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Impact of climate change on farming community and adaptation measures in semi-arid region of Tamil Nadu

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Abstract
Climate change is one of the most serious threats for sustainable agriculture development, with adverse impacts expected on the environment, human health, food security, economic activity, natural resource's management, and physical infrastructure. The aim of the study is to identify the impact of climate change on the farmers and adaptation measures. The study is carried out in the Namakkal district of Tamil Nadu which is a semi-arid region. Data is collected by primary field survey and Participatory Rural Appraisal (PRA) methods. The rainfall and temperature data for the past three decades is analysed to assess the seasonal and annual rainfall pattern. The statistical methods such as correlation and regression were used to analyse and assess the impact of climate change on the farming community. A sum of 500 small and marginal farmers were selected randomly from different panchayats in districts to collect the data. According to farmers, this problem is linked with the reduction in the number of rainy days for all seasons. It is identified there is a decreasing trend in the rainfall for the past eight years and temperature is increasing at a faster rate. The climate variability and the trends observed in the study area has direct and indirect impacts on the farming community in the region, effective adaptation measures are suggested to address the impacts of climate change.

Keywords: Climate change, farmer, agriculture, temperature, adaptation

Introduction
Global warming and climate change are growing environmental concerns that are resulting from the accumulation of greenhouse gases such as carbon dioxide (CO_2) in our atmosphere. There is strong evidence that human activities have affected the world's climate (IPCC 2001a) [3]. Deforestation and burning of forests releases CO_2 to the atmosphere. Rainfall, being considered as the prime input for agriculture has its own erratic behavior in terms of amount and distribution. In crop planning, a detailed study on rainfall behavior is vital. Rainfall variability, both in time and space influences agricultural productivity and sustainability of a region, as opined by Anbazhagan (2004) [2]. Agriculture being mainly rainfed in Namakkal region of Tamil Nadu state ischaracterized by uneven and erratic distribution of rainfall. Since rainfall is the only source of moisture, the spatio-temporal distribution of rains holds the key in determining the fate of entire crop productivity in the region. There are so many authors studied about the rainfall variability, Krishnakumar (2010) [7] reported rainfall variability in Gujarat and Kerala state respectively. Balakrishna *et al*. (2011) [4] reported annual and seasonal rainfall variability at Dharwad, Karnataka. A similar attempt was made to analyze the rainfall distribution pattern in monthly, seasonally and annually for Gulbergacity, karnataka region. Apart from the landless and urban poor, small farmers are among the most disadvantaged and vulnerable groups in the developing world. The share of surveyed smallholder households falling below the poverty line is close to 55 percent in most continents. Most climate change models predict that damage will be disproportionately borne by small farmers, particularly rain-fed agriculturists in the Third World. In some African countries, yields from rain-fed agriculture – the predominant form of agriculture in Africa - could be reduced by 50 percent by 2020. Jegankumar et al. (2012) [6] averred that soil quality, water availability or drought stress and climate change are three biophysical factors which need to be addressed for food security in the face of climate change.

RS and GIS have been found useful for soil characteristics mapping, agro-climatic assessment, land use suitability for crop production, irrigation management, precision farming, crop type mapping, crop condition assessment, among others.

Study Area

Namakkal district is located in 11.23°N latitude and 78.17°E longitude in the west centre of Tamil Nadu. It has an average elevation of 218 metres MSL. The major drainage system in the area is Cauvery river and Thirumanimuthar. The total population during 2011 census is 1,726,601 and the population density is 505 persons per sq. km. It is a semi-arid region and hence agriculture normally depends on seasonal and monsoon characteristics of rainfall. The major soil types found in this district is Black soil, Brown soil, Alluvial soil and Mixed soil. The major crop found in this district is Groundnut, Paddy, Cotton, Cumbu, Tapioca, Ragi, Pulses and Millets.

