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Livelihood Vulnerability of Semi-Mobile Pastoral Communities to Climate Change in Arid and Semiarid of Iran

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Abstract
Climate change is impacting on natural resource based livelihood systems such as pastoralist communities in arid and semi-arid regions. Vulnerability to climate change refers to the potential of a system to be harmed by this external stress. The level of vulnerability of pastoral communities and the effective components determine the extent of climate change impacts on these communities and thereby help identify institutional options that have the potential to reduce their vulnerability. This study assessed climate change vulnerability of semi-mobile pastoralist communities in five main regions (Gozm, Kaht, Madan, Rochon and Jarob) of Khabr rangelands, Kerman, Iran using the Livelihood Vulnerability Index (LVI). The data comprised of primary data on seven main components including socio-demographic profile, livelihood strategies, social networks, health, food, water availability, natural disasters and climate variability which were collected through survey of 70 semi-mobile pastoral households, and secondary data on rainfall and temperature. Data were aggregated using composite LVI index and vulnerabilities of communities were compared. Results suggested that semi-mobile pastoralists in Rochon region had the highest (0.63) LVI showing relatively the greatest vulnerability to climate change impacts in terms of Socio-Demographic Profile, Livelihood Strategies and Health while Kaht region had the least (0.49) LVI showing relatively the smallest vulnerability to climate change impacts. The results of this study are useful to access pastoralist communities' vulnerability and set risk management policies.
Keywords: climate change; livelihood vulnerability index ; semi-mobile pastoralists

1. Introduction

Pastoralism is a livestock production strategy based on extensive rangelands use and herd mobility (Dong et al., 2011) and is one of important production systems in drylands of Iran (Ansari-Renani et al., 2013). Pastoralists are important for the food and economic services they provide and the contributions they make to the health of dryland ecosystems through good rangeland management and biodiversity conservation. In addition, they help maintaining knowledge and experience of adaptation to increasing aridity and variability in climatic conditions (Dong et al., 2011; Nassef et al., 2009). In arid and semi arid environment of Iran, these livelihoods respond appropriately to fluctuations in natural resources availability by creative and opportunistic strategies based on moving livestock. Currently, pastoralists represent about 1.9% of Iran's population (Ansari-Renani et al., 2013). These valuable livestock production systems have been experiencing challenges associated with climate change and increasing resource competition (Nassef et al., 2009).

Climate change is affecting millions of livelihoods around the world. These impacts pose very serious risks for ecosystems, agriculture, forestry, health, local economic activities and biodiversity (Khajuria and Ravindranath, 2012; Orindi and Murray, 2005; IPCC, 2007). Pastoralist communities in the developing countries such as Iran are vulnerable to climate change due to their livelihood dependence on natural resources (UNFCCC, 2009). Vulnerability assessments, by means of deriving adaptation and mitigation strategies, help to reduce the harmful impacts.

According to the IPCC (2007), vulnerability is defined as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change and stress. The vulnerability of pastoralist systems to climate change depends on the rate of climate variation to which they are exposed and their adaptive capacity, *i.e.* their ability to cope with or recover from exposure (Etwire et al., 2013; IPCC, 2007; FAO, 2009; UNEP, 2009)

There is increasing need to understand the impacts of climate change on pastoralist communities and their level of vulnerability. Action, investment and support at local, national and international level are required to help pastoralist communities respond to climate change (Nori and Davies, 2007; Kirkbride and Grahn, 2008). The level of vulnerability of pastoralists to climate change and variability has not been investigated in Iran. The level of

vulnerability to climate change among households varies from place to place and is based upon socio-ecological interactions. In order to provide sound management policies in the pastoralist communities to address the pressures and impacts of climate change and variability, it is required to identify likely communities that are vulnerable to climate change and evaluate the communities' livelihood vulnerability components. The present study aimed to estimate level of vulnerability of semi-mobile pastoralist communities to climate change in Khabr region in Iran, using the Livelihood Vulnerability Index (LVI) developed by Hahn *et al*. (2009). Primary data from households and climatic parameters from local meteorological stations were used and the communities were compared in terms of vulnerability to climate change.

