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Drought Vulnerability Assessment:

The Case of Wheat Farmers in Western Iran

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Abstract

Drought, as a natural and slow-onset phenomenon, creates numerous damages to agricultural communities. As a drought prone area in the Middle East, Iran has currently launched a crisis management approach to mitigate the harmful impacts of drought. However, thus far studies indicate that effective drought management strategies should be designed based upon vulnerability management which can increase farmers' ability to challenge the impacts. The purpose of this study was to assess drought vulnerability across three drought intensities (very high, extremely high, and critical) areas in Western Iran. Accordingly, a survey study was applied and 370 wheat farmers who all experienced drought during 2007-2009 were selected through a multi-stage stratified random sampling method. Face to face interviews were used to collect data on vulnerability indices from the farmers. Me-Bar and Valdez's vulnerability formula was applied to assess the vulnerability of wheat farmers during drought. Results revealed that the farmers' vulnerability is influenced mainly by economic, socio-cultural, psychological, technical, and infrastructural factors. The results also indicated that the farmers in Sarpole-Zahab township were most vulnerable compared to those in the Kermanshah

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township as the least vulnerable. Accordingly, some conclusions and recommendations are drawn for both policy-makers and practitioners who often must prioritize limited resources in the design vulnerability-reducing interventions.

Keywords: Vulnerability, drought intensity, coping strategy, wheat farmers, Western Iran.

1. Introduction

Drought is one of the nation's most costly natural disasters in Iran. During the past 40 years, Iran has experienced 27 drought occurrences (Amir Khani and Chizari, 2010). This shows that drought is a slow-onset, creeping natural hazard that is a normal part of climate for virtually most part of the country. Current studies (Karami, 2009; Keshavarz et al., 2013) show that national drought planning efforts are mainly based on 'crisis management'. However, making the transition from crisis to risk management is difficult because little has been done to understand and address the risks associated with drought. Drought risk management involves mitigation programs which modifies operations before a drought strikes in order to reduce the impending harmful impacts. For instance, the National Drought Mitigation Center in the United States has promoted drought mitigation and preparedness in order to reduce vulnerability (Knutson et al., 2001).

In the context of drought, assessing vulnerability is a starting point to determine the effective means of remedial actions and to mitigate the impacts by supporting coping strategies and facilitating adaptation (Kelly and Adger, 2000). Since farmers are the most vulnerable groups in rural areas (Zahedi Mazandarani and Zahedi Abghari, 1996), the identification of vulnerable groups can act as an entry point for both understanding and addressing the processes that cause and exacerbate vulnerability (Brooks et al., 2005). Moreover, farmers' vulnerability assessment aims to not only identify which groups of farmers are most at risk but also to understand why. On the one hand, this information is critical for drought management policy-makers in Iran who often must prioritize limited resources when designing the vulnerability-reducing interventions. On the other hand, the assessment of "who" is vulnerable and "why", recognizes the interactions between drought hazard and vulnerability that define the risk of serious impacts, and is one of the main aspects of drought mitigation and planning (Wilhelmi and Wilhite, 2002). Hence, the purpose of this study was to assess farmers' vulnerability toward drought in Western Iran.

2. Vulnerability assessment

The scientific use of 'vulnerability' has its roots in geography and natural hazards research but this term is now a central concept in a variety of other research contexts such as ecology, public health, poverty and development, secure livelihoods and famine, sustainability science, land change, climate impacts and adaptation (Fussel, 2007). Vulnerability is defined as the characteristics of a person or group in terms of their capacity to anticipate, resist, cope with, and recover from the impact of natural or man-made hazards (Paavola, 2008; Ethlet and Yates, 2005; IFRC, 1999; Blaikie et al., 1994). According to IPCC (2001), vulnerability is defined as the extent to which a natural or social system is susceptible to sustaining damage from climate change. Vulnerability is a function of the sensitivity of a system to changes in:

i) climate (the degree which a system will respond to a given change in climate, including beneficial and harmful effects);

ii) adaptive capacity (the degree to which adjustments in practices, processes, or structures can moderate or offset the potential for damage or take advantage of opportunities created by a given change in climate); and

iii) the degree of exposure of the system to climate hazards.

Perkins (2001) categorized vulnerable individuals on the basis of their exposure and stress; most sensitive to perturbations or stress, and generally weak coping strategies. Therefore, vulnerability is a condition in which individuals face food insecurity (hunger), job insecurity (unemployment), social insecurity (power isolation), and insecurity of health (illness and physical weakness) (Zahedi Mazandarani and Zahedi Abghari, 1996).

United Nations International Strategy for Disaster Reduction (UN/ISDR, 2004) distinguishes four groups of vulnerablility factors that are relevant to the context of disaster reduction:

1) physical factors, which describe the exposure of vulnerable elements within a region;
2) economic factors, which describe the economic resources of individuals, populations groups, and communities;
3) social factors, which describe non-economic factors that determine the well-being of individuals, population groups, and communities, such as the level of education, security, access to basic human rights, and good governance; and
4) environmental factors, which describe the state of the environment within a region.

