the agricultural land is susceptible to inundation and salinity. Extreme weather conditions in the form of droughts floods and cyclones wipe out standing crops and the farmers are left impoverished and helpless. It is observed that in arid regions including Gujarat, malaria epidemics have often followed excessive rainfall. The high temperatures of summer provide favorable breeding conditions for disease causing vectors and the heavy rains that follow causes flooding and subsequently waterborne diseases. The health implications of climate change will need to be carefully monitored[1]. Thus, this paper aims at putting forward the potential impacts of climate change and variability on Gujarat state's agricultural economy on the basis of which the possible adaptation and mitigation strategies could be devised in the perspective of policy development.

Methodology

The rainfall deviations (per cent) from the mean (surplus/deficit) were computed for the selected districts falling under various agro-climatic zones of Gujarat. A study period of 31 years from 1978 to 2008 was taken into consideration. Based on the magnitude of these deviations, frequency distribution tables were constructed to identify all those years in which the rainfall was surplus/deficit and the extent of surplus/ deficit rainfall in

percentage. The frequencies of surplus/ deficit annual rainfall years during the period of study were also worked out. Furthermore, the distribution of frequency of clusters of below average rainfall years during the period 1978 to 2008 were worked out for the selected districts of Gujarat.

In order to get a more holistic idea about the vulnerability of the various districts to climate change, vulnerability indices were worked out using Sudarshan and Iyenger's method[2] for various districts of Gujarat for the year 2008. The indices were worked out under four components *viz;* i. Demographic vulnerability indices ii. Climatic vulnerability indices, iii. Agricultural vulnerability indices and iv. Occupational vulnerability indices. The districts were ranked on the basis of component-wise indices.

Results and Discussion

The distribution of frequencies of clusters of below average rainfall years along with the number of below average rainfall years pertaining to Gujarat's Agro-climatic Zones are presented in table 1. It can be observed that in general, during the period 1978-2008, more than ninety per cent of the districts had more number of years with below average rainfall. Only the districts of Dangs and Narmada had more number of years with above average rainfall as compared to below average rainfall during the entire period of study The results presented also reveal that in comparison to the clusters of different years, the 'No cluster' category showed a greater frequency of occurrence in majority of the districts. This implies inconsistency in rainfall during the period.

It can be inferred from table 1 that the districts of Surat, Narmada, Patan, Gandhinagar and Amreli had more number of clusters of three years and above with below average rainfall years and thereby, indicating a high variability of rainfall in these districts. It can be concluded that these districts could have a greater vulnerability towards climate change so far as rainfall parameter is concerned. On the contrary, Bhavnagar and Bharuch districts were two such districts in which there was only '*one*' cluster of three years and above thereby indicating a relatively low variability of rainfall.

According to a World Bank report, consecutive two years of less rainfall makes it difficult for the communities to sustain their livelihoods and it becomes worse, when there is three years of consecutive less rainfall. Hence, improving crop production in these regions largely depends on better capture and storage of rainwater. Thus, rainwater harvesting and better storage technologies must be developed. Apart from this, better land and crop management are equally important. Policies to improve irrigation efficiency are also critical. Research is needed on water flows and water quality, and infrastructure needs to be improved. Further, the analyses of rainfall data for the state of Gujarat reveals that Gujarat experienced 12 years of drought and four major scarcity situations. However, the intensity and return period of major drought events have increased substantially in last two-three decades, and it is often correlated to the impact of climate change. Traditionally, Gujarat has a drought cycle of 5 years, wherein 2 years, there is moderate rainfall, 2 years less rainfall, and 1 year of good rainfall. Consecutive 2 years of less rainfall makes it difficult for the communities to sustain their livelihoods. It becomes worse, when there is 3 years of consecutive less rainfall. Statistical data show that in last two decades, the intensity of the 3 years of consecutive less rainfall is increasing, and thereby creating severe drought situation.

A perusal of results in table 2 indicate that for Gujarat state as a whole, it could be concluded that the year 1987 was undoubtedly the driest year across the various agro-climatic zones during the entire period of study. Similarly, the years 2006 and 2007 were observed to receive heavy rainfall across considerable number of districts, thus being recognized amongst the wettest years for the state. Kutch district, belonging to the Northwest Arid Zone, received the least annual rainfall of only 5.00 mm during 1987 which also happened to be the lowest quantum of rainfall for the state as well during the entire period of study from1978 to 2008. The maximum quantum of annual rainfall in Gujarat state being 4647.60 mm was received by the Dangs district of Southern Hills Agro-climatic Zone in 1994. In Gujarat, the maximum deviation in the quantum of average rainfall between the driest and wettest years was observed in Junagadh district *i.e.;* 1794.18 mm.