2. Study area

The study was conducted in Khabr National Park rangelands, located in Kerman Province, south-east of Iran. The area spreads from 28º 37' to 28º 45' N, 56º 11' to 56º 27' E (Fig.1) with a land area of 281.71 km^2. Area under study has arid and semi-arid climate and experiences annual precipitation of about 261 mm which mostly occurs in winter during November to May and the annual mean temperature and evaporation of this area are 17.6ºC and 1500 mm, respectively. According to Gaussian ambrothermic diagram, aridity period is 7 months. The area is comprised of five main regions, Gozm, Kaht, Madan, Rochon and Jarob. The households in the area have semi-mobile life style.

More than 70 households are living in the area and their livelihoods mainly depend on animal husbandry. Their livestock feed on the local rangelands for at least six months of the year. These rangelands forage production plays an important role in their livestock feed. The rangelands productivity is mainly affected by precipitation, temperature and vapor pressure deficit. These pastoralists have not received adequate attention regarding their traditional land rights, improving animal health and nutrition, health and education services and poor access to markets. Over the past few years, unsustainable policies have pushed settling these communities (Ansari-Renani et al., 2013).

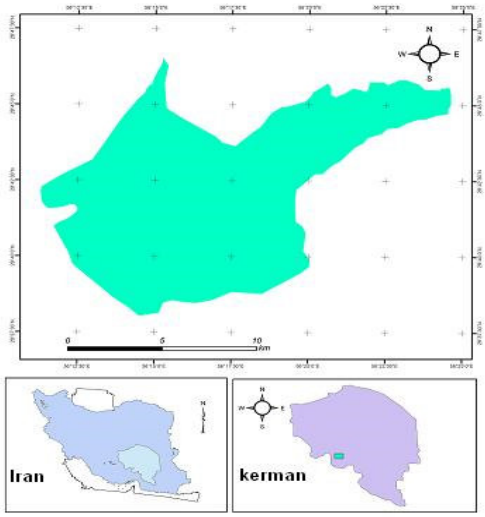

Fig. 1 Location of the study area, Khabr region in Kerman, Iran

3. Data and methods

3.1. Methodology

Livelihood vulnerability index (LVI) developed by Hahn *et al*., (2009) was used to assess livelihood vulnerability. The LVI included seven major components namely Socio-demographic Profile, Livelihood Strategies, Social Networks, Health, Food, Water, Natural Disasters and Climate Variability. Each component had several indicators or sub-components (Table 1). The sub-components developed by Hann *et al*., (2009) were slightly modified based on practicality of collecting the data through pastoralist households' surveys and the area under study. Major components, sub-components, survey questions used to gather data are indicated in tables 1 and 2.

For LVI calculation, a balanced weight average with equal contribution of each subcomponent in the overall index was used. Since each of the sub-components is measured with different scales, each sub-component was standardized to an index using equation (1) developed by United Nations Development Program (UNDP, 2007). This was necessary in order to combine all measures in a single LVI index.

$$indexs_d = \frac{s_d - s_{min}}{s_{max} - s_{min}} \quad (1)$$

Where s_d is the original sub-component for the region d, and s_{min} and s_{max} are the minimum and maximum values, respectively, which were determined using data collected from the five regions for each sub-component.

After standardization of sub-components, they were averaged using equation (2) to calculate the value of each major component:

$$M_d = \frac{\sum_{i=1}^{n} index_{sd}i}{n} \quad (2)$$

Where M_d is one of the seven major components for region d [Socio-demographic Profile (SDP), Livelihood Strategies (LS), Social Networks (SN), Health (H), Food (F), Water (W), or Natural Disasters and Climate Variability (NDCV)], $index_{sd}$ represents the sub-components, indexed by i that make up each major component. *n* is the number of sub-components in each major component (Hahn, et al, 2009).

After calculation of each seven major component of a region, they were averaged using equation (3) and LVI at region level was obtained:

$$LVI_d = \frac{\sum_{i=1}^{7} W_{M_i} M_{di}}{\sum_{i=1}^{7} W_{M_i}} \quad (3)$$

Where LVI_d, is the Livelihood Vulnerability Index for region d and equals the weighted average of the seven major components. The weights of each major component, W_{Mi}, were determined by the number of sub-components of each major component. Thereby, it is ensured that the overall LVI is the result of equal contribution of sub-components. In this study The LVI is scaled from 0 (minimum of vulnerability) to 1 (maximum of vulnerability).