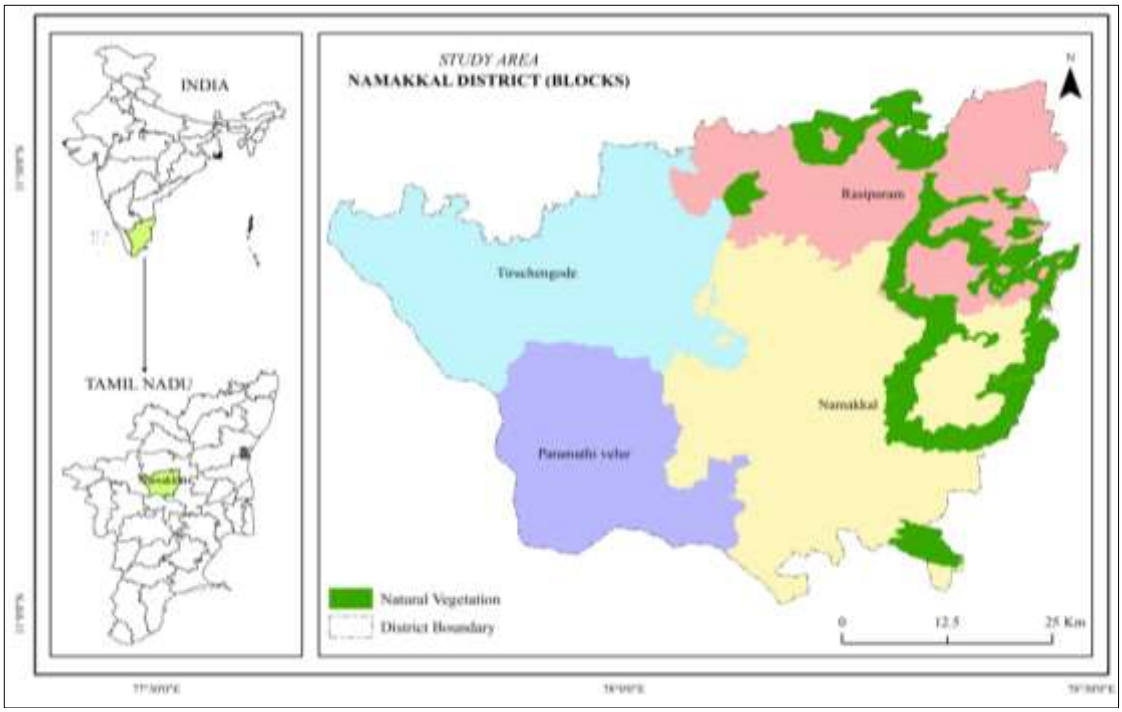

Fig 1: Location of Study Area

Methodology

The study carried out using participatory and interactive process to understand the perception of climate change by the small and marginal farmers in Namakkal district, impact of climate change on their livelihood, future threats that are looming over them, and also steps that are being taken at their level to cope up with the extreme events of climate change.

The relevant data for the study were gathered by administering the finalized Interview Schedule on the respondents. Participatory methods such as Focus Group Discussions (FGD) and Participatory Rural Appraisal (PRA) were also adopted to collect relevant information for this study. It helped to understand the perception of the farmers on climate change, its impact and adaptation measures. The PRA techniques such as seasonal calendar, timeline and trend change were also followed to gather information. PRA is a tool used for collecting information from the communities (Mascarenhas *et al*., 1991). It is a very useful tool as it involves many stakeholders. This is important as the knowledge of the rural people and the way they look at things like their living conditions, their needs and interests and also possibilities they have to develop and change can also be included (Robert Chambers, 1990 and 1994). PRA tools have been used to enable respondents to express and share their knowledge of life and conditions.