All of these factors describe properties of the vulnerable system or community rather than of the external stressors (Fussel, 2007). Chambers (2006) believes that vulnerability has two folds: an external aspect of risk, shocks, and stress to which an individual or household is the subject; and an internal aspect which is defencelessness, meaning a lack of means to cope without damaging loss. Loss can take many forms–becoming or being physically weaker, economically impoverished, socially dependent, humiliated or psychologically harmed. Furthermore, Aysans (cited in Wisner, 2004) identifies eight types of vulnerability: economic, social, ecological, educational, attitudinal and motivational, political, cultural, and physical.

According to the literature, many scholars from different fields of specialization have been conceptualizing vulnerability differently based on the objectives to be achieved and the methodologies employed. These differences limit the possibility of having a universally accepted definition and methodological approach to assessing vulnerability against which the appropriateness of a given concept or method can be judged. However, the knowledge of the existing conceptual and methodological approaches can guide the choice of one of the methods, or the combinations of existing methods, in analyzing vulnerability for a specific area of interest (Deressa et al., 2008). Some of these techniques have been used in assessing the vulnerability such as: fuzzy modeling (Alcamo et al., 2005; Azadi et al., 2007; 2009), statistical analysis (Shewmake, 2008), GIS and mapping techniques (Wilhelmi and Wilhite, 2002), cluster analysis (Haan et al., 2001; Sharma and Patwardhan, 2008) and using index (Zakieldeen, 2009; Patnaik and Narayanan, 2005; Adger, 1999). Recently, there have been growing attempts to develop mathematical models to measure vulnerability (Fontaine et al., 2009; Slejko et al., 2009; Deressa et al., 2008; Brooks et al., 2005; Me-Bar and Valdez, 2005; Metzger et al., 2004; Davis, 2004; Wisner, 2004; Luers et al., 2003; Riely, 2000).

Vulnerability assessment requires that researchers measure factors influencing such a phenomenon. This in turn, would enhance social and environmental resistances toward drought. According to the literature, many studies have focused on factors influencing external vulnerability. Researchers believe that some individuals and groups will suffer more in times of natural disasters. This difference in vulnerability is due to different individual (e.g. gender, age, education, attitude), socio-economic (e.g. social class, religion, ethnicity, social networks, access to resources and power, political structures, income diversification, infrastructural constraints, poor technology, lack of market access and capital, land size), and biophysical attributes (e.g. irrigation, type of product, type of irrigation) (Benight et al., 1998; Simelton et al., 2009; Shewmake, 2008; Paavola, 2008; Brant, 2007; Alcamo et al., 2005; Ethlet and Yates, 2005; Vásquez- León et al., 2003; Downing and Bakker, 2000; Wilhelmi and Wilhite, 2002; Norris, 2002; Knutson et al., 2001; Coeelho, 2000; Elfaigh, 2000).

3. Drought vulnerability

Factors influencing drought vulnerability are numerous, and their inclusion may depend on data availability. Despite limitations, available information on regional drought vulnerability could aid decision makers to be proactive to take appropriate mitigation actions before the drought occurence (Wilhelmi and Wilhite, 2002). Bohle et al. (1996), Azadi et al. (2011a,b), and Rudi et al. (2011) believe that vulnerability, in the most general sense, refers to the relations between nature and society. They believe in this way, vulnerability is a concept originated from "human ecology" that mainly shows how the risk and threats of environmental hazards like drought are experienced by individuals and society. They consider farmers and pastoralists as most vulnerable groups to drought. They believe that among rural households, vulnerability might be doubled in times of drought, particularly if national institutions fail to provide timely support to the food system (Wilhelmi and Wilhite, 2002). According to Sonmez et al. (2005), high economic cost and social vulnerability of drought problem have led to increasing attention to the drought vulnerability in recent years. Losses from drought events across the world have significantly increased in line with the increased number or severity of droughts. The impacts of drought depend largely on societal vulnerability at the time when drought occurs. In recent years, increased losses from droughts are increasingly being focused on societal vulnerability. For example, Blaikie et al. (1994) showed how the risk of drought is a combination of a hazard and societal vulnerability.

Furthermore, drought vulnerability can be different for different individuals and nations. According to Brooks et al. (2005), it is important to note that factors that make a rural community in a developing country vulnerable to drought could be different from those of a wealthy industrialized nation. Even for a given system, vulnerability is unlikely to be the same for low and high frequent droughts (Smit and Wandel, 2006). Downing and Bakker (2000) stated that hazardous weather differs from normal weather by its potential to do damage, and not by its physical or statistical properties. Blaikie et al. (1994) showed that the risk of possible disaster is a combination of hazard and vulnerability. Therefore, the level of risk that the hazard poses to people is directly related to societal vulnerability.

Downing and Bakker (2000) also stated that vulnerability largely defines drought risk rather than the frequency and severity of weather anomalies on their own. In order to lessen the impacts of drought, societal vulnerability must be reduced. However, more effort has been spent on predicting and monitoring climatic, hydrological and biological conditions, than on identifying societal vulnerabilities. Keenan and Krannich (1997) emphasized that vulnerabilities associated with drought are linked more closely to the social context in which water scarcity occurs, rather than with just the physical and climatological events that contribute to scarcity. Attempts to more effectively address the need to plan for drought will fall short unless differential vulnerability is recognized and taken into account as a key consideration in the overall planning effort (Wilhelmi and Wilhite, 2002).