The results from table 3 indicate that the Northwest Arid Zone was the most vulnerable zone among all the agro-climatic zones due to extreme deviations in rainfall pattern. This was followed by North Saurashtra, South Saurashtra and Middle Gujarat Zones. The Southern Hills Zone had the least per cent of years with extreme deviations. State-sponsored interventions in Kutch have not only failed to mitigate water scarcity but have exacerbated problems in some areas. This has been largely due to the dryland blindness of planners who have applied solutions from the rest of Gujarat to Kutch where uncertainty seems to be a part and parcel of the life in the drylands, instead of designing strategies suited to the region. What Kutch needs is rainwater harvesting, livestock development and better techniques of dryland agriculture[3].

In the year 2008 (table 4, 5, 6), it may be observed that the top two demographically most vulnerable districts were Banaskantha, followed by Panchmahal district. Surat district was found to be the third most vulnerable district during the period so far as demographic vulnerability was concerned. The lowest literacy rate (51.26%) amongst the selected districts was the major contributing factor for Banaskantha being the demographically most vulnerable district. In spite of a high literacy rate in Surat district (75%), it ranked as the third most vulnerable district due to a very high density of population (653 persons per sq km) in the district.

Table -1
Distribution of below average rainfall years of the selected districts of Gujarat state (1978-2008)

Sr. No.	Agro-climatic zones and districts	Number of years	No. of below average rainfall years	No. of above average rainfall years	Frequency of clusters with below average rainfall					Total no. of clusters (3 and above)
					No cluster	Cluster of two	Cluster of three	Cluster of four	Cluster of five and above	
A.	North West Arid Zone									
1	Kutch	31	20	11	3	2	1	1	1	3
	Per cent	100	65	35	10	13	10	13	19	
B.	South Saurashtra									
2	Porbandar	31	19	12	2	1	1	1	1	3
	Per cent	100	61	39	6	6	10	13	26	
3	Junagadh	31	17	14	2	0	1	1	1	3
	Per cent	100	55	45	6	0	10	13	26	
C.	North Saurashtra									
4	Amreli	31	17	14	2	0	1	3	0	4
	Per cent	100	55	45	6	0	10	39	0	
5	Bhavnagar	31	16	15	8	2	0	1	0	1
	Per cent	100	52	48	26	13	0	13	0	
6	Jamnagar	31	17	14	1	1	0	0	2	2
	Per cent	100	55	45	3	6	0	0	46	
7	Rajkot	31	16	15	4	0	1	1	1	3
	Per cent	100	52	48	13	0	10	13	16	
8	Surendranagar	31	17	14	3	2	1	0	1	2
	Per cent	100	55	45	10	13	10	0	23	
D.	North Gujarat									
9	Banaskantha	31	16	15	4	2	1	0	1	2
	Per cent	100	52	48	13	13	10	0	16	
10	Gandhinagar	31	21	10	0	1	1	0	3	4
	Per cent	100	68	32	0	6	10	0	52	
11	Mehsana	31	20	11	3	2	1	1	1	3
	Per cent	100	65	35	10	13	10	13	19	
12	Patan	31	21	10	1	1	1	1	2	4
	Per cent	100	68	32	3	6	10	13	35	
13	Sabarkantha	31	16	15	3	3	1	1	0	2
	Per cent	100	52	48	10	19	10	13	0	
E.	Southern Hills									
14	The Dangs	31	14	17	3	0	1	2	0	3
	Per cent	100	45	55	10	0	10	26	0	
15	Navsari	31	18	13	4	2	0	1	1	2
	Per cent	100	58	42	13	13	0	13	19	
16	Valsad	31	16	15	4	1	0	1	1	2
	Per cent	100	52	48	13	6	0	13	20	
F.	Middle Gujarat									
17	Ahmedabad	31	18	13	5	1	1	2	0	3
	Per cent	100	58	42	16	6	10	26	0	
18	Anand	31	18	13	3	0	0	1	2	3
	Per cent	100	58	42	10	0	0	13	35	

