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Farmers' perception of drought impacts, local adaptation and administrative mitigation measures in Maharashtra State, India

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ABSTRACT

Recurring drought is a major challenge in the Drought Prone Area of Maharashtra State in India. Agriculture (e.g., rainfed cropping and livestock) is the major income activity of over 64% of the state's population. The objective of this study is to understand the rural farming community's perception of drought impacts on their socio-economic activities and environment, their adaptation at the household level and opinions on government drought mitigation measures. This study is based on both secondary and primary data collected via a survey of 223 farming households. The results show that decrease in yield of cereals, horticultural crops, livestock production and loss of employment, all associated with decreased income of farmers, were the most immediate economic impacts of drought. Social impacts such as population migration, impacts on health and schooling of children, hopelessness and sense of loss, conflicts in society for water, and malnutrition due to changed food preferences were also reported. The environmental impacts such as increases in average atmospheric temperature, pasture-forest degradation, deteriorated water quality, damage to fish habitat-wild life, and groundwater depletion were perceived by farmers to high extent. In spite of good perception of severity of drought impacts by farmers and their familiarity with various adaptation options, the preference given for their adoption in agriculture was not good enough. Also to mitigate drought, the government provided various mitigation measures, but the level of satisfaction amongst farmers was low. It is expected that this study will help policy makers to develop more appropriate drought adaptation policies in India.

1. Introduction

A warmer climate with increasing climate variability will increase the risk of climate extremes [1,2]. This will consequently alter the magnitude, frequency, duration and spatial extent of natural hazards such as flood and drought. Among all the natural hazards, drought ranks first in terms of the number of people directly affected [3–5]. Drought is a creeping phenomenon, difficult to understand and define due to differences in hydro-meteorological variables and socio-economic factors along with the stochastic nature of water demand in various

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regions of the world [5]. Although specific definitions of drought may vary by sector and region, it is basically an extended period of months or years, in which precipitation is less than the annual average, resulting in water scarcity. Generally droughts are classified as either a meteorological drought (lack of precipitation over a region for a period of time), hydrological drought (a period with inadequate surface and sub-surface water resources), agricultural drought (a period with declining soil moisture and consequent crop failure due to lack of surface water resources) or socio-economic drought (failure of water resources systems to meet water demands, which impacts human activities both directly and indirectly) [1,5–7]. The India Meteorological Department (IMD) defines meteorological drought as a situation when rainfall over an area is less than 75% of the climatological normal [8] (i.e., a rainfall deficiency of 25%). According to the Disaster Prevention Organization [9] approximately 410 major drought events were reported globally during 1980–2008, affecting 53.5 million people each year. Due to increasing temperature, water stress, frequency of El Nino events, and decreasing number of rainy days, production of rice, maize and wheat has declined in many parts of Asia in the past few decades [10]. According to the report of Centre for Low Carbon Futures [11], there will be a marked increase in drought severity across much of Asia in the 2020s compared to the 1990–2005 period, affecting wheat and maize production in China and India (Asia's largest food producers) and ultimately threatening Asia's food security over at least the next two decades.

India, which faced drought conditions at least once every three years over the last few decades, is amongst the most vulnerable and drought prone countries in the world [12]. Since the mid-1990s, India has been experiencing prolonged and widespread droughts in consecutive years, with increased frequency in recent times [12–14]. It is now well accepted that droughts will pose an increased threat to climate sensitive economic sectors in India, especially agriculture [12]. About two-thirds of India's population depends on agriculture and allied activities, hence drought events are likely to threaten the overall economy of the country. The agriculture in India is primarily dependent on Southwest monsoon rainfall (i.e., on average 80% of annual rainfall occurs between June and September) [15]. Due to the temporal and spatial uncertainties of monsoon rainfall, Indian agriculture is at risk. According to National Rainfed Area Authority of India [16], about 60% of the total cultivated area in India still relies on natural rainfall (rainfed agriculture) and hence changes to rainfall patterns are a significant threat to India's agrarian economy. The direct impact of drought on Indian agriculture is decrease in crop (food grains, cereals, oilseeds etc.), vegetable and fruit production. This creates drastic reductions in farmers' income. The situation becomes worse if the drought prolongs and the groundwater availability for irrigation (as a buffer to sparse and variable rainfall) also declines. Furthermore, drought impacts on livestock results in livestock mortality, poor-productivity, health and fertility [17]. In addition, drought increases the chance of food insecurity, shortage of drinking water, mental and physical health problems, migration for work, and debt etc. These impacts can vary significantly from one region to another region. Human drivers, such as increasing water demand and poor water management can further exacerbate the drought impacts. Because of the interplay between a natural drought event and various human factors drought perception varies amongst the people from region to region [18–20].

Still, few studies have endeavored to identify the complexity of drought impacts at the local and regional scale [19–21]. Given projections for increasing drought impacts, it is important to inform policy makers on the causes of drought, its impacts, various adaptation responses and possible mitigation measures perceived at local levels in order to alleviate human suffering [22,23]. Also, the concept of providing short-term drought relief without much reference to the major constraints and problems does not significantly help the region or the poor [19,20,24,25]. Hence, the main objectives of the study are to examine, via a case study investigation conducted in a drought prone region, the level of farmers' perception and awareness about drought, the severity of various drought impacts, and various adaptation measures in practice at the household level. This study also attempts to evaluate farmers' satisfaction with administrative drought mitigation measures at the local level and, finally, recommends where and how improvement to current measures could be made.

2. Study area

The study area is the Upper Bhima catchment which is located in the Drought Prone Area (DPA) of Maharashtra State as shown in Fig. 1.The Upper Bhima catchment is the second largest sub-catchment in the Krishna basin, covering an area of 46,000 km^2. It receives average annual rainfall of 2500 mm and 500 mm in the upper and lower reaches respectively [26]. The mean maximum temperature varies from 38 to 40 °C (usually occurring in May) and minimum temperature varies from 11 to 16 °C (usually occurring in January) [27]. The catchment aggregated annual average rainfall over the period from 1998 to 2013 was 679 mm. About 80% or more of the annual rainfall in the basin takes place during the Southwest monsoon season (June–September). The rainfall zones in the catchment are shown in Fig. 1. The Upper Bhima catchment frequently suffers from droughts and water scarcity. There are three prominent district areas, namely Pune, Ahmednagar and Solapur. Each district is divided into sub-district areas with low population density (below 200 people per sq. km).

Agriculture is the major land use in the Upper Bhima catchment (with about 69% of total land area under agriculture) that comprises 16% irrigated, 21% rainfed and 32% mixed (rainfed & supplemental irrigation) [28,29]. There are two main agricultural seasons i.e., Kharif (hot wet season from June to September) and Rabi (cool dry season from November to March). The hottest season (April and May) is called summer. Almost every year, a large portion of the Upper Bhima catchment is often subjected to water stress conditions due to erratic nature of monsoon [30]. It has resulted in heavy dependence of