Similarly, studies of past famines suggest that a drought can affect different areas and people within the same stricken area very differently (Eriksen et al., 2005). In developing countries, drought vulnerability constitutes a threat to livelihoods, the ability to maintain productive systems, and healthy economies. In developed economies, drought poses significant economic risks and costs for individuals, public enterprises, commercial organizations, and governments (Downing and Bakker, 2000). Overall, farmers' vulnerability to drought is affected by economic, socio-cultural, psychological, technical and infrastructural factors. Downing and Baker (2000) believe, given the dynamic state of vulnerability, quality and quantity of the drought vulnerability can be different from realm to realm, from region to region and from family to family.

The purpose of this study was to assess the vulnerability of wheat farmers during drought in Western Iran. Accordingly, the following specific objectives are considered to determine the extent of: i) economic; ii) socio-cultural; iii) psychological; iv) technical; v) infrastructural; and iv) total vulnerability of wheat farmers in Western Iran.

In this study, the vulnerability formula proposed by Me-Bar and Valdez (2005) was applied to assess vulnerability of wheat farmers during drought in Western Iran. The result of this study is critical for drought management policy-makers who often must prioritize limited resources in the design vulnerability-reducing interventions.

4. Research method

This study utilized a survey research design in the Kermanshah province in Western Iran. The province is distinguished as one of the main cereal-growing regions in the west part of Iran, with a total area of 24,980 km^2. Its annual precipitation varies from 375 to 500 mm and its total cropped area is about 820,000 hectares of which the rain-fed area constitutes more than 75%.

The drought intensity (DI) was obtained from the Mapping Concentration in Meteorological Center in Kermanshah during 2008-2009. These intensities are categorized as “very high”, “extremely high”, and “critical”. Accordingly, there are twelve regions in all the categories of which half (six regions; namely Kermanshah, Sarpolzahab, Sahne, Eslamabad-e-Gharb, Javanrood, and Ravansar) with an equal DI distribution (two townships per category) were selected for this study.

[insert Fig. 1]

The selected townships include a total population of 94,223 farmers. Using Bartlett et al. (2001) table of sample size (which certifies a 5% margin of error), 370 farmers were selected by a multi-stage stratified random sampling method. A researcher-made questionnaire was developed to collect data through interviews using retrospective questions. In order to test the internal validity of the questionnaire, a panel of experts (including the scientific staff of the College of Agriculture, Razi University, and the extension espcialists[2] of the Agricultural Organization of Kermanshah province) reviewed the research instrument. The aggregate reliability of the vulnerability scale of this study was confirmed by the estimation of Cronbach's alpha coefficient ($\alpha = 0.704$).

Among vulnerability assessment techniques, a formula suggested by Me-Bar and Valdez (2005) was considered as the most appropriate for this study. According to them, the main steps in our method of vulnerability assessment are as follows:

1. Selecting the locations for which the assessment will be carried out.
2. Defining the relevant main parameters (the same for all the cases), and numbering them (i=1…n). Each one of these main parameters consists of a different set of sub-parameters, numbered j (j=1…k_i where k_i is the number of sub-parameters within the i^{th} main parameter). Table 1 lists the main parameters and their sub-parameters.

[insert Table 1]

3. Estimating the values of the sub-parameters within each one of the main parameters for each one of the locations (Pj; j=1,2,…,k_i). In this study, this estimation was done by the farmers themselves. The farmers were instructed to use a 5-point Likert continuum (from 1= best situation for farmers during drought to 5 = worst situation for them). The values given in Tables 2–6 are the averages of the farmers' estimates.
4. Defining the scale of the weights to be given to the sub-parameters under consideration (the same scale for all the cases). Here, the weights were ranged from 1 (minimum weight) to 10 (maximum weight).
5. Defining the weight of each sub-parameter within each one of the main parameters, for each one of the locations (Wj; j=1,2,…,k_i). It concerns the relative importance of each

[2] The extension espcialists who are known as intermediate agents between researchers and farmers, hold high education (university level) and work as educational and training planners for farmers.

one of the sub-parameters to the total vulnerability. In this study this definition was done by the agricultural experts. These experts were also instructed to weigh the parameters with an arbitrarily imposed value of Ci = 1/2(Wmax × k_i) to the sum of all the weights, where Wmax is the maximum value of the weight scale (i.e. – Wmax = 10). This measure prevents the simultaneous attribution of high values to all the sub-parameters, and "forces" the assessor to think in terms of the relative contribution of a given sub-parameter to the total effect of the respective main parameter on the level of vulnerability of the specific location. Here also, the values of the weights given in Tables 2–6 are the averages of the experts' estimates.

6. Calculating the value of the component of the main parameter in the total vulnerability for each location. It is presumed in the model that the "normalized" product of the sub-parameter value (Pj) and its weight in the vulnerability (Wj), defined as the "component value" (PjWj) /Ci constitutes the part that the j^{th} sub-parameter has in the total effect of the respective main parameter on the total vulnerability, so that the value of this total effect is the sum of the values of these components:

$$V_i = \frac{1}{C_i} * \sum_{j=1}^{k_i} (P_j * W_j) \qquad (1)$$

The results of these calculations are given in Tables 2–6.