Results and Discussion

Rainfall Trend Analysis

Annual: Trend analysis of the study locations was carried out to understand the long-term changes in rainfall and their magnitude of change. The change in amount of yearly rainfall will directly affect the availability of water. Therefore, it is vital to know whether there is a decrease in rainfall so that, the information can be used for regulating the planning and management of irrigation project and water resources associated issues. Annual trend analysis reveals in 6 out of 7 locations witness a decrease in rainfall. The highest rainfall of 1491.8mm on Sendamangalam in the year 2012. Most of the rain gauge stations received highest rainfall in the year 2011. In Namakkal district, At Puduchatram 864mm, erumaipatti 720.6mm, Mohanoor 783.2mm, Rasipuram 968.9mm and Mangalapuram 955.9mm, Tiruchengode 717.8mm, Kumarapalayam 983.4mm received higher average rainfall as compared to anormal rainfall of 680 mm. The average rainfall observed in all the rain gauge stations during 2004 to 2018 for postmonsoon, premonsoon, southwest monsoon and northeast monsoon are given in Table 1.The only location Paramathy had increasing trend while all other locations had negative trend. Among the locations that witnessed a decreasing trend of rainfall, Rasipuram had the highest decrease (11.38 mm) followed by Namakkal (10.65mm).

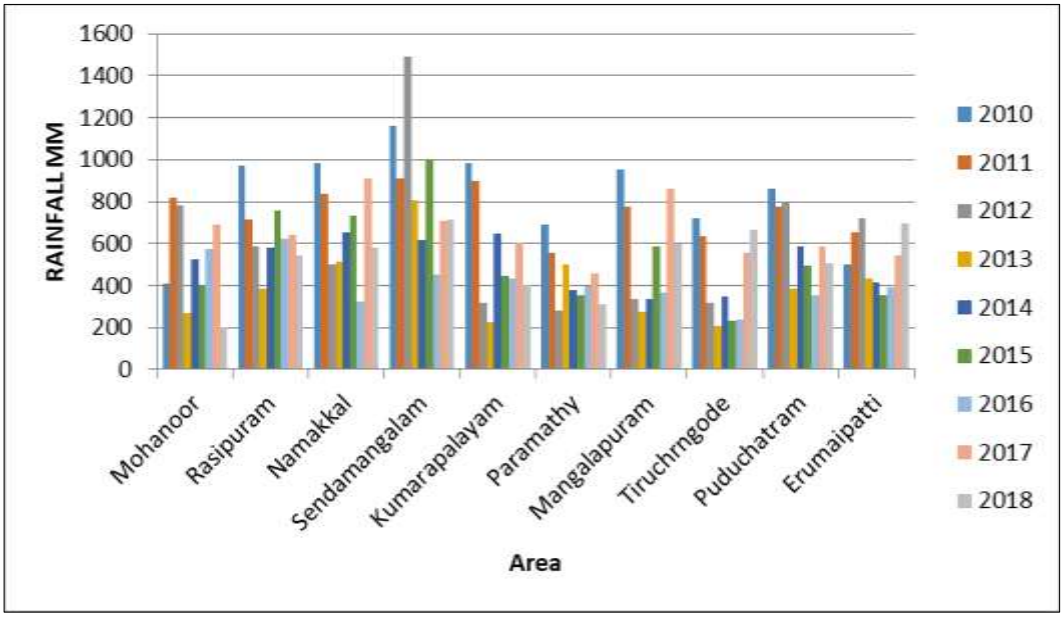

Fig 2: Annual rainfall in Namakkal district

Summer Season

Further the data was segregated seasonally to analyze the trend in the seasonal rainfall. Interestingly, all other seasons had varying trends among the study locations. All the locations had a decreasing trend in winter rainfall ranging from 0.71 mm over Mangalapuram to 0.25 mm over Paramathy and Sendamangalam. During summer, out of 7 rainfall locations 3 had increasing trend during the study period. Among the locations witnessed the increasing trend is maximum over Kumarapalayam (2.03 mm) location and the minimum is found over Mangalapuram (0.66 mm) location. The ranging of decreasing trend is varied from 0.86 mm to 0.43 mm during the study period. Tiruchengode has the highest decrease of rainfall and Rasipuram had the lowest among the rainfall locations in the study area.