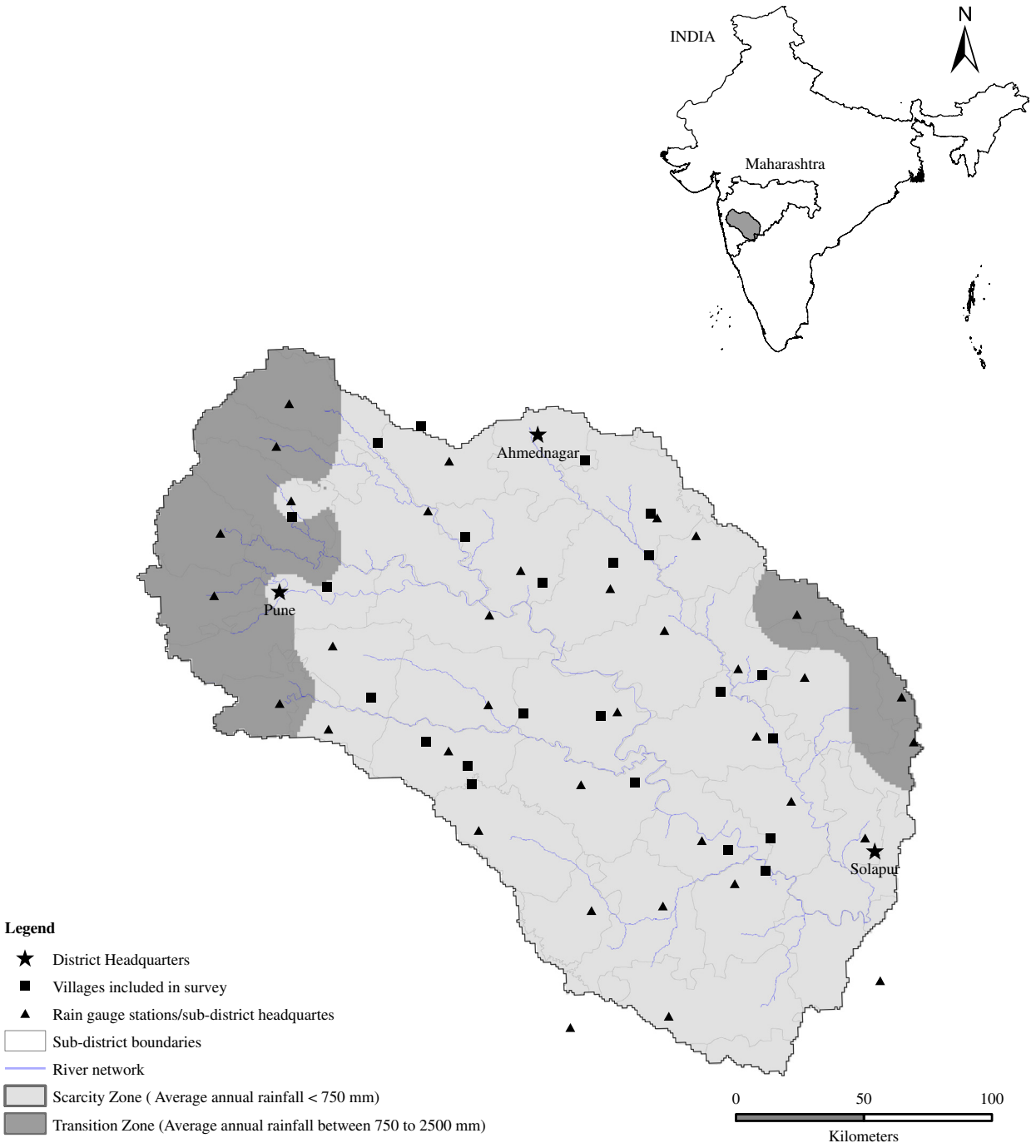

Fig. 1. Location map of the Upper Bhima catchment in the Maharashtra State of India.

population on groundwater resources. More than half of irrigation water comes from groundwater [28]. The groundwater in the region acts as a buffer for long-term rainfall and surface water shortage, however, the average residence time of the shallow, accessible groundwater in the sub-catchment is less than four years [31]. Therefore, prolonged droughts (i.e., greater than two years duration) or consecutive years of reduced monsoon rainfall can severely threaten the livelihoods of farmers in the Upper Bhima catchment.

The IMD has classified drought as moderate drought when rainfall deficiency is 25–50% and severe drought when rainfall deficiency is more than 50% of long term annual average (i.e., rainfall less than 50% of the climatological normal). The monthly rainfall data for 36 sub-districts in the Upper Bhima catchment for the period of

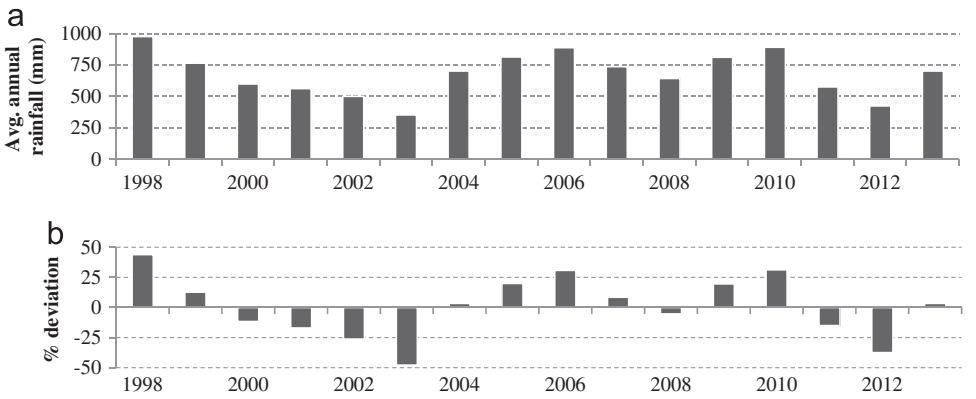

Fig. 2. (a) Average annual rainfall (mm) and (b) deviation from 50 years average annual rainfall in the Upper Bhima catchment.

1998–2013 is obtained from Department of Agriculture, Government of Maharashtra. The deviation from normal rainfall is used for the characterization of meteorological drought according to the definition of IMD. The average annual rainfall for the period of 1998–2013 and its deviation from 50 years average annual rainfall over the catchment is shown in Fig. 2.

A rainfall deficiency of 15% was observed in the year 2011. Conditions further deteriorated in 2012 where the rainfall deficit reached 37% (i.e., moderate drought conditions). Fig. 3 shows spatial and temporal drought incidence (with deficit rainfall, moderate & severe drought intensity) in the Upper Bhima catchment for the period 1998–2013. At the sub-district level, out of 36 sub-districts in the Upper Bhima catchment 6, 16, and 14 for the year 2012 and 14, 6 and 0 for the year 2013 faced deficit rainfall, moderate and severe intensity drought respectively. These figures indicate the intensity of drought and area affected, which is likely to face greater impacts of drought on agriculture and allied activities.

3. Methodology

3.1. Questionnaire design

The questionnaire survey is one of the effective instruments of data collection. Face-to-face interviews, telephone interviews, mail questionnaires, and internet questionnaire are various modes of questionnaire survey. Of all modes, face-to-face survey delivers the most representative results; however the selection of survey mode depends on topic, local feasibility, goal and budget of the study [32]. In order to allow the investigator to collect the most accurate data from a target population, questionnaire must be unbiased. Bias is a problem in the design and administration of the questionnaire. It is a result of an unanticipated communication gap between the investigator and respondents, which yields inaccurate results [33]. It can arise from the way individual questions or questionnaire as a whole is designed and administered. To avoid these biases, [33–37] suggest various steps while designing and administering the questionnaire.

The words used in the questions should be simple, familiar and unambiguous to the target population. The length of the questionnaire should be short in order to avoid response fatigue and skipping questions tendencies. The investigator should be careful while designing and administering the questionnaire to avoid various types of biases [33–37]. The investigator should pay attention towards the flow of questions. Questions on a same topic should be grouped together and transitional statements should be used to switch between different topics or sections. During the administration of questionnaire care should be taken to avoid respondents' conscious reaction (fake responses to seek sympathy), sub-conscious reaction (tendency of trying to be conservative), inaccurate recall, and cultural differences.

The questionnaire was designed referring to earlier perception studies by Habiba et al. [38], Manandhar et al. [39], Ashraf and Routray [40], Keshavarz et al. [41] etc. At the same time climate change and agriculture experts were also consulted. And it was administered as a face-to-face interview by the researcher. The questionnaire intended to gather information on farmers' awareness towards drought and its impacts, types of preparedness and adaptation strategies adopted by farmers, administrative mitigation and relief measures and farmers opinion towards them. The survey was conducted in local language (Marathi) for better understanding. Prior to the survey, the questionnaire was pre-tested with sub-sets of the targeted population (i.e. few farmers from two representative villages) to check the redundancy, missing information, relevancy as well as validity of the questions. The questionnaire was then modified based on pre-test results. The individuals included in pre-test were omitted from the sample considered in this study.

3.2. Procedure

In order to fulfill the objectives of the study and to capture the scenario of recent drought 2012, a structured questionnaire survey was conducted in the Upper Bhima catchment during May 2013 (Appendix A). An individual farming household is considered as a primary sampling unit. A multi-stage stratified systematic sampling technique was used to select samples from the target population (villages as a penultimate unit (cluster) and household as final unit) [40]. The catchment area was divided into three