7. Calculating the "Total Vulnerability" of each location as the weighted average of the main parameters component values, that is:

$$V_L = \frac{\sum_{i=1}^{n} V_i * C_i}{\sum_{i=1}^{n} C_i} \qquad (2)$$

Where L stands for the location for which the "total vulnerability" is calculated. The results of these calculations are given in Table 7.

8. Calculating the "Relative Vulnerability" of a given location (L) relative to the "reference location" (here Kermanshah was selected to be the reference location):

$$V_{R,L} = \frac{V_L}{V_{Kermanshah}} \qquad (3)$$

The results of these calculations are presented in Table 7.

5. Results

5.1. Economic factors

Table 2 illustrates the weight and value of the economic parameters provided by the experts and farmers. The weight of each parameter was assessed by the following formula:

$$\sum W_1 = C_{econ.}$$

$$\sum W_1 = (W_{max} \times k_1) / 2 = (10 \times 9) / 2 = 45$$

[insert Table 2]

As shown in the table, the farmers are economically vulnerable toward drought. According to the results, the experts believe that investment, crop insurance, and agricultural income are the major sources of vulnerability among the wheat farmers. According to the farmers, Kermanshah is the most vulnerable in terms of government support, non-agricultural income, and the size of land. Moreover, in the regions with extremely high drought intensity (Eslamabad-e-Gharb), the size of land, government support, and agricultural income farmers are more vulnerable toward drought. In the critical drought intensity regions, farmers in Ravansar are most vulnerable in terms of agricultural income, size of land, and government support. Overall, these parameters are the most influential in all the studied regions.

5.2. Socio-cultural factors

The weights and values of the socio-cultural parameters are presented in Table 3. The weight of each parameter was assessed by the following formula:

$$\sum W_2 = C_{socio.}$$

$$\sum W_2 = (W_{max} \times k_2) / 2 = (10 \times 9) / 2 = 45$$

[insert Table 3]

According to Table 3, access to the agricultural resources ranked highest (5.9) compared to family cooperation (5.7) and community solidarity (5.6). Based on socio-cultural vulnerability, the farmers were most vulnerable in depending on government's help in Sarpolzahab followed by participating in local institution. Moreover, the educational background of the wheat farmers affected their socio-cultural vulnerability. In extremely high drought intensity, Sahne was most vulnerable in terms of educational background, participating in local institutions, and dependence on the government's help. The results also revealed that in the critical zones, Javanrood was most vulnerable in terms of government dependency, educational background, and farmers' participation in local institutions.

5.3. Psychological factors

Table 4 explains the weight and value of the psychological parameters stated by the experts and farmers. The weight of each parameter was assessed by the following formula:

$$\sum W_3 = C_{psych.}$$

$$\sum W_3 = (W_{max} \times k_3) / 2 = (10 \times 6) / 2 = 30$$

[insert Table 4]

With regard to psychological vulnerability, the experts emphasized that risk taking (6.00), self-esteem (5.3), and drought coping self-efficacy (5.00) is affected the most during the onset of drought. The farmers on the other hand, believed that their risk taking propensity, believing in fatalism, and their hopelessness in very high drought intensity (Kermanshsh) did not help them much to overcome the harsh experience of drought. In extremely high drought regions (Eslamabad-e-Gharb) farmers had similar situation with Kermanshah except that they were more vulnerable in terms of these parameters. In addition, farmers' patience was also a key factor in their vulnerability. Finally, the farmers in Ravansar felt more vulnerable with their low risk taking ability, fatalism, and drought coping self-efficacy.

5.4. Technical factors

The weights and values of the technical parameters are shown in Table 5. Here, the weight of each parameter was assessed by the following formula:

$$\sum W_4 = C_{tech.}$$

$$\sum W_4 = (W_{max} \times k_4) / 2 = (10\times7) / 2 = 35$$

[insert Table 5]

The result of this study also showed that the technical parameters such as access to water resources, being irrigated or rain-fed farmer, and irrigation methods, made the farmers more vulnerable as perceived by the experts. In other words, the experts believed that access to water resources plays a major role in whether or not a farmer is vulnerable. Moreover, the farmers in Sarpolezahab ranked "irrigation method" as a major reason in their vulnerability. Access to water resources and using drought tolerance varieties shape their vulnerability during drought conditions. Interestingly, the farmers in Javanrood also suffered from access to water resources, being irrigated or rain-fed farmer, and participating in extension classes.

5.5. Infrastructural factors

Table 6 demonstrates the weight and value of the infrastructural parameters perceived by the experts and farmers. The weight of each parameter was assessed by the following formula:

$$\sum W_5 = C_{infra.}$$

$$\sum W_5 = (W_{max} \times k_5) / 2 = (10\times2) / 2 = 10$$

[insert Table 6]

Overall, the infrastructural parameters revealed that the farmers' vulnerability is also affected by access to information sources. This item proved to be effective across the regions except Kermanshah where access to resources is ranked high. In other words, drought severely affected the farmers' resources in such a way that access to information sources was diminished during the onset of drought.