Table 1: Annual Average Rainfall in Namakkal District

Rain gauge stations	Rainfall in mm														
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Mohanoor	785.3	521.2	794.3	711.9	531	762.1	408.4	817.7	783.2	268.99	523.8	404.4	573	692.7	199.7
Rasipuram	621.3	862.5	717.8	585	775.4	627.8	968.4	714.2	588.5	385.5	579.6	755.9	621.3	640.2	544.4
Namakkal	794.3	1491.6	711.9	678	997.5	537	982.5	835.53	502	514.5	654.85	731	324	911	581.3
Sendamangalam	659.5	983.8	1165.8	843.5	589.3	776.5	1161.2	909.8	1491.8	808.9	616.8	1002.6	450	709.6	715.8
Kumarapalayam	968.4	1010.5	846.2	932.5	678.9	732.9	983.4	899.9	316.4	222.7	645.2	444.7	431	604.7	405.1
Paramathy	621.3	444.7	314.9	585	404.4	703	691.6	552.7	282	498.6	380.3	354.1	399	455.4	312.2
Mangalapuram	909.8	523.8	385.5	268.9	199.7	784.3	955.9	773.5	337.7	271.5	335.7	585	368.5	862.5	596
Tiruchrngode	694.4	590.9	573.1	401.9	720.6	698.8	717.8	632.2	314.9	209.9	348.7	232.9	237.5	554.9	668.6
Puduchatram	743	559.2	468.5	864.9	720.6	657.9	864	775.4	801.6	386.3	589.2	495.1	352.1	583.7	506.9
Erumaipatti	683.2	482.5	576.2	548.9	602.8	458.4	498	651.71	720.6	433.1	416.8	356.6	392	545.2	697

(Source: IMD Annual report and namakkal KVK)

Monsoon Season:

Namakkal district gets maximum rainfall during the south west monsoon seasons. Paramathy is the only location showing positive trend while all other locations has negative trend during this season. Among the negative trend location Rasipuram had a highest decrease of 8.88 mm and the lowest decrease is identified in Mangalapuram 2.16 mm followed by Kumarapalaym 3.33 mm during the study period over the study area. During NEM season among the rainfall locations the increasing trend is witnessed only in two stations they are Paramathy 2 mm and Sendhamangalam 0.31 mm. All other location in the district had a decreasing trend during the study period. Among the decreasing trend the highest decrease is observed over Namakkal 2.34 mm and the lowest is noticed over Managalapuram 0.39 mm station. It is observed that comparatively less amount of rainfall is received in NEM season than SWM season in the area however two stations Paramathy and Managalapuram shows increasing trend during the study period over the study area.

Table 2: Seasonal Average Rainfall in Namakkal District

Seasons	**Rainfall in mm**														
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Postmonsoon	0	7	21.67	0	30.3	0.66	0	7.67	1	4.33	0	9.33	0	3	7
Premonsoon	96.5	25.2	50.25	25.25	46.75	16.75	55	53	34.5	14.5	55.5	54.25	46.25	40.5	36.25
Southwest monsoon	21	21.3	154.47	109.5	95.5	205.5	81	22	42	33.49	33.49	79.5	67	84	24.75
Northeast monsoon	122.33	181	112.33	119.3	176.33	88.67	110	146.67	106.33	120.67	122.67	109.33	34.4	190.67	121.97

Temperature Analysis

Temperatures play a major role in determining the growth, productivity and duration of the crop growth in the study area. Mean, maximum and minimum temperatures prevailed during SWM and NEM. In addition, annual mean temperature in the study region was analyzed for its trend considering 33 years data set. Normally, sub-tropical climate prevails over the study area without sharp variations. Temperature increases slowly to a maximum in summer months up to May, after which it drops slowly. The mean of maximum temperature is 34°C. The mean of minimum temperature is 22.7°C.

Seasonal Temperature Trend

Trend analysis results clearly state that maximum temperatures are increasing at a faster rate and there is slight decrease in minimum temperature. Mean maximum/minimum temperatures recorded during annual, SWM and NEM are 34/22.7, 35.02/24.5 and 31/21.5°C respectively (Figure 3 and 4). Increase in maximum temperature is more during SWM period. In the case of minimum temperature, a slight decrease is observed during both NEM and SWM seasons. The likely trend of higher rate of increase in temperature would definitely decline the productivity of many annual crops. Studies indicate an increase in the temperatures to the tune of 0.57°C per 100 years (Rupakumar *et al*., 1994). The decadal departures found are above and below the long time averages alternatively for three consecutive decades (Kothari and Singh, 1996). The study also found that the increase had been higher since 1970. When seen alongside the Inter-Governmental Panel on Climate Change's Fourth Assessment Report (2007), global mean surface temperatures had risen by 0.74°C ± 0.18°C over the period 1906 – 2005. In the period 1955 – 2005, the rate of warming was almost double than the 100-year average.