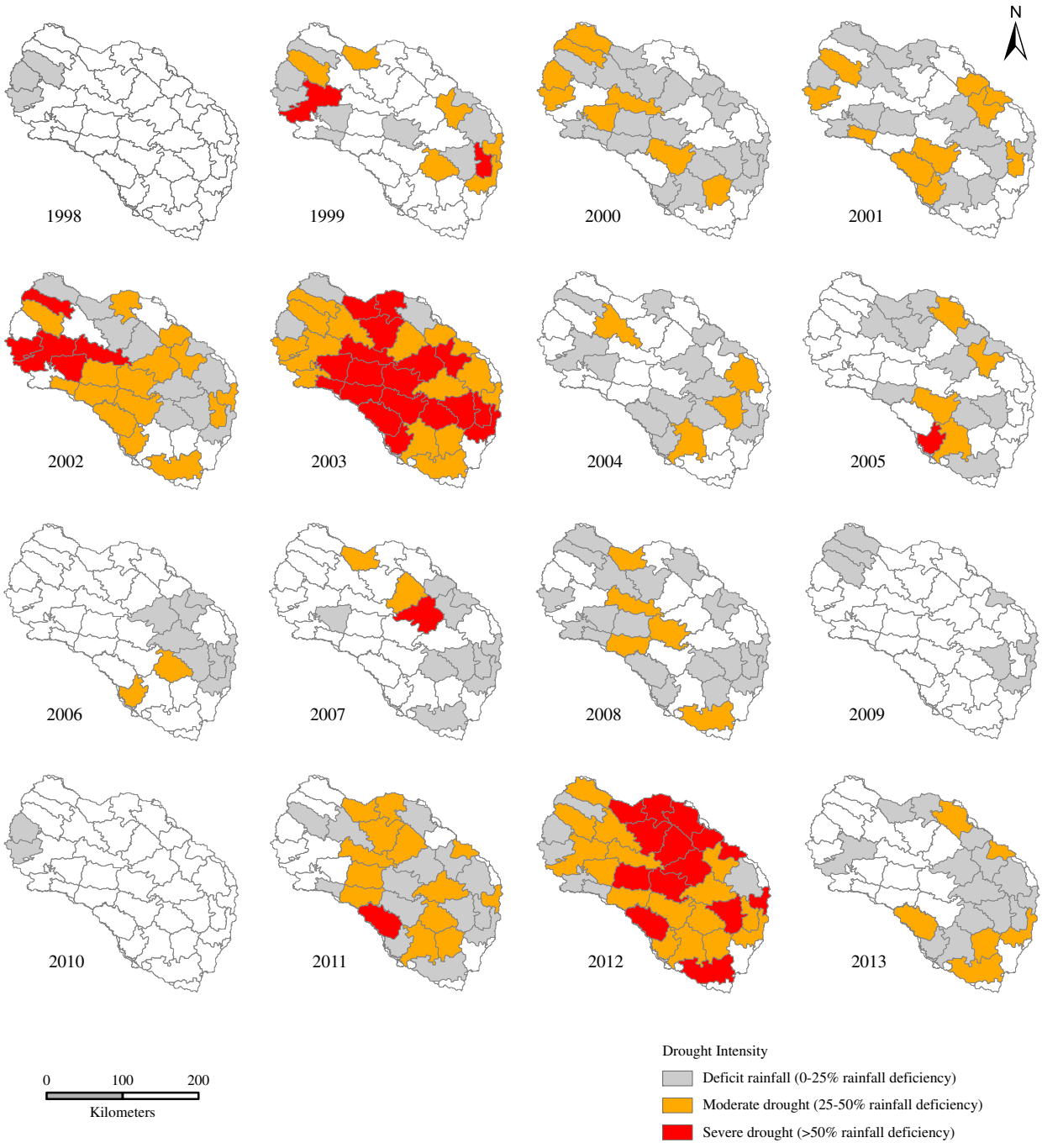

Fig. 3. Drought intensity in space and time in the Upper Bhima catchment.

strata-areas with less than 15% (low irrigated), between 15–30% (medium irrigated) and more than 30% (highly irrigated) irrigation of the total cultivated area, considering average irrigation percentages over each sub-district. This grouping is based on three equal intervals of percent irrigation coverage range of 0–45 over sub-districts. It is assumed that the extent of irrigation will influence the farmers' perception of drought impacts, adaptation, and mitigation measures. The gridded irrigation percent data in the catchment was obtained from FAO (Global Maps of Irrigated Area) [29]. The list of villages and population data in the catchment was obtained from a website of Census of India [42].

In the first stage, the villages were selected by probability proportional to size (PPS) sampling technique, and in the second stage households were chosen from selected villages by random walk sampling technique. Sample size determination formula by Akin and Colton [43] and household survey sample design procedure by UN Statistics Division [44] were used to calculate minimum sample size

of 138 and 178 respectively, but in actual conditions total 223 households were included in the survey. Considering the population proportion in all three strata, 76, 74 and 73-households were selected from less-, medium- and high- irrigated areas respectively from 23 villages. Each respondent household head or representative was interviewed face to face with the help of pre-tested questionnaire, which had both close-ended and open-ended questions. The response rate was almost 100% during the face-to-face interview due to the respondents' interest to know and discuss more about drought in the area, and their availability at home in off season for agriculture in the month of May.

3.3. Data analysis

The primary data was processed and statistically analyzed using PASW SPSS 18. Responses to an open ended question were coded under similar answers, with coding 1 for "affirmative response" and 0 for "no answer/response", to speed up data entry into SPSS. Only the affirmative response is expressed in percent. A five point Likert scale (1 for very less to 5 for very high) was used to code farmers' response to the various close-ended questions. The aggregate reliability of Likert-type items related to drought impact severity (20 items) was confirmed by Cronbach's alpha, $\alpha = 0.80$ (the acceptable limit is > 0.70). However, in case of Likert-type items for adaptations (6 items) and level of satisfaction from government mitigation measures (4 items), Cronbach's alpha was 0.5–0.7. It is due to the reason that, with the few scale items (less than ten), it is common to get low Cronbach's alpha ($\alpha = 0.5$). In this case, to check the reliability Likert-type items, mean inter-item correlation of these items was obtained 0.25 and 0.35 respectively (an optimal range 0.20–0.40 is acceptable) [45].

Descriptive and inferential statistics have been used to assess farmers' perception of various drought impacts, coping/adaptive strategies being practiced to mitigate the effects of drought and government level administrative mitigation activities as relief measures. To analyze the difference in perception of respondents, in addition to grouping based on sub-district wise irrigation strata [Low ($< 15\%$), medium (15–30%) – and high ($> 30\%$) – irrigated area of total cultivable area], population is grouped based on their land holding size [households with marginal (< 1 ha), small (1–2 ha), medium (2–4 ha), large (> 4 ha) land holdings] [46], annual household income [low (< 791 USD), middle (791–3313 USD) and high (> 3313 USD)] [47], education (illiterate-, primary-, secondary- and higher-education) [42] and drought intensity (severe- and moderate-drought) [8] faced. All these groupings are standards that are commonly used except irrigation strata. Data were analyzed using non-parametric significance testing, Kruskal–Wallis *H*-test (for comparison of 3 or more groups with multiple variables) and Mann–Whitney *U*-test (for comparison of two groups with multiple variables) at 5% significance level [45,48–52].

4. Results and discussion

4.1. Profile of the respondent households

A total of 223 households were interviewed from three irrigation strata, of which 79.4% were household heads and 20.6% were relatives of household heads. The average age of the respondents was 42 years (range was 14–76 years). The overall average household size of the sampled population was 6, which is larger than the average size of 5 persons per household in the Maharashtra State [42]. Data on education indicated that 9.4%, 29.1%, 47.5% and 13.9% respondents had no education, completed their primary education, secondary or higher secondary, and bachelors or higher education, respectively. Crop farming, livestock farming and agricultural labor are income sources of 98.2%, 79.8% and 37.2% respondents respectively. The average annual household income of each respondent is 1975 USD (1 USD = 54.33 INR as on March 31, 2013). Detail figures are given in Table 1.

Table 1
Socio-economic characteristics of respondent households in the Upper Bhima catchment.

Household (HH) Characteristics ($n = 223$)	Less irrigated	Medium irrigated	High irrigated	Average
HH proportion (%)	34.1	33.2	32.7	
HH heads interviewed (%)	75	83.8	79.5	79.4
Relatives of household head interviewed (%)	25	16.2	20.5	20.6
Average age of respondents (years)	40.6	43.3	41	41.6
Average HH/family size (persons)	5.9	6.0	5.9	5.9
Education (%)				
No education	13.2	10.8	4.1	9.4
Primary education	31.6	27.0	28.8	29.1
Secondary school	42.1	44.6	56.2	47.5
Higher secondary school	13.2	17.6	11.0	13.9
Source of HH income (%)				
Agriculture	100	98.6	95.9	98.2
Animal husbandry	85.5	85.1	68.5	79.8
Wage/farm labor	48.7	43.2	19.2	37.2
Average land holdings per HH (acres)	6.6	4.7	3.8	5.0
Average livestock per HH	6.9	6.3	4.8	6.0
Gross annual HH income (USD)[a]	2257	2024	1630	1975

[a] 1 USD = 54.33 INR as on March 31, 2013.

4.2. General perception of drought impacts

Farmers were asked in their local languages about their perception of drought and its impacts on their socio-economic activities. Drought has different meaning to respondents based on their physical environment, type and degree of involvement in agricultural activities, and level of impact on their financial well being [53,40]. Various responses emerged for the open ended question: *"What does drought mean to you?"* Farmers defined drought as less or no rain over the season resulting in water scarcity for various uses mainly for drinking and agriculture (87.0%), lack of water and fodder for livestock (45.7%), poor cereals and food grain production (18.4%), food scarcity (17.5%), and less agricultural employment (13.9%). Besides this, few farmers have also perceived drought as increased atmospheric temperature, financial weakness, increased commodity prices and no electricity supply.