5.6. Total vulnerability

Table 7 shows the total vulnerability of all the six regions. The total vulnerability is estimated according to Formula (2):

[insert Table 7]

As shown in the table, among others, the farmers in Sarpolzahab and Kermanshah have faced the most (3.26) and the least (2.77) total vulnerability despite the fact that they are both in the same DI catrgory ("very high"). Furthermore, considering Kermanshah as the reference case, the "relative vulnerability" of each tonship was calculated. According to the table, compared to the reference case, Sarpolzahab comprises the most (1.17) and Eslamabad-e-Gharb holds the least (1.03) relative vulnerability. In other words, the drought vulnerability in Sarpolzahab is about 20% higher than Kermanshah even though they are both in the same DI category. The main reason for such a high vulnerability variation could be explained by the fact that Kermanshah is the capital city of the province and not only often receives most facilities but also holds most influential officials who could easier be approached and contacted by farmers for more support during drought whereas farmers in Sarpolzahab have little access to such facilities and officials and therefore less able to cope with drought.

6. Discussion and conclusion

This study shows that the vulnerability has different aspects in different regions depending on its drivers, farmers‘ understanding and their coping strategies. Our findings revealed that vulnerability is different at a sub-regional level. However, all the related technical and financial governmental plans are regarded at national and (slightly) regional levels and do not reflect the sub-regional differences. More specifically, the plans have never focused on “farmers’ families” as units of analysis. Accordingly, the efficiency of such interventions is under scrutiny. Furthermore, the distribution of the bank’s financial supports shows that although they are presumed to improve the social equity within the farmers, they have increased the gap between the poor and rich as the latter could gain more of these supports. This failure mostly resulted from the ignorance of the government agencies in different regions. To avoid such failures, before launching a general and equal supportive plan for all regions, it is very imperative to understand the most vulnerable groups as well as the least vulnerable groups. In addition, more information should be provided to policy makers on regions that need most assistance (Keshavarz et al., 2011).

According to the results, agricultural income of farmers tended to increase their vulnerability. In other words, during a drought, farmers’ income decreased and thus failed to mitigate the harsh feeling of vulnerability. In line with this finding, Paavola (2008) showed that the farmers’ income is one of the main factors that influence the vulnerability. In Segnestam’s (2009) point of view, as an economic factor, “income” has a significant influence on mitigating the vulnerable situations. Hence, the farmers should employ some coping strategies (e.g. diversifying their cultivation by planting some more resistant species) to increase their income when drought occurs.

Another economic parameter was the size of land. The results showed that the farmers' size of land did not help them to overcome the drought effects. This clearly indicates that small farmers with limited resources could not use their land in coping with drought. This conclusion is in line with studies of Simelton et al. (2009), Brant (2007), Vásquez-León et al. (2003), and Knutson et al. (1998). It is therefore suggested that training programs, especually agricultural extension systems (Azadi and Filson, 2009) should focus on small farmers before the onset of a drought.

Moreover, social vulnerability assessment showed that when level of education among farmers increases, their vulnerability toward drought decreases. Indeed, education helps farmers to consult published extensional leaflets on drought. This in turn would help them learn different methods in coping with drought. Moreover, higher level of education tends to increase individuals social status. Studies of Vásquez-León et al. (2003), Najarian and Barati Sade (2001) also indicated that higher levels of education tend to decrease the vulnerability level among disaster affected individuals. It is therefore recommended that farmers be exposed to sets of trainings that emphasize observational learning such as visiting successful farmers in the region.

Our results further show that dependence on the government's help also increased farmers' vulnerability toward drought. This indicates that farmers look up to such helps as soon as they are faced with drought. Since drought mitigation plans in Iran are mainly based on crisis management, it is not surprising that farmers rely on the government's help during onset of drought. Moreover, the lack of farmers participation in drought mitigation in Iran makes them more passive and this in turn increases their dependency on the government. Hosseini et al. (2009) also found similar results in their study. It is therefore recommended that taking a multi-stakeholder approach into account (Azadi et al., 2011c), drought policy-makers allow for more participation of local farmers in planning and implementing drought recovery management.

Results also revealed that local institutions did not affect the farmers' vulnerability. This can be shown by the lack of participation of farmers in such institutions. Perhaps one reason for this low participation is that local institutions in Iran are more symbolic. For example, rural cooperatives or rural production cooperatives have not been very successful in Iran (Zarafshani et al., 2010) because they are mainly established based on a "top-down" approach (Azadi et al., 2010) without any participation of farmers in planning. Interestingly, Iglesias (2007) found that in areas where farmers participate in local institutions, vulnerability decreases due to the fact that social capital in such institutions is enhanced. In other words, societies with institutional coordination and strengths for public participation are less vulnerable to drought and that agriculture is only one of the sectors affected by drought. Moreover, the farmers' participation in local meetings has the potential to impact social networks which in turn will develop more social capital needed to cope with diverse effects of drought. Studies have found that social capital increases diffusion of information and enhances mutual trust between local people (Gangadharappa et al., 2007). It is therefore suggested that local institutions be made aware of government policies toward drought and that local media motivate farmers to participate in local institutions such as rural cooperatives. These local cooperatives play an important role in drought mitigation plan.