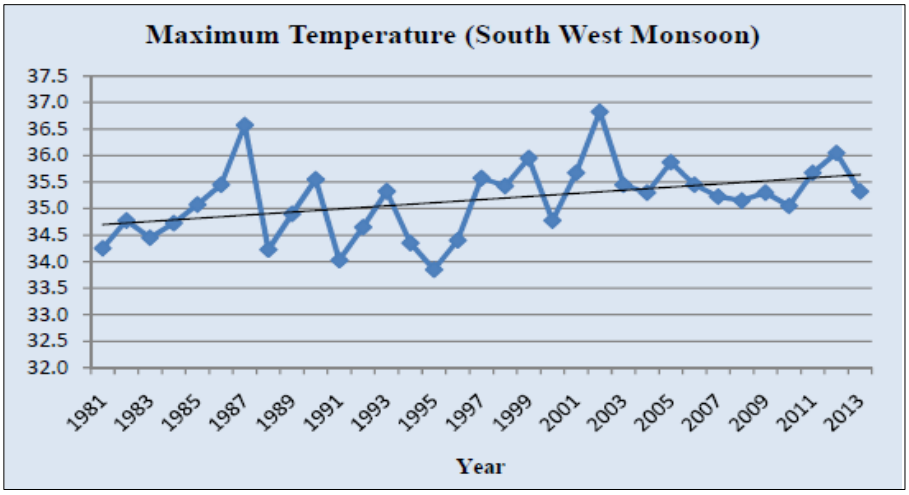

Fig 3: Maximum Temperature (SWM)

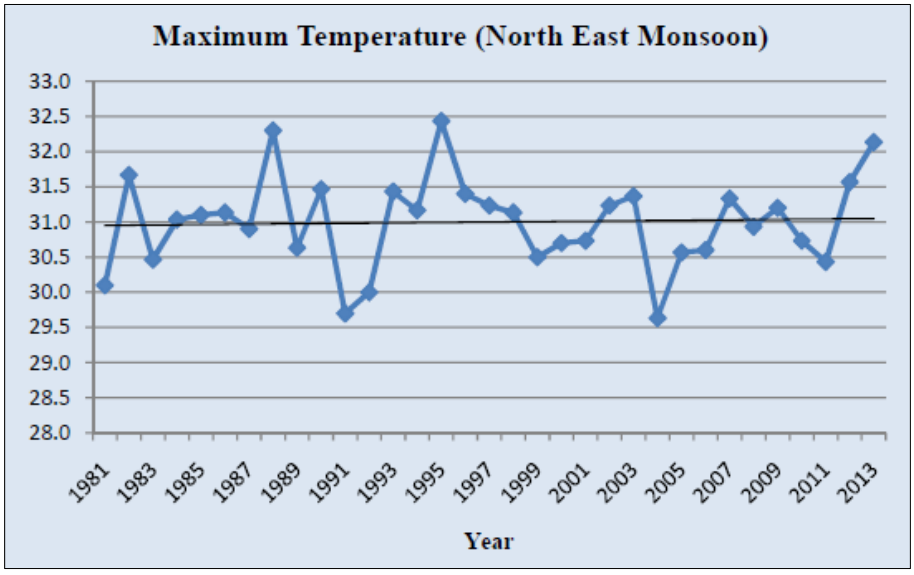

Fig 4: Maximum Temperature (NEM)

Adaptation Strategies followed by farmers

An attempt was made to investigate how farmers perceived and adapted to climate change impacts in the study area. The adaptation strategies and coping mechanisms adopted by semi-arid farmers in the study area include active participation in watershed development programmes offered by Government and Non-Government agencies. The measures to cope with the climatic change impacts are discussed here under.

Suggestions

Soil conservation measures

The following measures were suggested to reduce surface run-off by structures or by changes in land management

which will help to reduce erosion, increase infiltration and water conservation.