Out of all the farmers interviewed, about 92.8% farmers' perceived drought as a natural phenomenon, while 7.2% perceived it as a mismanagement of water resources by the responsible authority. It was found that about 85.6% of farmers have experienced drought in the past years. About 28.3% and 37.7% of them remembered the drought event in the year 1972–1973 and 2002–2003 respectively, due to their severe intensity. When asked about the frequency of severe drought experienced by farmers, about 11%, 68% and 21% of farmers believed that very severe drought occurred once in every 5–6, 7–10 and 20 years respectively. According to the report by EM-DAT (Emergency Event Database), numbers of drought disasters recorded in Maharashtra State were 5–6 for the period of 1974–2004 [54]. About 95% of respondents believed that drought has been becoming more frequent in the locality during the recent 10–12 years. The television or radio (78.9%) and newspapers (35.4%) were the main sources of information to the farmers regarding drought and possible mitigation and adaptation. When farmers asked about their ability to fight back with drought, only 33.2% farmers believed that they were able to deal with drought with the majority (about 66.8%) indicating they were not ready or unable to mitigate drought impacts. This supports previous work that indicated low resilience and high vulnerability of farmers in this area to deal with drought and its impacts [55].

Information on earlier drought impacts is very important for planning future drought responses. By comparing most severe impacts of drought, policymakers can plan to minimize the most severe impacts [56]. Drying of water resources, crop failure, increase in food prices, poor health – and a decline in prices – of livestock were the most immediate impacts of drought perceived by farmers as shown in Fig. 4. The diverse drought impacts can be classified as social, economic and environmental impacts [40,57,58] which are explained in subsequent subsections.

4.3. Perception of socio-economic impacts

An understanding of the socio-economic impacts of drought is essential in designing technological and policy interventions for effective drought mitigation and relief [23]. Droughts have significant economic impacts as it affects the main economic activities of residents in the area (in this case rainfed or limited irrigation agriculture) [59]. In case of rainfed agriculture, drought always results in crop failure, decreases the yield of food grains (cereal and pulses), horticultural crops, and livestock production, which weakens the income of agrarian households. It results in unemployment of unskilled labors and loss of their time in water collection activities. All of these impacts ultimately weaken the financial condition of farmers. Fig. 5 shows the severity of drought impacts on agriculture in terms of percent reduction in the total cropped area and production of crops for the year 2012–2113, for the three prominent districts in the catchment.

Various Likert type responses related to socio-economic impacts of drought perceived by farmers are

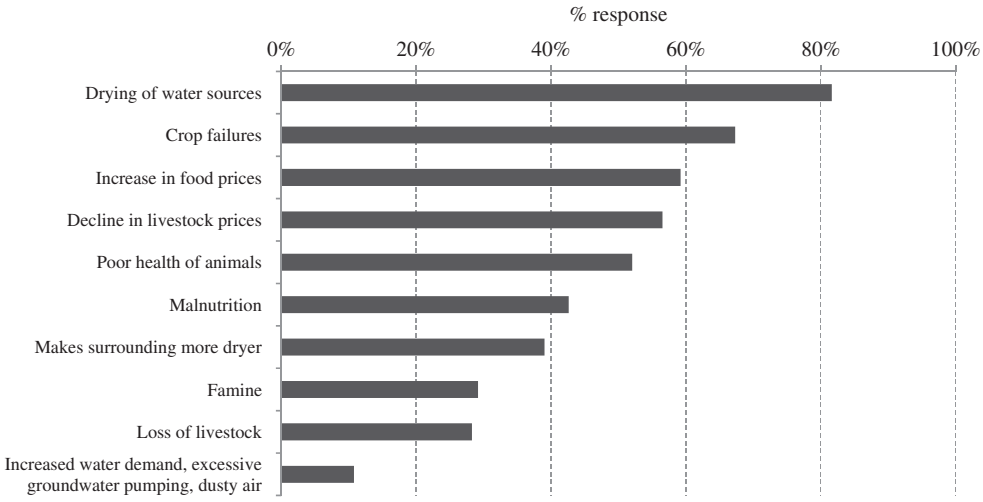

Fig. 4. Farmers' perception of drought impacts in the Upper Bhima catchment ($n=223$).

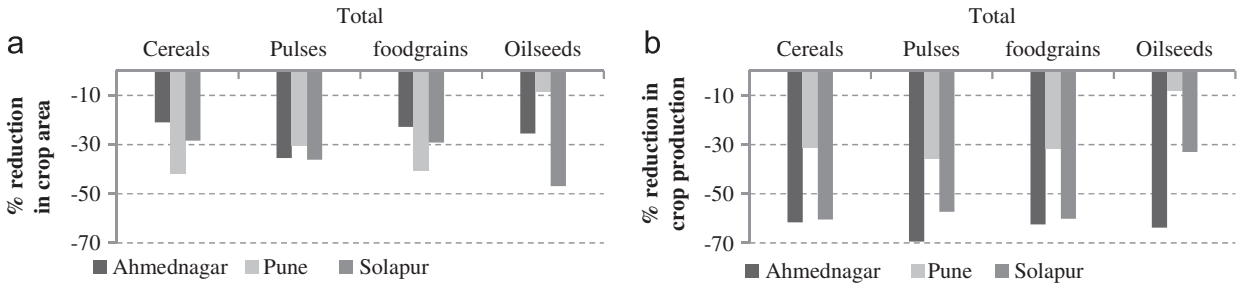

Fig. 5. Percent reduction in (a) cropped area and (b) production for the year 2012–2013 compared to average of 2005–2006 to 2010–2011 in districts which falls completely or partially in the Upper Bhima catchment [60].

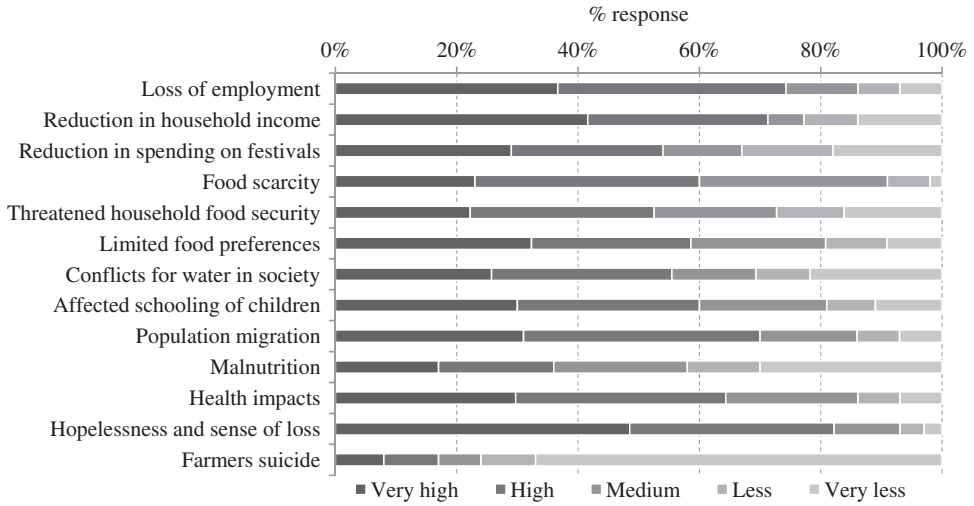

Fig. 6. Farmers' perception of various socio-economic impacts in the Upper Bhima catchment ($n=223$).

shown in Fig. 6. For the Likert type questions related to economic impacts of drought, 72–75% of respondents have answered that drought caused high to a very high reduction in employment opportunity and income. A typical rural household in India spends about 15% of its annual income on celebrating festivals [61]. But, drought mostly affected the income of low income farmers forcing them to reduce their expenses on festivals, which has a negative impact on social life and mental health. Nearly 54% of respondents reported high to a very high reduction in their expenses on festival celebrations. About 60% of respondents reported high to very high food scarcity during the drought years as compared to the normal years and 52% of respondents said that drought has threatened their household food security to a greater extent. Approximately 58% of respondents agreed that they have less to very less food grain choices for their daily consumption. Empirical findings of Fig. 5 (i.e. about 30.4% average reduction in crop areas and 39.4% average reduction in crop production) falls in line with the farmers' perception of high loss in food production, which resulted in high food scarcity as a direct impact of drought. It also explains the severity of reduction in employment (as 80% rural population engaged in agriculture and allied activities), and other indirect economic impacts of drought mentioned earlier.

These economic impacts resulted into social, health and psychological impacts on farming livelihoods. It involved impacts such as inequities in the distribution of water or conflicts between water users, reduced school attendance, population migration, poor health and hopelessness or a sense of loss due to drought. Fig. 6 shows that about 56%, 60%, 70%, 65% and 83% respondents rated these impacts to high to a very high extent respectively. In spite of the growing number of farmers' suicides in Maharashtra State of India [62], farmers believe that drought was not a driving factor for farmers' suicide. It seemed a combined effect of inadequate government policies, along with ecological and social issues. Similar socio-economic impacts mentioned here were also reported in studies done by Keshavarz et al. [41], Guha [63]Karpisheh et al. [64] and Bryan et al. [65].