Access to water resources also showed to be an important factor in the farmers' drought vulnerability. Farmers in this study had limited access to water resources. Farmers coping strategies indicated that they use less frequent irrigation and ignore irrigating the whole plot and settled on irrigating only a limited part of their lands. Zarafshani et al. (2007, 2005) found that farmers in the Fars province used more problem-focused and less emotion-focused coping strategies to counteract the harmful effects of drought. Brant (2007), Wilhelmi and Wilhite (2002) also found that limited access to water supply exerts more pressure on farmers and thus increases their vulnerability toward drought. It is therefore recommended that farmers should aim at conserving a maximum of the rainfall by using cheap methods like stone bunds, check dams, infiltration trenches, in situ preparation of beds and furrows (Nyssen et al., 2004; 2007). Farmers also believed that inefficient irrigation methods made them more vulnerable to drought. Vásquez-León et al. (2003) also found similar results discussing that in developing countries, farm irrigation is basically less efficient and water resource management is not as effective as those in more developed countries. In this regard, when asked if sprinkler irrigation could substitute their conventional irrigation methods, the farmers complained about high cost and complicated procedures. They also complained that modifying farm operations to prepare for drought was expensive and even some producers could not afford to purchase different types of tillage equipment or install irrigation equipments. Vásquez-León et al. (2003) and Knutson et al. (2001) asserted that financial burden was one of the key factors that affected farmers use of pressurized irrigation system. Accordingly, government can aid farmers with low interest rate loans so that they can afford pressurized irrigation systems. Moreover, extension training in adult education classes can enhance water management practices among farmers through improved methods of irrigation, train them to use more conservative water practices, and develop better water scheduling.

Participation in extension classes seemed to have an influence on the farmers' vulnerability to drought. This conclusion is in line with the studies of Simelton (2009) and George et al. (2007). However, the lack of farmers' participation in extension classes can be explained by the fact that no extension classes are organized during drought and that even when these classes are organized, the content is too out-dated to let the farmers feel a real need to participate. Gangadharappa et al. (2007) and Segnestam (2009) found that extension classes significantly increased the farmers' knowledge toward drought which in turn made them less vulnerable. It is therefore recommended that extension personnel use more participatory approaches when conducting training programs. For example, participatory rural appraisal, action learning, and other interactive modes of training can create an attractive atmosphere for farmers during out-set of drought.

Risk taking propensity was also low among the drought affected farmers. Perhaps this can be explained by the fact that less resourceful farmers found themselves in a more conservative position and thus making them more vulnerable. Geravandi (2010), Ferdusi and Koohpei (2007), Ehsan et al. (2009) found that farmers in general are less risk taking. However, farmers with risk taking personality are more willing to take all measures necessary to counteract the harmful effect of drought (for example, illegal digging of wells, use of new and more resistant cultivars). Geravandi (2010) found that education and participating in extension classes influence risk taking propensity among farmers, therefore, we recommend that extension agents try to develop these two variables among the farmers.

In addition, psychological vulnerability assessment showed that fatalism proved to be an influential variable in farmers' vulnerability. Fatalistic behavior tends to take more passive coping strategies because they believe "He (God) who has caused drought will take it away". Moreover, this type of personality faces less stress compared to proactive farmers who take more problem-solving coping strategies (Zarafshani et al., 2007; Zamani et al., 2006; Zarafshani et al., 2005). Fatalistic behavior was also studied in different regions in Iran. For example, Azkia (cited in Afshar, 2008) found that Iranian farmers are generally fatalistic in their coping strategies to drought. Community awareness program by extension agents can help farmers to take more proactive measures during onset of drought. For example, the use of clergy-men in training farmers with strong religious belief could be suggested.

Besides, access to information also affected the farmers' vulnerability to drought. Vásquez-León et al. (2003), Leichenko and Obrien (2001) and Hosseini et al. (2010) suggested that infrastructural factors significantly influence the farmers' vulnerability. For example, access to radio, TV, and other media enhances farmers' coping strategies. Interestingly, Simelton et al. (2009) found that although farmers receive formal media to stay tuned to weather reports, distrust meteorological information makes them rely more on their own experience. In this regard, extension agents should try to build up media trust in such a way that farmers adopt meteorological reports in their drought management strategies.

Finally, given the vulnerability difference between Sarpolzahab and Kermanshah despite their same DI catrgory, this study showed that vulnerability can be affected by other factors than those used in this study. It highlights the complexity of vulnerability and the need for further studies in this regard in the incidence of drought.