Deep tillage: Tillage operations during the summer below the normal tillage depth to modify adverse physical and chemical properties of the soil will help in the retention of higher moisture in the root zone for a longer period of time.

Summer ploughing: Ploughing the soil in advance of the start of the monsoon season would help in opening the hard topsoil, which would increase the rate of infiltration besides reducing the soil-borne pests, diseases and weeds as well as controlling soil erosion.

Application of tank silt: Application of tank silt will help for insitu soil moisture conservation by improving the soil structure, texture, and infiltration rate. It will also improve the available soil nutrient status that would enable increased crop yields.

Shelter belts/Wind breaks: Shelter belts are barriers of trees or shrubs help in reducing wind velocity and, therefore, reduce soil erosion. It helps to retain the soil moisture for crop growth by reducing moisture loss through evaporation.

Water conservation measures

The following water conservation methods suggested for increasing the amount of water stored in the soil profile by trapping or holding rain where it falls, or where there is some small movement as surface run-off.

Percolation pond: The main advantage of percolation pond is improvement in ground water recharge in a scenario where there is increased draft for agriculture and increase in temperature and reducing rainfall.

Afforestation on the boundaries of the percolation pond would help in reducing the siltation of the ponds, minimizing evaporation losses and also stabilizes the bunds for a longer period of time.

Check dam: Construction of check dams help in controlling gully erosion. It serves to slow down the movement of water, allowing increased percolation into the soil.

Farm pond: Farm pond helps in storing the runoff water locally that can be utilized during critical water needs of the crop or for livestock during dry periods.

Diversion drain: In order to safely dispose of excess runoff during high intensity rainfall events, waste weir / diversion drain structures can be constructed at feasible locations.

Loose boulder structure: Loose boulder structures are created across the slope to arrest the sediment movement. Field bunds: Field bunds are constructed up to the height of 30-45 cm wherein the run-off water is retained in the field during the rainy season.

Broad bed and furrow system: Broad bed and furrow helps in draining off excess water in the field and soil, provides congenial condition for the plant growth and development.

Ridging and Tie ridging: It acts as mini-dam which collects the rainwater and minimizes the flow of water off the field.

Soil nutrient management

Organic matter content in the soil can be improved through application of vermi compost or bio-fertilizers at a frequent interval. Bio fertilizers such as Azospirillum/ Phospobacterium can also be applied to the soil to increase the availability of nutrients to the plants. Alternatively green manure crops such as Sesbania can be grown during the SWM period with minimum rainfall and incorporated into the soil at the age of 40 days when the crop is in peak flowering stage. This will increase the water holding capacity of the soil by increasing organic matter content.

Micro irrigation

Drip irrigation is the targeted, intelligent application of water directly to the root zone, fertilizer, and chemicals that when used properly can provide great benefits such as: Increased revenue from increased yields (up to 80%), increased revenue from increased quality, decreased water costs, decreased labour costs, decreased energy costs, decreased fertilizer costs, decreased pesticide costs and improved environmental quality. Water use is reduced by 40 – 60 percent.

Fertigation: Application of liquid fertilizer through drip will increase the nutrient use efficiency, cost on fertilizer is reduced and yield of most of the crops is increased. Cross seeding: Sowing the seed across the slope is known as cross seeding. This helps in maximizing water use efficiency in addition to controlling the soil erosion.

Agro-forestry: Mix up of long lasting forest crops with annual agricultural income provides big profits on annual basis too. Agro-forestry system increases the fertility of soil and also helps in preventing soil erosion.

Agri-horticulture: Fruit crops such as aonla, pomegranate, guava, sapota, mango, etc. can be grown for more profit in the study area. It provides better microclimate for the annual crops besides providing off season employment and income to the farming families.