Table 2 gives the results of the nonparametric statistical tests (asymptotic significance) values for perceived severity of drought impacts against various respondent groups. There was a significant difference observed in spending on festivals based on income groups with poorer farmers affected the most. Also, farmers from low income groups reported that their expenses on wedding ceremonies were reduced or ceremonies were postponed due to drought. A significant difference was observed in perception of

Table 2
Farmers' perception of various socioeconomic impacts in the Upper Bhima catchment (asymptotic significance values, $n=223$).

Socio-economic impacts	Irrigation strata	Land holding size	HH income	Education	Drought intensity
1. Caused unemployment	0.67	0.18	0.78	0.79	0.83
2. Caused reduction in household income	0.60	0.69	0.28	0.89	0.82
3. Reduction in spending on festivals	0.92	0.86	0.05*	0.30	0.10
4. Caused food scarcity	0.59	0.83	0.67	0.87	0.17
5. Threatened household food security	0.52	0.46	0.66	0.92	0.27
6. Limited food preferences	0.49	0.61	0.07	0.26	0.27
7. Caused conflicts for water in society	0.12	0.76	0.69	0.01*	0.83
8. Affected schooling of children	0.08	0.77	0.65	0.12	0.73
9. Caused population migration	0.99	0.63	0.99	0.78	0.19
10. Caused malnutrition	0.18	0.68	0.28	0.54	0.43
11. Affected on health	0.78	0.35	0.31	0.27	0.76
12. Caused hopelessness and sense of loss	0.81	0.44	0.32	0.11	0.54
13. Caused farmers suicide	0.90	0.92	0.74	0.45	0.02**

* Kruskal–Wallis *H*-test significant at 5% significance level.
** Mann–Whitney *U*-test significant at 5% significance level.

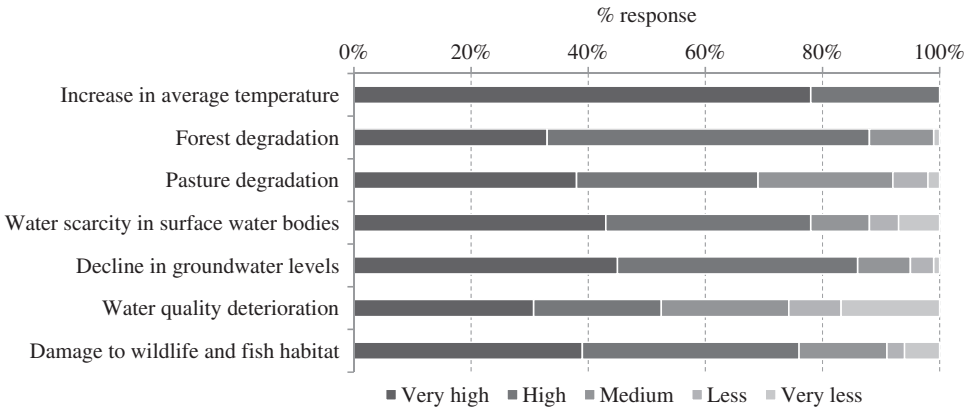

Fig. 7. Farmers' perception of various environmental impacts in the Upper Bhima catchment ($n=223$).

conflicts for water in the society due to drought based on farmers' education level. Less educated farmers said that drought driven water scarcity caused conflicts in the society. Farmers from frequent and severe drought affected areas believed that drought was one of the major causes of suicidal tendencies of farmers due to less income and indebtedness with growing interest. Due to reduced income and social status farmers become mentally depressed, which ultimately ends in suicide. Similar cases were reported in drought affected rural Australia [66].

4.4. Perception of environmental impacts

Drought also affects environment in number of ways. Drought results in decreased river flows, lake water levels and groundwater aquifers. Low-flow conditions in combination with high water temperatures may cause deterioration of water quality to critical values [59]. Furthermore, droughts reduce water in the soil, which has negative impacts on soil fertility, biodiversity and can cause wildfire [67,68]. Fig. 7 shows the environmental impacts of drought perceived by farmers. They reported an increase in the average atmospheric temperature during the drought year as compared to the normal year. Farmers perceived very high water scarcity in surface water bodies. As a result of drought, water storages in major, medium and minor irrigation projects of Pune division (Ahmednagar, Pune and Solapur districts) were also reduced to 12%, 16% and 10% of live storage capacity respectively as on May 2013 [69].

Drought followed by excess heat and water scarcity has greatly affected the forests and pastures. In overall, respondents have perceived high environment impacts of drought in the catchment. The main reason behind this could be a prolonged drought with moderate severity over the whole catchment. Groundwater extraction is increasing every year, except for a partial (but temporary) recovery following years of exceptionally heavy monsoon rainfall. Excessive pumping of groundwater to cope with drought impacts has led to groundwater depletion, which is an important concern of Maharashtra State. About 19 out of 35 districts in the Maharashtra State show more than 4 m (20 cm/year) decline in groundwater level during 1981–2000 [70]. Respondents rate the severity of groundwater depletion as high, mainly due to less rainfall and recharge followed by excessive pumping of groundwater

to buffer against surface water scarcity. Environmental issues such as damage to wildlife and fish habitat (e.g., death of peacocks) due to water scarcity in Balaghat sanctuary, Osmanabad district [71] and deterioration of water quality are also reported.

Table 3 gives the results of the nonparametric statistical tests (asymptotic significance) values for perceived severity of environmental impacts of drought against various respondent groups. Less educated farmers believed that drought has caused pasture degradation. Farmers from low irrigation strata believed that drought causes damage to wild life and fish habitat. There was no significant difference observed in perception of other environmental impacts due to high vulnerability of the study area to the drought of moderate to severe intensity [55]. Historical experience and knowledge about adaptation at the local level is critical for future adaptation policy formulations [72]. Hence after assessing farmers' perception and awareness of drought and various drought impacts, the following sub-section tries to focus on adaptation strategies to mitigate drought.

4.5. Adaptation and mitigation measures

4.5.1. Household level adaptations

Adaptation to drought is a two-step process, which initially requires the perception that drought is occurring and then responding to its various impacts through adaptation and mitigation activities [38]. The previous section has shown that the farmers are well aware of drought impacts and its severity. Based on the perception of drought impact severity, farmers used various drought preparedness and adaptation measures to mitigate the drought impacts.

Various drought preparedness measures adopted by farmers are shown in Fig. 8. Drought mainly affects the crop and livestock production, therefore, about 78.8% of farmers preferred not to sell their crop produce, and instead they stored it to deal with anticipated droughts. About 47.9% of farmers stored crop residues to fulfill the fodder demand during the anticipated drought, and 51% of farmers reduced their expenses and saved money. Farmers seek various options such as migration for employment, selling of livestock, non-agricultural income sources to lessen the drought impacts. Fig. 8 shows only few farmers having irrigation facilities sow crops on time despite of irregular monsoon and even less choose crops requiring less water to deal with drought. However, it is observed that farmers from less irrigated areas tend to be well prepared to deal with anticipated drought by storing harvested grain and saving money as compared to medium- and high-irrigated areas (Table 4). Farmers with small land holding tend to sell their livestock and seek alternative sources of income to cope with drought.

Table 3
Farmers' perception of various environmental impacts in the Upper Bhima catchment (asymptotic significance values, $n=223$).

Environmental impacts	Irrigation strata	Land holding size	HH income	Education	Drought intensity
1. Increase in average temperature	0.99	0.89	0.54	0.94	0.11
2. Forest degradation	0.34	0.69	0.25	0.73	0.31
3. Pasture degradation	0.81	0.51	0.66	0.02*	0.79
4. Water scarcity in surface water bodies	0.89	0.48	0.81	0.81	0.62
5. Decline in groundwater levels	0.41	0.22	0.42	0.21	0.76
6. Water quality deterioration	0.84	0.50	0.26	0.99	0.60
7. Damage to wildlife and fish habitat	0.04*	0.70	0.07	0.51	0.52

**Mann–Whitney *U*-test significant at 5% significance level.
* Kruskal–Wallis *H*-test significant at 5% significance level.