Table -1 Continued

Sr. No.	Agro-climatic zones and districts	Number of years	No. of below average rainfall years	No. of above average rainfall years	Frequency of clusters with below average rainfall					Total no. of clusters (3 and above)
					No cluster	Cluster of two	Cluster of three	Cluster of four	Cluster of five and above	
19	Dahod	31	18	13	4	1	1	1	1	3
	Per cent	100	58	42	13	6	10	13	29	
20	Kheda	31	17	14	3	0	0	2	1	3
	Per cent	100	55	45	10	0	0	26	19	
21	Panchmahal	31	16	15	3	1	1	2	0	3
	Per cent	100	52	48	10	6	10	26	0	
22	Vadodara	31	17	14	2	1	0	2	1	3
	Per cent	100	55	45	6	6	0	26	16	
G.	South Gujarat									
23	Bharuch	31	15	16	7	2	0	1	0	1
	Per cent	100	48	52	23	13	0	13	0	
24	Narmada	31	18	13	4	0	2	2	0	4
	Per cent	100	58	42	13	0	19	26	0	
25	Surat	31	17	14	1	1	2	2	0	4
	Per cent	100	55	45	3	6	19	26	0	

Table – 2

Driest and wettest years during the period 1978-2008 in selected districts of Gujarat

Sr. No.	Agro-climatic Zone/ District	Driest Year	Rainfall (mm)	Wettest year	Rainfall (mm)
A	Northwest Arid Zone				
1.	Kutch	1987	5	1979	840.1
B.	South Saurashtra				
1.	Porbandar	1999	164.00	1983	2538.00
2.	Junagadh	1987	194.10	1983	2538.00
C.	North Saurashtra				
1.	Amreli	1987	112.60	2007	1357.00
2.	Bhavnagar	1987	121.00	2007	1371.00
3.	Jamnagar	1987	36.00	2007	1945.00
4.	Rajkot	1987	180.00	2007	1408.00
5.	Surendranagar	1987	81.00	2007	974.00
D.	North Gujarat				
1.	Banaskantha	1987	60.80	2006	1578.00
2.	Gandhinagar	1987	135.90	2007	1284.00
3.	Mehsana	1987	109.40	2005	1323.00
4.	Patan	1987	109.40	2006	1675.00
5.	Sabarkantha	1987	168.00	2006	1590.00
E.	Southern Hills				
1.	The Dangs	2000	1431.00	1994	4647.60
2.	Navsari	1999	984.00	1994	3261.80
3.	Valsad	1993	1300.20	1994	3261.80
F.	Middle Gujarat				
1.	Ahmedabad	1987	251.30	1994	1325.20
2.	Anand	1986	301.30	2006	1403.00
3.	Dahod	2000	271.00	1990	1542.00
4.	Kheda	1986	301.30	2006	1361.00
5.	Panchmahal	1999	331.00	1990	1542.00
6.	Vadodara	1986	303.80	2005	1986.00
G.	South Gujarat				
1.	Bharuch	1991	433.00	2007	1427.00
2.	Narmada	1991	433.00	2006	1473.00
3.	Surat	1987	632.00	1988	2298.00

Table – 3
Deviations in rainfall by Agro-Climatic Zones (Per cent)

Rainfall deviatio-ns deficit/ excess (%)	North-west Arid	North Saurashtra	South Saurashtra	North Gujarat	Middle Gujarat	South Gujarat	Southern Hills
<10	6.45	16.77	11.29	16.31	19.35	21.51	27.96
10 – 20	9.68	14.19	24.19	18.24	21.51	15.05	31.18
20 – 30	12.90	12.26	11.29	14.42	14.52	20.43	20.43
30 – 40	6.45	17.42	11.29	13.04	12.37	11.83	6.45
40 – 50	3.23	5.81	11.29	9.86	9.14	13.98	6.45
50 and above	**61.29**	**33.55**	**30.65**	**28.14**	**23.12**	**17.20**	**7.53**