Table 1 Major components and sub-components comprising the Livelihood Vulnerability Index (LVI) developed for five regions of Khabr area

Major components	Sub-components	Explanation of sub-components	Survey question	Source
Socio-demographic profile	Dependency ratio	Ratio of the population under 15 and over 65 years of age to the population between 19 and 64 years of age.	Please list the names, ages and sexes of every person who lives in this household? If you had a quest stayed here for the last 3 days, please include them as well	Adapted from Domestic Household Survey (DHS) (2006). Measure DHS: Model Questionnaire with Commentary and Hahn et al. (2009)
	Percent of female-headed households	Percentage of households where the primary adult is female. If a male head is away from the home>6 months per year the female is counted as the head of the household.	Are you the head of the household?	Adapted from DHS (2006) and Hahn et al. (2009)
	Percent of householdswhere head of household has not attended school and do not read news	Percentage of households where the head of the household reports that they have attended 0 years of school and not reading news.	Did you ever go to school? If yes, do you usually read a newspaper at least once a week?	Adapted from DHS (2006) and Hahn et al. (2009)
Livelihood strategies	Percent of households with family member working in a different community	Percentage of households that report at least one family member who works outside of the community for their primary work activity.	How many people in your family go to a different community to work?	Adapted from World Bank (1997)
	Percent of households whose agricultural activities are not part of their income	Percentage of households that report agriculture as a source of income.	Do you or someone else in your household grow crops?	Adapted from World Bank (1997)
	Average agricultural livelihood diversification index	The inverse of the number of Agricultural livelihood activities reported by a household	----------	Adapted from DHS (2006) and Hahn et al. (2009)
	Percentage of households that do not earn an income from livestock	Percentage of households that report raising animals as an income	Do you or someone else in your household raise animals?	Developed for the purposes of this questionnaire
	Average livestock livelihood diversification index	The inverse of the number of livestock livelihood activities reported by a household	---------	Adapted from DHS (2006)
	Percentage of households that do not earn an income from beekeeping	Percentage of households that report beekeeping as an income	Do you or someone else in your household work in the field of beekeeping?	Adapted from World Bank997)
	Percent of households that report selling products from rangelands.	Percentage of households that report selling products from rangelands as an income	Do you or Someone else in your household collect something from the bush, the forest, or lakes and rivers to sell?	Adapted from World Bank (1997)
	Percentage of households that do not earn an income from rain-fed agriculture	Percentage of households that report selling rain-fed agricultural products as an income	Do you or Someone else in your household grow rain-fed crops?	Adapted fromWorld Bank (1997)
Water	Percent of households reporting water conflicts	Percentage of households that report having heard about conflicts over water in their community	In the past year, have you heard about any conflicts over water in your community?	Hahn *et al.* (2009)
	Percent of households that utilize a natural water source	Percentage of households that report a creek, river, lake, pool, or hole as their primary water source	Where does your drinking water generally come from?	Adapted from DHS (2006)
	Average time to water source	Average time it takes the households to travel to their primary water source.	How long does it take to get to your water source?	Adapted from DHS (2006)
	Percent of households that do not have a consistent water supply	Percentage of households that report that water is not available at their primary water source everyday	Is this water available every day?	Adapted from World Bank (1997)
	Inverse of the average number of liters of water stored per household	The inverse of (the average number of liters of water stored by each household + 1	Do you store water? What containers do you usually store water in? How many? How many liters are they?	Hahn et al. (2009)

Table 1 continued Major components and sub-components comprising the Livelihood Vulnerability Index (LVI) developed for five regions of Khabr