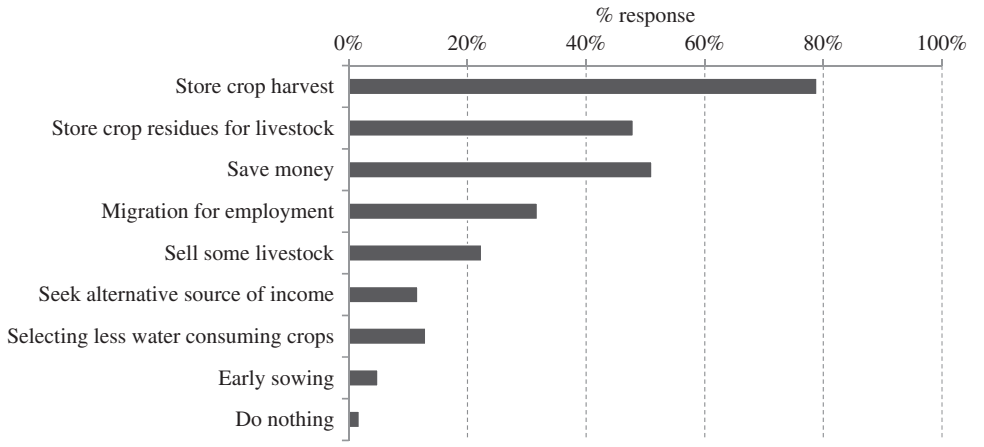

Fig. 8. Drought preparedness measures adopted by farmers in the Upper Bhima catchment ($n=223$).

Table 4
Drought preparedness measures adopted by farmers in the Upper Bhima catchment (asymptotic significance values, $n=223$).

Preparedness activities	Irrigation strata	Land holding size	HH income	Education	Drought intensity
1. Do nothing	0.76	0.27	0.66	0.62	0.34
2. Store crop harvest	0.01*	0.63	0.96	0.63	0.52
3. Store crop residues for livestock	0.77	0.70	0.29	0.04*	0.73
4. Save money	0.04*	0.98	0.98	0.03*	0.54
5. Migration for employment	0.89	0.27	0.77	0.67	0.62
6. Sell some livestock	0.49	0.05*	0.19	0.37	0.86
7. Seek alternative source of income	0.39	0.00*	0.74	0.24	0.48
8. Selecting less water consuming crops	0.43	0.12	0.40	0.33	0.10
9. Early sowing	0.18	0.13	0.97	0.00*	0.82

* Kruskal–Wallis *H*-test significant at 5% significance level. ** Mann–Whitney *U*-test significant at 5% significance level.

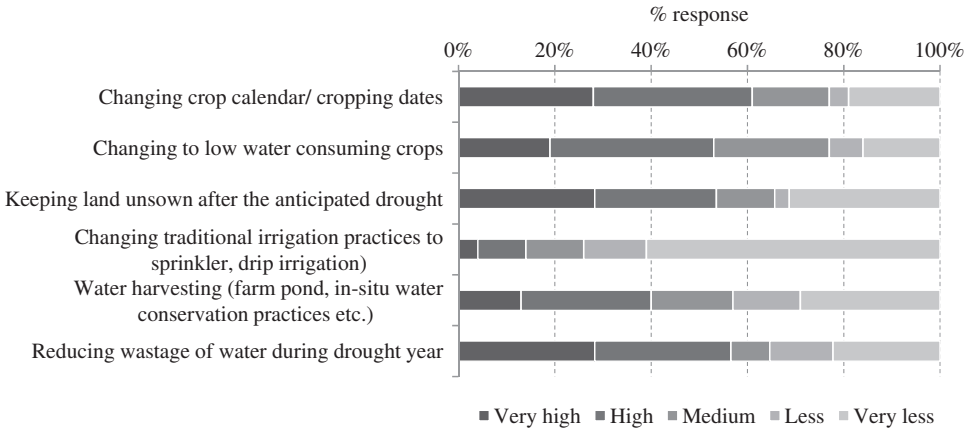

Fig. 9. Major agricultural adaptation measures adopted by farmers in the Upper Bhima catchment ($n=223$).

A significant difference was observed in storing harvested crop, money saving and adjusting sowing dates based on education level of the farmers. It is found that high educated farmers were more conscious about these drought preparedness activities.

Based on the perceived severity of drought impacts, farmers adopted a variety of autonomous adaptation strategies to mitigate drought impacts on agriculture. Fig. 9 shows major agricultural adaptations identified such as changing the crop calendar, using low water consuming crops, no sowing, using improved irrigation practices, water harvesting and reducing wastage of water during drought. Studies by Roy et al. [25], Habiba et al. [38], Dhaka et al. [73], Sahu et al. [74], and Gandure et al. [75] discussed similar agricultural adaptation practices. It was found that about 61% and 53% farmers gave high preference to changing their crop calendar or adjusting cropping dates and using drought tolerant – less water consuming crops respectively to mitigate the drought impacts. About 53% farmers highly preferred not to sow crops if the soil moisture is insufficient for a successful crop. During drought years, about 56% farmers reduced wastage of water to high to very high extent. These adaptation practices were widely used as these practices do not need extra financial cost and are easier to implement.

In the case of rainwater harvesting through various structures and use of modern irrigation practices such as sprinkler and drip irrigation, farmers' preference for this response was low. Only 40% of farmers rated as high or very high use of water harvesting and in-situ water conservation practices, whose use is seriously constrained by costs associated with them [76]. The use of modern micro-irrigation practices such as sprinkler- and drip-irrigation was also not popular, due to high initial investment, high cost involved in renewing systems and lack of irrigation water source. Use of this micro-irrigation technology by farmers has been reported very low as compared with the potential this technology offers and the main reasons for this are constraints associated with obtaining, understanding or maintaining the technology, household income, farm size, and power supply constraints [77].

Land holding size, household income and education are among factors that significantly influence farmers' behavior with respect to adaptation strategies [78]. Also, irrigation area, frequency and intensity of drought are other factors possibly influencing adaptation strategies of farmers. Table 5 gives the results of nonparametric statistical tests for adoption of adaptation strategies against various groups of respondents mentioned earlier. It was found that farmers with high land holding size highly preferred to change their crop calendar and used low water consuming crops against farmers with marginal and small land holdings. A significant difference was observed in adoption of adaptation practices such as use of sprinkler and drip irrigation practices from groups such

Table 5
Major agricultural adaptations adopted by farmers in the Upper Bhima catchment (asymptotic significance values, $n=223$).

Agricultural adaptations	Irrigation strata	Land holding size	HH income	Education	Drought intensity
1. Changing their crop calendar	0.92	0.04*	0.07	0.44	0.67
2. Changing to low water consuming crops	0.34	0.04*	0.65	0.39	0.20
3. Keeping land unsown after the possibility of drought	0.21	0.20	0.97	0.53	0.86
4. Changing traditional irrigation practices to sprinkler, drip irrigation	0.01*	0.02*	0.01*	0.34	0.00**
5. Water harvesting (farm pond, in-situ water conservation practices etc.)	0.64	1.00	0.18	0.43	0.65
6. Reducing wastage of water during drought year	0.92	0.03*	0.03*	0.37	0.71

* Kruskal–Wallis *H*-test significant at 5% significance level.
** Mann–Whitney *U*-test significant at 5% significance level.

Table 6
NREGA employment act and households responses in the Upper Bhima catchment.

	NREGA (Year 2012–2013)	Yes		No	
	Total respondent from 23 villages=223	Frequency	%	Frequency	%
1	Know about NREGA from GPs ($n=223$)	103	46.2	120	53.8
2	Demand for employment ($n=103$)	78	75.7	25	24.3
3	Gets employment opportunity ($n=78$)	32	41	46	59
4	Average labor wages per day (Male)	2.82 USD	–	–	–
5	Average labor wages per day (Female)	2.19 USD	–	–	–

*Exchange rates as on 31st march 2013 1 USD=54.33 INR.

as irrigation strata, landholding size, household income and drought intensity. This clearly indicates that the use of these adaptation strategies is highly affected by availability of water for irrigation, farm size and income. Also, farmers facing frequent drought of severe intensity were more likely to take steps to reduce their vulnerability to drought before it occurred by adopting various water management practices such as micro-irrigation practices. Similar findings were reported by Malik and Rathore [77] and Wallander et al. [79]. Farmers with high income and high land holding size concerned about management of available water without wasting it. It was observed that, in spite of good perception of severity of drought impacts and familiarity with various adaptation options, the preference given for their adoption in agriculture was not good enough.

4.5.2. *Administrative mitigation measures*

Besides household level adaptation measures, administrative strategies play a very crucial role in adapting to drought. As a response to serious drought events in the Maharashtra State, the government has undertaken various relief measures, which included provision of employment, supply of drinking water and distribution of fodder in cattle camps. In addition to this, the government has also provided agricultural loans with low interest rates, crop insurance schemes, and waived electricity bills depending on intensity of drought. Major drought relief measures undertaken by Government of Maharashtra during drought 2012–2013 are explained and discussed in the following sub-sections.