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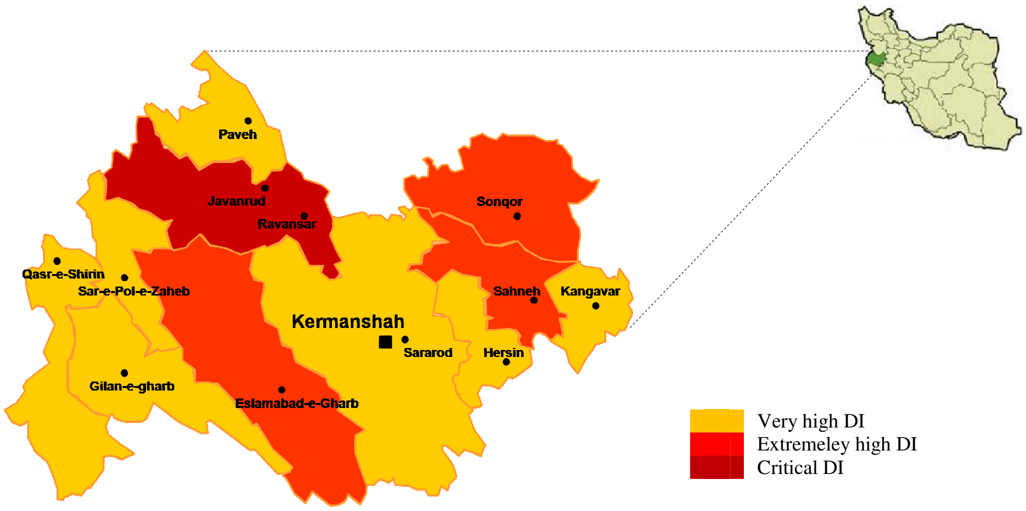

Fig. 1. The study area according to DI.

Table 1. List of the main parameters and sub-parameters used in our vulnerability assessment.

	i				
j	1 Economic	2 Socio-cultural	3 Psychological	4 Technical	5 Infrastructural
1	Investments	Easy access to chemicals, fertilizers, improved seeds, etc	Risk taking	Access to water resources	Access to information sources
2	Crop insurance	Family farming	Self-esteem	Being irrigated or rain-fed farmer	Access to resources in the village
3	Agricultural income	Social unity	Self-coping	Irrigation method	
4	Price of agricultural commodities	Educational background	Patience	Using drought resistance varieties	
5	Land tenure system	Dependence on government's help	Hope	Cultivation pattern (sowing once a year to twice a year)	
6	Government support (access to credit)	Beliefs and values	Fatalism	Participating in extension classes related to coping with drought	
7	Size of land	Social status		Being mechanized or traditional farmer	
8	Non-agricultural incomes	Participating in local institutions			
9	No. of land holdings	Contact with rural elites, neighbors, other farmers			
k_i	9	9	6	7	2

Table 2. The values and weights of economic sub-parameters.

Economic sub-parameters	Weight (Wj)	Value (Pj)					
		Very high		Extremely high		Critical	
		Kermanshah	Sarpolzahab	Eslamabad-e-Gharb	Sahne	Ravansar	Javanrood
1. Investments	6.53	3.67	4.2	3.81	3.96	4	4.5
2. Crop insurance	6	4.3	3.75	3.56	4.4	4	3.6
3. Agricultural income	5.6	3.67	4.35	3.9	4.29	4.64	4.15
4. Price of agricultural commodities	5.27	2.24	2.3	2.45	2.6	2.93	2.73
5. Land tenure system	4.93	1.13	1	1.1	1.12	1.14	1
6. Government support (access to credit)	4.93	4.16	4.25	4.13	3.88	4.21	4.27
7. Size of land	4.53	3.84	3.95	4.2	4.21	4.43	4.08
8.Non-agricultural incomes	3.93	3.8	3.75	3.44	3.96	3.64	3.93
9. No. of land holdings	3.27	1.53	1.05	1.44	2.28	1.64	1

Pj: The average value of each sub-parameter when: 1 = best situation and 5 = worst situation (perceived by farmers).

Wj: The average weight of each sub-parameter when: 1 = best situation and 10 = worst situation (perceived by experts).

Table 3. The values and weights of socio-cultural sub-parameters.

Social-cultural sub-parameters	Weight (Wj)	Value (Pj)					
		Very high		Extremely high		Critical	
		Kermanshah	Sarpolzahab	Eslamabad-e-Gharb	Sahne	Ravansar	Javanrood
1.Easy access to chemicals, fertilizers, improved seeds, etc	5.9	2.12	2.7	1.85	2.4	2.57	2.47
2. Family farming	5.7	2.72	2.9	2.56	1.95	2.43	2
3. Social unity	5.6	2.54	3.4	2.81	2.2	3.08	2.27
4.Educational background	5.27	2.65	3.75	2.76	3.48	3.36	3.47
5.Dependence on government's help	5.13	3.54	3.85	3.36	3.24	3.62	3.5
6.Beliefs and values	4.9	1.66	2.35	1.62	1.44	1.21	1.6
7. Social status	4.47	2.17	2.75	1.96	1.8	2.36	2.13
8.Participating in local institutions	4.4	2.51	4.1	3.77	3.4	3.14	2.67
9.Contact with rural elites, neighbors, other farmers	3.93	2.41	3.75	2.87	3	3	2.57

Pj: The average value of each sub-parameter when: 1 = best situation and 5 = worst situation (perceived by farmers).

Wj: The average weight of each sub-parameter when: 1 = best situation and 10 = worst situation (perceived by experts).