Major components	Sub-components	Explantation of sub-components	Survey question	Source
Social networks	Percent of households that have not gone to their local government for assistance	Percentage of households that reported that they have not asked their local government for any assistance in the past 12 months.	In the past 12 months, have you or someone in your family gone to your local goverment official for help?	Adapted fromWHO/RBM (2003)
	Average receive help: give help ratio	Ratio of (the number of types of help received by a household in the past month + 1) to (the number of types of help given by a household to someone else in the past month + 1)	In the past month, did relatives or friends help you and your family:(e.g., Get medical care or medicines, Sell animal products or other goods produced by family, Take care of children) In the past month, did you and your family help relatives or friends: (same choices as above)	Adapted from DHS (2006)
	Average borrow: lend Money ratio	Ratio of a household borrowing money in the past month to a household lending money in the past month	Did you borrow any money from relatives or friends in the past month? Did you lend any money to relatives or friends in the past month	Adapted from World Bank (1997)
Health	Average time to health facility (minutes)	Average time it takes the households to get to the nearest health facility	How long does it take you to get to a health facility?	Adapted from World Bank (1997)
	Percent of households where a family member had to miss work or school due to illnesses	Percentage of households that report at least 1 family member who had to miss school of work due to illness in the last 2 weeks	Has anyone in your family been so sick in the past 2 weeks that they had to miss work or school?	Adapted from World Health Organization/Roll Back Malaria (2003). Determination of the Socio-economic Impacts of Malaria Epidemics in Africa.
	The number of months that biting insects are present	Months reported exposure to biting insects	How many months of the year are biting insects hurting people?	Adapted from DHS (2006)
	The proportion of families who lost their livestock	Percentage of households that lost their livestock due to disease	Have you lost any livestock due to disease?	Developed for the purposes of this questionnaire.
	Percentage of households with no veterinary facilities	Percentage of households that have access to veterinary facilities	Do you have access to veterinary facilities?	Developed for the purposes of this questionnaire.
	Percentage of households with no facilities (such as bed nets) to deal with biting insects	Percentage of households with facilities (such as bed nets) to deal with biting insects	Do you use bed nets or any other facility against biting insects?	Adapted from DHS (2006)
Food	Percentage of households that do not produce their own supplies	Percentage of households that do not get their food primarily from their personal farms.	Where does your family get most of its food?	Developed for the purposes of this questionnaire.
	Percentage of households required to purchase meat	Percentage of households that buy meat from outside sources	Do you buy meat from other sources?	Developed for the purposes of this questionnaire.
	Average number of months households struggle to find food	Average number of months households struggle to obtain food for their family.	Does your family have adequate food the whole year, or are there times during the year that your family does not have enough food? How many months a year does your family have trouble getting enough food?	Adapted from World Bank (1997)
	Percent of households that do not save crops	Percentage of households that do not have seeds from year to year.	Does your family save some of the crops you harvest to eat during a different time of year?	Hahn et al. (2009)

Table 1 continued Major components and sub-components comprising the Livelihood Vulnerability Index (LVI) developed for five regions of Khabr

Major components	Sub-components	Explantation of sub-components	Survey question	Source
Natural disasters and Climate Variability	Average number of flood, drought and cyclone events in the past 6 years	Total number of floods, droughts, and cyclones that were reported by households in the past 6 years.	How many times has this area been affected by a flood/cyclone/drought in the past 6 years?	Adapted from Williamsburg Emergency Mngmnt (2004). Household Natural Hazards Preparedness Questionnaire
	Percent of households that did not receive a warning about the pending natural disasters	Percentage of households that did not receive a warning about the most severe flood, drought, and cyclone event.	Did you receive a warning about the flood/cyclone/drought before it happened?	Adapted from Williamsburg Emergency Mngmnt (2004)
	Percent of households with an injury or death as a result of recent natural disasters in the past 6 years.	Percentage of households that reported either an injury to or death of one of their family members as a result of the most severe flood, drought, or cyclone in the past 6 years.	Was anyone in your family injured in the flood/cyclone/drought? Did anyone in your family die during the flood/cyclone/ drought?	Hahn et al. (2009)
	The annual mean maximum temperature (1989-2012)	1989–2012: provincial data; Baft weather station	Iran Meteorological Organization	Reliance on average data
	The annual mean minimum temperature (1989-2012)	1989–2012: provincial data; Baft weather station	Iran Meteorological Organization	Reliance on average data
	Average annual precipitation (1989-2012)	1989–2012: provincial data; Baft weather station	Iran Meteorological Organization	Reliance on average data
	Average annual hours of sunshine (1989-2012)	1989–2012: provincial data; Baft weather station	Iran Meteorological Organization	Reliance on average data

3.2. Data Sources and Sampling Procedure

Primary data from semi-mobile pastoralist households in the five selected regions of Khabr area including Gozm, Kaht, Madan, Rochon and Jarob, was used in this study. A questionnaire covering 32 key variables, was designed, tested and administered at the household level and applied to calculate LVI. A total of 70 households were sampled and interviewed during March 2012. Simple random sampling technique was used to select households. Temperature and precipitation data were obtained from the Khabr meteorological station. The reference period for the climate events data was selected from 1898 to 2011.