4.5.2.1. *Employment scheme.*

The National Rural Employment Guarantee Act (NREGA) was introduced in 2005 aiming to provide 100-days employment to adult members of any rural household, who are willing to do unskilled manual work at the wage rate fixed by the government every year [80]. In the DPA, the scheme is designed to serve mainly two purposes – first is creating employment opportunities for rural households affected by drought and second is building drought resilience. Under this scheme, drought proofing activities such as water conservation, increase in water harvesting potential of ponds and reservoirs in terms of manual excavation and construction of tanks, check dams, percolation tanks, underground dykes, ponds, rain water harvesting structures etc. are undertaken in DPA. Along with these activities, it also includes activities such as watershed development, tree plantation, labor intensive fencing, nursery raising, canal development, renovation of traditional water bodies and other related activities [81]. In this study, this scheme is considered as one of the administrative level adaptation and mitigation measures. For the questions related to the employment scheme, mixed types of responses were received from the farmers. Only 46.2% of respondents knew about work started under NREGA from Gram Panchayats (GPs: local self-governments at the village or small town level in India), the rest of them did not receive any information or did not know anything about it. Approximately 75.7% of respondents having information about NREGA demanded for employment under the scheme, while only 41% of them got opportunity to work (Table 6).

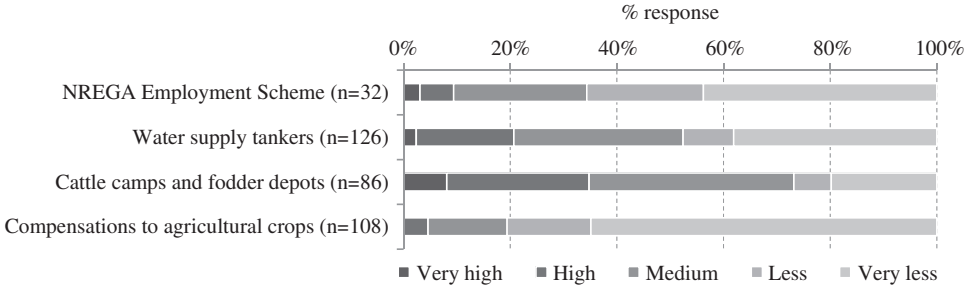

Fig. 10. Level of satisfaction amongst beneficiaries about Government drought mitigation measures in the Upper Bhima catchment.

An average male and female labor wages per day were 2.82 and 2.19 USD respectively. About 56.3% of respondents rated the labor wage as insufficient, while 43.7% of them said the amount was just enough to fulfill their household needs. This opinion differs among households depending on number of family members, employment condition and living standard. Problems such as lack of desired and timely employment, low and untimely payment of wages, corruption, fake jobs and lack of proper NREGA implementation guideline were reported by the respondents. Beneficiary household's satisfaction rating of the employment scheme was very less on 5-point Likert type responses as shown in Fig. 10.

4.5.2.2. Tanker water supply. Prolonged drought always results in increased dependency on groundwater resources. Excessive exploitation of groundwater resources results in depletion of groundwater level and drying of bore wells. These kinds of problems are observed very frequently in the DPA, which threatens the household drinking water supply. However, water is made available to villages and hamlets through private and government tankers depending on intensity of drought and villagers need [82]. In this situation, agricultural and industrial water use was controlled. In 2012–2013, Maharashtra government deployed 1730 water tankers for 1356 villages and 3938 hamlets until February 2013 [83]. About 56.5% of respondent households were provided with tanker water supply under government drought relief measures. Level of satisfaction from the tanker water supply scheme was very less amongst the respondents (Fig. 10), because water-supplying tankers did not have a fixed schedule, water supply was irregular (once in two days to once in two weeks), both quantity and quality of water was insufficient, and inequity in water distribution among households. To avoid conflicts among households, many village GPs dropped water into a public open dug well, from which households took water with the help of rope-bucket. But it resulted into excessive labor and even accidents while taking water out of the dug well with rope bucket. Community suggested dropping water from tankers into existing elevated public water supply tanks, and distributing through pipes for fixed duration to all households as a possible solution to the aforementioned problem.

4.5.2.3. Cattle camps. Water- and fodder- scarcities are the major issues for livestock management during drought. At the very early stages of drought, fodder distribution depots were assigned to private investors in the villages. They transported fodder from some fodder rich areas and distributed it amongst the needy farmers at low price. But as the drought prolonged, these cattle fodder depots converted into mass cattle camps and supplied free fodder and fodder supplements to the livestock. The state provided USD 1.5 and 0.7 per day to cover fodder, transportation, water supply and other related facilities costs for a big and small animal, respectively, accommodated in the cattle camp [83]. According to Government of Maharashtra, about USD 46.6 million was spent on cattle camps until 15th August 2012 and USD 37.9 million was projected until June 2013. The projected expense for Ahmednagar and Solapur district was very high as compared to other districts (most of these district areas falling in the Upper Bhima catchment). Despite of ineffective implementation of the relief measure, respondents agreed that it was better than having nothing. Respondents' level of satisfaction to fodder depots and cattle camps as relief measures was medium on 5-point Likert type response (Fig. 10). The major drawbacks of cattle camps highlighted by respondents' were allocation of less fodder to the cattle violating the government rules, no or less water availability for cattles, and no shadow or shelter, provision of poor quality nutrient, etc. Furthermore, it also had some social impacts such as many families were forced to live apart as men and young boys stayed in camp with their livestock and women were left behind in villages to take care of their families. Similar social impacts were reported in a case study by World Society for the Protection of Animals [84].

4.5.2.4. Compensations to agricultural losses. Government provided assistance or relief fund to support horticultural- and agricultural-crop loss due to drought. In the year 2012–2013, government provided USD 147.2 and 55.2 per hectare as a compensation for the horticultural and agricultural crops damaged by drought respectively [83]. Also, farmers from DPA bought crop insurance. In case of worst and prolonged drought, the government also provides loan, subsidy scheme, waives interest and increases loan repayment period as relief measures to the farmers. According to Government of Maharashtra, total drought damage compensation cost estimated for the year 2012–2013 was approximately USD 133 million [83]. This relief measure had some negative impacts such as some farmers did not pay back loans in spite of their ability, and waited for crop loan and interest waiver from the government. A similar case was observed in case of electricity bill payment. On an average, the level of satisfaction from this relief and mitigation efforts was very

less among the respondents on 5-point Likert type response (Fig. 10).

Provision of employment scheme, cattle camps, fodder depots, and water supply tankers; and compensations for damaged agricultural crops and fruit gardens were the major drought mitigation measures found in the Bhima catchment. According to Drought Memorandum, Government of Maharashtra [83], these mitigation measures (except NREGA) incurred cost of approximately USD 332 million for drought 2012–2013. Even though these administrative drought mitigation measures have provided some relief to the affected households, the level of satisfaction was still low among them (Fig. 10). According to Roy et al. [25], only few farmers got information and benefit from contingency plan. There was lack of awareness and information on administrative drought mitigation measures observed amongst potential beneficiaries. Also, according to the Indian Agriculture Ministry's crisis management plan [85], drought is not a disaster, it is a management issue; improvement in the management of these relief measures is necessary to mitigate the drought impacts on farming community.

5. Conclusions and recommendations

Drought is a recurrent phenomenon in Maharashtra State. Recently Maharashtra State has experienced a drought of moderate severity which commenced in 2011 and continued, expanded and further deteriorated into 2012. This drought, along with the other droughts that have occurred previously, threatened the agrarian economy of the Maharashtra State and caused considerable social and economic impacts on farming communities. Farmers were aware of drought and also well perceived the various socio-economic and environmental impacts of drought in the Upper Bhima catchment. Failure of agriculture subsequently resulted in lack of employment for unskilled laborers, which further exacerbated their livelihood situation and ultimately weakened the financial situation of farmers. Poor farmers affected by drought could not afford to participate in the celebration of festivals and showed a common tendency of postponement of wedding ceremonies due to drought. Less educated farmers reported that drought driven water scarcity has caused conflicts in the society. It is also found that farmers from frequent and severe drought affected areas considered drought as the main cause of suicidal tendencies due to lower incomes and high indebtedness. Environmental impacts of drought were perceived to be high to very high.

To mitigate the drought impacts farmers used various drought preparedness and adaptation measures. With anticipated drought, farmers stored crop harvest (grains), stored crop residues for livestock, saved money, migrated for employment, sold livestock for income generation (and also because they were unable to provide food and water for the livestock), and sought alternative source of income through employment under NREGA, labor for local construction work, sand mining etc. Although farmers were familiar with autonomous adaptation options in agriculture, less preference was given to their adoption. It is found that low education, small land holdings size and low incomes were major constraints in adoption of these adaptation strategies discussed earlier. Special attention should be given to these constraints while designing and formulating policies for increasing community resilience to future drought events. Also, the extent of irrigation was found to not affect the famers' perception of drought impacts and adoption of adaptation strategies, mainly due to a prolonged drought with moderate to severe intensity over the whole catchment. Emphasis should be given to water harvesting techniques to increase the extent of irrigation coverage. Besides household level adaptation measures, administrative strategies played a very crucial role in adapting to drought. As a response to serious drought events in the state, the government has undertaken various relief measures. It was observed that the mitigation measures provided relief to affected households to some extent, but the level of satisfaction was still low amongst beneficiaries due to ineffective planning and management.