Table – 4
Component–wise and overall vulnerability indices for the year 2008

Districts	Demographic	Rank	Climatic	Rank	Agriculture	Rank	Occupational	Rank	Overall	Rank
Ahmedabad	0.0355	4	0.0762	3	0.3131	2	0.1442	9	0.5690	2
Amreli	0.0213	11	0.0664	5	0.3014	3	0.1837	4	0.5729	1
Banaskantha	0.0486	1	0.0562	9	0.2418	12	0.1699	5	0.5165	6
Bharuch	0.0122	14	0.0272	13	0.3223	1	0.1614	6	0.5231	5
Jamnagar	0.0189	12	0.0253	14	0.2447	11	0.1879	2	0.4768	10
Junagadh	0.0258	9	0.1061	1	0.1464	14	0.1516	7	0.4299	13
Kheda	0.0317	6	0.0570	8	0.2668	7	0.1091	12	0.4646	11
Mehsana	0.0238	10	0.0711	4	0.2715	5	0.1485	8	0.5148	7
Panchmahal	0.0428	2	0.0507	11	0.2499	10	0.0665	14	0.4099	14
Rajkot	0.0149	13	0.0630	7	0.2639	8	0.1863	3	0.5281	4
Sabarkantha	0.0276	7	0.0814	2	0.2626	9	0.1406	10	0.5123	8
Surat	0.0388	3	0.0542	10	0.2853	4	0.1032	13	0.4816	9
Surendranagar	0.0268	8	0.0482	12	0.2699	6	0.1910	1	0.5359	3
Vadodara	0.0338	5	0.0650	6	0.2400	13	0.1174	11	0.4562	12

Table - 5
Component-wise contributions to the overall vulnerability to climate change for the year 2008 (Per cent)

Districts	Demographic	Climatic	Agriculture	Occupational	Total
Ahmedabad	6.23	13.39	55.03	25.35	100.00
Amreli	3.72	11.60	52.61	32.07	100.00
Banaskantha	9.40	10.88	46.82	32.90	100.00
Bharuch	2.32	5.21	61.62	30.85	100.00
Jamnagar	3.97	5.31	51.31	39.41	100.00
Junagadh	6.00	24.68	34.05	35.27	100.00
Kheda	6.82	12.27	57.43	23.48	100.00
Mehsana	4.61	13.80	52.73	28.86	100.00
Panchmahal	10.43	12.36	60.98	16.23	100.00
Rajkot	2.82	11.92	49.98	35.28	100.00
Sabarkantha	5.40	15.89	51.26	27.45	100.00
Surat	8.06	11.26	59.24	21.44	100.00
Surendranagar	4.99	9.00	50.36	35.65	100.00
Vadodara	7.42	14.24	52.62	25.72	100.00

Table – 6
Classification of selected districts under different degrees of vulnerability for the year 2008

Less vulnerable	Moderately vulnerable	Vulnerable	Highly vulnerable	Very highly vulnerable
Vadodara	Surat	------	Surendranagar	Amreli
Junagadh	Jamnagar	------	Rajkot	Ahmedabad
Panchmahal	Kheda	------	Bharuch	
		------	Banaskantha	
		------	Mehsana	
		------	Sabarkantha	

Further, Junagadh district stood at the first position, thereby being the most vulnerable district to climatic variability. Junagadh district witnessed the highest variability in annual rainfall as well as Southwest monsoon making it the most vulnerable to climatic variability. Bharuch and Jamnagar districts ranked last indicating the lowest vulnerability due to fairly low variation in temperature and rainfall parameters.

In case of agricultural vulnerability, Bharuch district ranked first and turned out to be the most vulnerable district due to the upcoming industrial sector. As a result of which, vast stretches of agricultural land are being converted into industrial sites. Apart from this, low values of productivity of major crops, cropping intensity, irrigation intensity, percentage area under food crops and non-food crops, less live stock population and grazing land led to greatest agricultural vulnerability of this district. Lastly, in case of occupational vulnerability, in majority of the years, the district of Surendrangar ranked first and Panchmahal district ranked last in all the selected districts.

Adaptation options for improving rural livelihoods in Gujarat: International communities have tried to respond to these changing phenomena though establishing high level Intergovernmental Panel on Climate Change (IPCC). Adaptation is the response in natural or human systems to actual or expected climatic stimuli and their effects, which moderates harm or exploits beneficial opportunities. It is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. The adverse impacts of climate change can be reduced to a certain extent through adaptation. However, the involvement of costs or consequent residual damage would be unavoidable. Over the past several years, there have been discussions on climate change adaptation through organizational response and adaptive response but little has been focused on the community level adaptation integrating the adaptation methods in the policy perspective[4].

Studies by IPCC[5] revealed that, though vulnerability differs substantially across regions, the impacts, adaptive capacity and vulnerability would differ even within regions due to varying spatial and temporal situations. Similarly, the case of Gujarat was not different. The results showed that the ranks and relative magnitudes of the vulnerability indices varied across the various districts in different periods. Thus, in line with Shaw's findings in 2005, it can be suggested that though international level intervention is essential for the commitments and negotiations among the governments, at the community level, there is an urgent need to send the messages to impacts of climate change, and its possible adaptation strategies. Thus, the link between local, state, and national governments to the community is of utmost importance.