Table 4. The values and weights of psychological sub-parameters.

Psychological sub-parameters	Weight (*Wj*)	Value (*Pj*)					
		Very high		Extremely high		Critical	
		Kermanshah	Sarpolzahab	Eslamabad-e-Gharb	Sahne	Ravansar	Javanrood
1. Risk taking	6	3.32	3.77	3.71	3.36	4.36	4.07
2. Self-esteem	5.3	1.96	3.25	1.98	2.25	2.33	2.67
3. Self-coping	5	1.79	2.95	1.83	1.72	2.5	1.6
4. Patience	4.9	1.95	2.4	2.07	2.12	1.63	1.64
5. Hope	4.5	1.99	3.05	2.07	1.96	2	1.87
6. Fatalism	4.3	3.27	3.7	3.48	4.08	4.07	3.67

Pj: The average value of each sub-parameter when: 1 = best situation and 5 = worst situation (perceived by farmers).

Wj: The average weight of each sub-parameter when: 1 = best situation and 10 = worst situation (perceived by experts).

Table 5. The values and weights of technical sub-parameters.

Technical sub-parameters	Weight (*Wj*)	Value (*Pj*)					
		Very high		Extremely high		Critical	
		Kermanshah	Sarpolzahab	Eslamabad-e-Gharb	Sahne	Ravansar	Javanrood
1. Access to water resources	6.2	3.85	4.05	2.29	4.05	4.42	4.83
2.Being irrigated or rain-fed farmer	5.6	2.85	1.75	4.07	3.16	3.64	4.47
3.Irrigation method	5.53	3.51	4.1	4.04	3.4	3.57	4.2
4. Using drought resistance varieties	5.47	2.71	3.9	2.92	2.76	3.5	2.93
5.Cultivation pattern (sowing once a year to twice a year)	4.13	2.15	3.5	2.83	2.6	3.28	3.38
6. Participating in extension classes related to coping with drought	4.13	2.99	3.7	3.2	3.64	2.93	4.2
7.Being mechanized or traditional farmer	3.93	1.76	2.1	1.88	2.72	1.57	1.92

Pj: The average value of each sub-parameter when: 1 = best situation and 5 = worst situation (perceived by farmers).

Wj: The average weight of each sub-parameter when: 1 = best situation and 10 = worst situation (perceived by experts).

Table 6. The values and weights of infrastructural sub-parameters.

Infrastructural sub-parameters	Weight (Wj)	Value (Pj)					
		Very high		Extremely high		Critical	
		Kermanshah	Sarpolzahab	Eslamabad-e-Gharb	Sahne	Ravansar	Javanrood
1.Access to information sources	5.07	2.39	3.68	3.37	3.12	2.36	2.4
2.Access to resources in the village	4.93	2.57	1.95	2.06	1.62	2.14	1.53

Pj: The average value of each sub-parameter when: 1 = best situation and 5 = worst situation (perceived by farmers).

Wj: The average weight of each sub-parameter when: 1 = best situation and 10 = worst situation (perceived by experts).

Table 7. The coefficients of the total vulnerability in all the regions.

Vulnerability parameters (V_i)	Drought intensity					
	Very high		Extremely high		Critical	
	Kermanshah*	Sarpolzahab	Eslamabad-e-Gharb	Sahne	Ravansar	Javanrood
Economic	3.23	3.3	3.2	3.48	3.5	3.37
Social-cultural	2.5	3.28	2.61	2.54	2.77	2.54
Psychological	2.39	3.2	2.54	2.58	2.85	2.63
Technical	2.92	3.34	3.07	3.23	3.38	3.8
Infrastructural	2.48	2.83	2.72	2.38	2.25	1.97
Total vulnerability (V_L)	2.77	3.26	2.86	2.94	3.1	3.02
Relative vulnerability (V_{RL})	1*	1.17	1.03	1.06	1.10	1.09

* Kermanshah was considered as the reference case.

Appendix - excerpts from the questionnaire used in this study.

Depending on government:

1. During drought, I didn't feel that government is responsible for everything so I tried to cope with challenges.
2. Government help can be effective during drought, but I should stick to my own abilities.
3. When drought occurs, both government and me can help to overcome the problems.
4. I think government is more accountable than me when it comes to solve problems.
5. It is the full responsibility of the government to help us solve our problems because I can't do anything.

Self-esteem:

1. I counted on myself to solve challenges created by drought.
2. During onset of drought, I hardly doubted my abilities to cope with drought so I kept thinking about more effective drought strategies.
3. I really wasn't sure if I could do anything to solve my problems during drought.
4. In most of the times during drought, I felt hopelessness.
5. I came to believe that drought is something that I can not do anything about it.

Crop insurance:

1. During drought, crop insurance policies became easier, cheaper, and more accessible so insured my crop.
2. During drought, crop insurance was more accessible and more appropriate but more expensive but I insured my crop anyways.
3. During drought, crop insurance was somewhat accessible but I doubted if it would help me so I didn't buy insurance.
4. During drought, crop insurance was expensive and damages were not paid on time so I refused to insure my farm.
5. Didn't know if companies provided crop insurance so I wasn't lucky to buy insurance.