Responses to drought in the Maharashtra State are generally re-active in terms of crisis management and poorly coordinated. Hence, the state needs to change from a re-active crisis management strategy to a more pro-active strategy. This is consistent with the findings from other countries [19] where lessons can be learnt and existing strategies considered for implementation in India.

Based on the findings of this study, the following recommendations are provided to improve farmers' resilience and to enable farmers and governments to better combat future droughts:

i. Promotion of various micro (farm) as well as macro (National) level adaptation strategies amongst farmers with the help of government officials to cope with drought;
ii. Developing, introducing and implementing water harvesting practices at the community level and in situ water harvesting practices such as conservative agriculture should be introduced through community participation;
iii. During drought, about 75% of farmers use flood irrigation practice to irrigate their crops. To save wastage of water, traditional flood irrigation practices should be changed to water saving irrigation practices such as sprinkler or drip irrigation;
iv. Introduction of crops that consume less water and drought resistance varieties of crops should be explored as a way of increasing resilience against drought and reducing crop failure in dry spells;
v. Television, radio and newspapers should be used as a tool to disseminate weather information to the larger community about the current and predicted state of the drought and also drought adaptation practices;
vi. Although there are government drought relief measures, community based effective planning, implementation and management should be done to overcome the failure of the relief measures.

The results of this study are based on qualitative data derived from questionnaire survey, which explains farmers' tendencies to mitigate drought impacts. However the introduction of quantitative data and drought vulnerability mapping at state level considering the sub-district as a local unit will be useful for prioritization and implementation of future strategies.

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Appendix. (Questionnaire)

Form no._____ Date:__/__/___

General household characteristics

1. Village details:
   Name:_____Block/Taluka:_____District:_____
2. Respondent details
   Name:_____Gender: (M/F)_____Age:_____Education:__
   Relation with house head:_____Category:_____Housing:_____Mobile:_____
3. What is the main source of income? i. Agriculture ii. Livestock
   iii. Agricultural labor iv. Small business v. Others (specify)_____
4. Employment amongst different age groups

	Gender	Male			Female		
	Age Group (yrs)	6 to 18	19 to 58	> 58	6 to 18	19 to 58	> 58
Employment	Unemployed						
	Unpaid family worker						
	Self employed/small business						
	Wage/salaried						
	Others						

Farmers' perception of drought & it impacts

5. What is drought?_____
   Drought is i) Natural disaster ii) Manmade disaster
6. What are the impacts of drought?
   i. Drying of water sources ii. Makes surrounding dryer iii. Famine
   iv. Crop failures v. Loss of livestock vi. Poor health of humans/malnutrition
   vii. Poor health of livestock viii. Increase in food prices ix. Decline in livestock prices
   x. Other impacts on livelihood
7. Have you ever experienced any other droughts except current drought? (Yes/No) _____
   If yes, please specify years: _____OR
   How often drought occurs? _____
8. Do you think droughts are becoming more or less frequent in last 10-12 years?
   i. More ii. No difference iii. Less iv. Don't know
9. How do you get information on weather forecasts?
   i. No information ii. Radio/TV iii. Word of mouth (friends/neighbors)
   iv. Newspapers v. Self judgment vi. Traditional knowledge sources vii. Other (specify)
   Can you anticipate onset of drought? Yes /No_____
10. How do you respond to drought forecast? _____
11. How prepared do you consider yourself to deal with drought?
    i. Very high ii. High iii. Medium iv. Less v. Very less

12. Please rate following drought impacts

	Very high	High	Medium	Less	Very les
i. Drought threatened household food security					
ii. Drought has caused food scarcity					
iii. Drought caused no choice in food preferences					
iv. Drought caused malnutrition					
v. Drought affected on health					
vi. Drought caused unemployment					
vii. Drought caused reduction in household income					
viii. Drought caused reduction in spending on festivals					
ix. Drought caused population migration					
x. Drought affected schooling of children					
xi. Drought caused hopefulness and sense of loss					
xii. Drought caused conflict for water in society					
xiii. Drought caused farmers suicide					

13. Do you delay repayment of loan due to drought?
    If yes, specify reason:
    i. Inability to pay by fulfilling households needs ii. Subsidy expectation from government
    iii. Reduction in income due to drought/crop failure iv. Others_____
14. Have you postponed any ceremony due to drought? If Yes, (Which and Why)_____
15. Reported farmers' suicides in village? Major reason (please specify, when and why)____
16. What are the reasons of farmers' suicide?
    i. In debt ness ii. Drought iii. Family problems vi.Others (specify)

Agricultural and Livestock

17. How much land holding do you have?_____(acre)
18. How much is the average sowing per year _____(acre)
    Average sowing during drought year?_____(acre)
19. How much is the average sowing cost per acre?_____INR
20. Do you use double sowing after delay in monsoon season or its erratic nature?
    Specify recent one?_____
21. How much land with irrigated and rainfed area? Irrigated:_____acre
    Rainfed:_____acre

22. What is a source of irrigation water during normal year and drought year?

	Dug well	Bore well	River	Lake/pond	Canal	Other
with electric pump						
with diesel pump						
Others						

23. Irrigation practice used? i. Flood irrigation ii. Sprinkler/Drip iii. Mixed
24. What was your approximate gross farm income in normal year (average year)? _____INR
    And current drought year?_____INR

25. Type and number of livestock

Bullocks	Cows	Buffalos	Others

26. Problems related to livestock

Problems	Less production	Water and pasture shortages	Livestock diseases	Lack of market
Normal year:				
Drought year:				

27. Do livestock get sufficient water in drought year?
i. Very less ii. Less iii. Medium iv. High v. Very high

28. Source of fodder

Source	From own farm	Bought from others	Govt. fodder depot	Cattle camps
Normal year:				
Drought year:				

29. Gross income from livestock
Average year_____INR
Drought year_____INR

Environmental impacts

30. How do you rate following environmental changes caused by drought

Scale	Very high	High	Medium	Less	Very Less
i. Increase in average temperature					
ii. Forest degradation					
iii. Pasture degradation					
iv. Water scarcity in surface water bodies					
v. Decline in groundwater levels					
vi. Deteriorated water quality					
vii. Damage to wildlife and fish habitat					

Adaptation strategies and mitigation measures

Household preparedness

31. How do you prepare during normal year to cope with drought?
i. Do nothing ii. Store crop harvest iii. Store crop residues for livestock
iv. Save money vi. Migration for employment vii. Sell some livestock
viii. Seek alternative source of income ix. Use less water consuming crops
x. Early sowing

32. Agricultural adaptations used to mitigate drought impacts?

Scale	Very high	High	Medium	Less	Very Less
i. Do you change your crop calendar?					
ii. Do you change to less water consuming crops?					
iii. Do you keep land unsown after the possibility of drought?					
iv. Do you change traditional irrigation practices to sprinkler, drip irrigation etc.					
v. Do you use water harvesting through farm pond, in-situ conservation practices					
vi. Do you save water by reducing wastage during drought year?					

Administrative mitigation measures

33. Are you satisfied with government water supply tankers? Specify following scale
    i. Very high ii. High iii. Medium iv. Less v. Very less
    Please specify the drawbacks of government water supply tankers?_____
34. Are you satisfied with government cattle camps? Rate your satisfaction on following scale
    i. Very high ii. High iii. Medium iv. Less v. Very less
    Please specify the drawbacks of government funded cattle camps? _____
35. Do you have information about government National Rural Employment Guarantee Scheme (NREGA)? (Yes/No)_____
    If Yes, Do you ask for job?_____
    Do you get sufficient Job opportunity?_____
    How much is the average wages for men and women respectively? _____
    Are you satisfied with government NREGA? Rate your satisfaction on following scale
    i. Very high ii. High iii. Medium iv. Less v. Very less
    Please specify the drawbacks/problems of NREGA?_____
36. Crop Insurance:
    Do you always have crop insurance in drought year? (Yes/No)_____
    If yes, do you get sufficient compensations?_____
    How much crop insurance per acre of failed crop area?_____
    Are you satisfied with government crop insurance scheme? Rate your satisfaction on following scale
    i. Very high ii. High iii. Medium iv. Less v. Very less
37. Loan subsidies:
    Do you have Kissan Credit Card? Yes/No?_____
    If Yes, How much loan do you have through Kissan Credit Card?_____
    Did you able to pay back loan during normal year? _____
    Are you able to pay back loan this year? Yes/No_____
    If No, why?
    i. Crop failure due to drought
    ii. Inability pay back fulfilling the family needs
    iii. Waiting for loan subsidies from government due to drought
    iv. Others (Specify) _____
38. Do you have some restriction on water use from dam/reservoir according to priorities set by governing authority? (Yes/No). If yes, specify order of water use allowed for different sectors according to priority set during drought year?_____

Thank you

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