Since the agricultural sector was found to have the greatest bearing towards the overall vulnerability of different districts to climate change in, there is a need to shift focus towards investments in adaptation research capacity: particularly, in the development of climate proof crops (drought resistant and heat tolerant varieties) as well as redeploying the existing improved crop varieties that can cope with wide range of climatic conditions. An improvement in the agronomic practices of different crops such as revising planting dates, plant densities and crop sequences can help cope with the delayed rainy seasons, longer dry spells and earlier plant maturity. Also, technologies for minimizing soil disturbance such as reduced tillage, conservation agriculture and crop rotation must be adopted. So far as the livestock sector is concerned, measures relating to utilization of fodder banks, control of livestock population and improvement in the livestock productivity, organizing of cattle camps and conservation of fodder must be undertaken. The percentage area under forests must also be increased as less than 10 per cent of Gujarat's land is designated forest area, and much of that is seriously degraded. The villages of Gujarat continue to depend on firewood as a major source of energy. About 65 per cent of all energy in villages is generated through wood, a report by the state Forest Department on social forestry in Gujarat, has revealed. Thus, there is a call for more effective afforestation programmes and changes in policies *e.g.* resource conservation technologies and resource use efficiency, use of non-renewable energy sources and bio-degradable materials, pricing of resources and credit for transition to adaptation technologies. New strategies must be built around 'green' agricultural technologies, such as adaptive plant breeding, pest forecasting and rainwater harvesting and fertilizer microdosing.

Following the agricultural indicators, the occupational indicators were found to be the second largest contributors towards overall vulnerability in the selected districts of Gujarat. Thus, to reduce the climate change impact or to adapt with it, the first and foremost is livelihood security through income diversification. The need to reduce the dependence solely on agriculture, by encouraging other non-farm sources of income, must be considered.

The migration problem in some of the districts like Surendranagar was noticed to be high because of the water scarcity in the region. New industries hardly come to this district. In the whole of Gujarat, Surendranagar district gets lowest amount of new industrial investment[6]. Thus, the policy makers must focus on generating better employment opportunities for the people in this region.

Apparently, the Northwest Arid Zone was found to be the most vulnerable zone among all the agro-climatic zones due to extreme deviations in the rainfall pattern. State-sponsored interventions in Kutch have not only failed to mitigate water scarcity but have exacerbated problems in some areas. The drought severity is the symptomatic manifestation of decades of dryland blindness.