Conclusion

Namakkal area has high spatial and temporal variability in rainfall. Both the seasons contributes almost equal amount of rainfall over the locations. Among the locations, Mangalapuram receives high rainfall with good distribution while Paramathy has least rainfall and is not dependable. Trend analysis reveals that the NEM rainfall has increased over most of the locations compared to SWM. In order to mitigate the effects of climate change farmers adapt certain adaptation measures such as participatory and inclusive approaches, soil and water conservation and restoration of water harvesting structures and ensuring judicial use of water resources for irrigating the crops. Adaptation measures followed by the farmers have augmented their farm income, raised agricultural productivity, generated rural employment, and reduced the risk by diversifying crops in the rain-fed area and conserved soil and water resources through the process of soil and water conservation. Finally, sustainable agriculture, enabled the farmers to minimize the use of pesticides and fertilizers, thereby saving money and protecting the environment and it has proved to be an effective approach to manage the drought with environmentally and economically sustainable agricultural production systems.

References

1. Anupama Mahato. Climate Change and its Impact on Agriculture. International Journal of Scientific and Research Publications 2014;4(4):1-6.
2. Anbazhagan S, Archana M Nair. Geographic Information System and groundwater quality mapping in Panvel Basin, Maharashtra, India. Environmental Geology 2004;45:753-761.
3. Akhtar R, Carcavallo R, Gubler D, Haines A, Kovats RS, Martens P *et al*. (IPCC, 2001a). Climate Change: Working Group II: Impacts, Adaptation and Vulnerability. Chapter 9, 2001.
4. Balakrishnan P, Abdul Saleem, Mallikarjun ND. Groundwater quality mapping using geographic information system (GIS): A case study of Gulbarga City,

Karnataka, India. African Journal of Environmental Science and Technology 2011;5(12):1069-1084.
5. Ines AVM, Honda K, Das Gupta A, Droogers P, Clemente RS. Combining remote sensing-simulation modeling and genetic algorithm optimization to explore water management options in irrigated agriculture. Agricultural Water Management 2006;83:221-232.
6. Jegankumar R, Nagarathinam SR, Kannadasan K. Spatial distribution of rainfall in Salem and Namakkal districts. International Journal of Geomatics and Geosciences 2012;2(4):976-994.
7. Krishnakumar KN, Prasad Rao. Trends and variability in North-East monsoon rainfall over Kerala. J Agromet 2008;10(4):123-126.
8. Lal R. Soils and Food Sufficiency, A review. Agron. Sustain. Dev 2009;29:113-133.
9. Mall RK, Ranjeet Singh, Akhilesh Gupta, Srinivasan G, Rathore LS. Impact of climate change on Indian agriculture: A review. Climatic Change 2006;78:445-478.
10. Marviya RB, Gupta SK, Patel JC. Analysis of rainfall data for crop planning under dryland agriculture at Rajkot. GAU. Res. J 1991;17(1):93-102.
11. Rupa Kumar K, Sahai AK, Krishna Kumar K, Patwardhan SK, Mishra PK, Revadekar JV *et al*. High - resolution climate change scenarios for India for the 21st century. Current Science 2006;90(3):334-345.
12. Rupsha R, Banerjee. Farmers' perception of climate change, impact and adaptation strategies: a case study of four villages in the semi-arid regions of India. Natural Hazards 2014,74. DOI 10.1007/s11069-014-1466-z.
13. Venkateswaralu B, Shanker AK. Climate Change an Agriculture Adaptation and mitigation strategies', Indian Journal of Agronomy 2009;52(2):226-230.
14. Vicente-Serrano SM, Cuadrat-Parts JM, Romo A. Aridity influence on vegetation patterns in the middle EbroValley (Spain): Evaluation by means of AVHRR images and climate interpolations techniques', Journal of Arid Environments 2006;66:353-375.
15. Yadav SB, Patel HR, Parmar P, Karande BI, Pandey. Effect of Date of sowing, Varieties and Irrigation Regimes on Pod Yield of Kharif Groundnut in Middle Gujarat Agro-Climatic Condition, International Journal of Agricultural Science and Technology 2013;2(1):13-18.
16. Yue S, Hashino M. Temperature trends in Japan: 1900–1990, Theoretical and Applied Climatology 2003;75:15–27.379.
17. Zhou Yuyu, Eom J, Clarke L. The effect of global climate change, population distribution, and climate mitigation on building energy use in the U.S. and China', Climatic Change 2013;119:979-992.