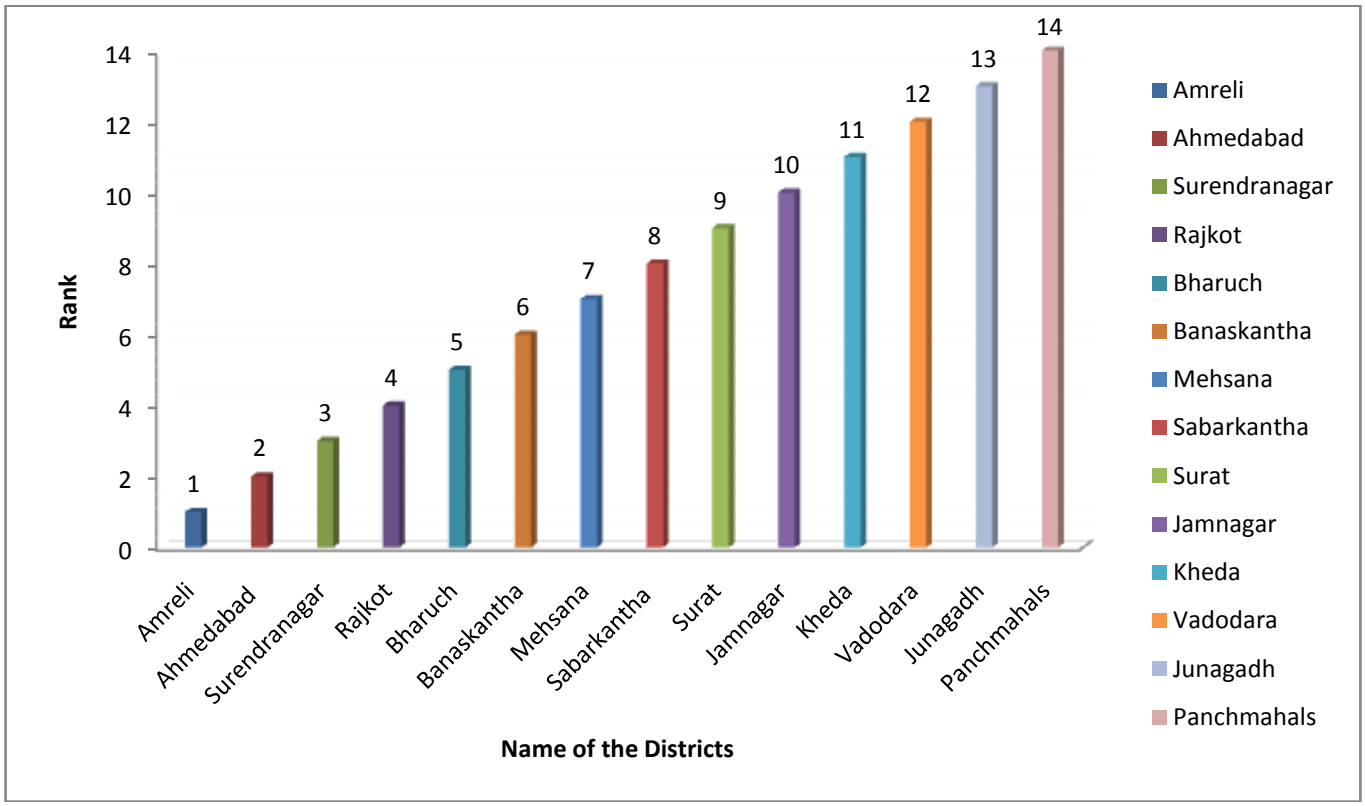

Figure – 1
Ranking of the districts based on vulnerability indices to climate change for the year 2008

Drylands such as the 'tortoise' Kutch may be dealt unfavorable cards by nature and are risk prone and uncertain. But strategies such as rainwater harvesting, livestock development and techniques to enhance dryland agriculture can help overcome many of these constraints. In short, drylands require strategies unique to their systems that take into account their uncertain dynamics. They are different perhaps even fragile, but they are definitely not liabilities.

Lastly, since the worst sufferers of climate change impacts are the rural communities, (who depends mainly on agriculture as their livelihoods), it is important to focus on the impacts of climate change on livelihoods, and re-establish the links among poverty, livelihood and environment. However, focusing on the communities only are not enough, and so long the community initiatives do not become part of the government policies, it is difficult to sustain the efforts. Moreover, a unique way of vulnerability reduction is through enhancing capacities of local people and communities. This can be considered as people and community dimension of human security, which should include livelihood security, environmental security, social security, self-security, and information security. Thus, for a state like Gujarat, what is required is a development strategy that integrates climate change policies with sustainable development strategies.

Conclusion

Gujarat state has the fastest growing economy in the country. It is rapidly expanding its production and consumption activities. Thus, the state not only contributes to climate change but is equally vulnerable to its impacts. There is a pressing need to balance this development by simultaneously acting upon climate change and other issues which are putting tremendous pressure on the environment's carrying capacity. The evidences are overwhelming; it is only the time to act! What is most pleasing is that Gujarat has already begun to tackle this menace by opting for a more sustainable and holistic development for itself.

References

1. http://www.ceeindia.org/cee/pr/climatechange04.html

2. Iyenger N.S. and Sudarshan P, A Method of Classifying Regions from Multivariate data. *Economic and Political Weekly*, Special Article, 2048-52 **(1982)**

3. Mehta, L., Drought Diagnosis: Dryland Blindness of Planners, *Economic and Political Weekly* **(2000)**

4. info.worldbank.org/etools/docs/library/230308/Session%202/Session%202%20Reading%202.doc

5. IPCC, Climate Change, Climate Change Impacts, Adaptation and Vulnerability. Summary for Policymakers, Inter-Governmental Panel on Climate Change **(2007)**

6. http://www.rashminsanghvi.com

7. Jani B.M., Economics of Drought in Gujarat: Issues and Policy Options for Drought in Gujarat, 1 **(1989)**

8. Modi, Narendra. Convenient Action: Gujarat's Responses to Challenges of Climate Change, 3 **(2009)**

9. IPCC. Climate Change: The Scientific Basis. http://www.ipcc.ch/ **(2001)**