4. Results and Discussions

LVI sub-component values for each region are presented in Table 2 and the major component values and LVI for each region are presented in Table 3. The first major component of LVI was Socio-demographic profile. The vulnerability index for this major component of LVI showed that Rochon community was the most (0.52) vulnerable and Madan community was the least (0.25) vulnerable. Rochon community had the highest number of female-headed households and the lowest number of household heads that have attended school. Generally, services such as education are not adequately provided for pastoralist households in Iran (Ansari-Renani et al. 2013). According to our observations, in Madan region where the level of education was higher, the household heads better managed the issues affecting their family livelihoods and had more adaptive skills which made them less vulnerable. In Rochon, the number of female-headed households was high due to seasonal outmigration of household heads to other areas for business and livestock trading which made this community more vulnerable to stresses compared to the others.

Table 2 Indexed sub-component values of LVI for Khabr area

Major components	Sub-components	Regions				
		Gozm	Kaht	Jarob	Madan	Rochon
Socio-demographic profile	Dependency ratio	0.55	0.34	0.38	0.34	0.3
	Percent of female-headed households	0.22	0.22	0.13	0.14	0.53
	Percent of households where head of household has not attended school	0.61	0.66	0.8	0.28	0.73
Livelihood strategies	Percent of households with family member working in a different community	0.22	0.11	0.23	0.28	0.2
	Percent of households whose agricultural activities are not part of their income	0.66	0.55	0.8	0.85	0.86
	Percent of households have no income from the sale of ancillary products range.	0.83	0.88	0.9	1	0.86
	Percentage of households that do not earn an income from beekeeping	0.55	0.88	0.8	0.71	0.73
	Average agricultural livelihood diversification index	0.68	0.56	0.46	1	0.92
	Percentage of households that do not earn an income from livestock	0.16	0.33	0.42	0.28	0.4
	Average livestock livelihood diversification index	0.68	0.65	0.65	0.46	1
	Percentage of households that do not earn an income from rain-fed agriculture	0.44	0.57	0.77	0.85	0.93
Social networsk	Percent of households that have not gone to their local government for assistance	1	0.71	0.92	1	1
	Average receive help: give help (ratio)	0.42	0.19	0.54	0.6	0.39
	Average Borrow: Lend money (ratio)	0.7	0.66	0.6	0.75	0.7
Health	Average time to health facility	0.35	0.26	0.2	0.4	0.43
	Percent of households where a family member had to miss work or school due to illnesses	0.83	0.55	0.42	0.57	0.66
	The number of months that biting insects are present	0.27	0.22	0.27	0.31	0.31
	The proportion of families who lost their livestock	1	1	0.85	1	1
	Percentage of households with no veterinary facilities	0.86	0.88	0.61	1	0.88
	Percentage of households with no facilities to deal with biting insects	0.83	0.77	0.85	0.71	0.86
Water	Percent of households reporting water conflicts	0.5	0	0.23	0	0.2
	Percent of households that utilize a natural water source	1	1	1	1	1
	Average time to water source	0.28	0.42	0.65	0.21	0.49
	Percent of households that do not have a consistent water supply	0.88	0	0.9	1	1
	Inverse of the average number of liters of water stored per household	0.93	0	0.68	1	0.67
Food	Percentage of households that do not produce their own supplies	0.88	0.77	1	1	1
	Percentage of households required to purchase meat	0.11	0.33	0.33	0.28	0.4
	Average number of months households struggle to find food	0.23	0.14	0.26	0.27	0.26
	Percent of households that do not save crops	0.88	0.88	0.95	1	0.8
Natural disasters and climate variability	Average number of flood, drought events in the past 6 years	0.8	0.8	0.54	0.46	0.73
	Percent of households that did not receive a warning about the pending natural disasters	1	1	1	1	1
	Percent of households with an injury or death as a result of recent natural disasters	0.11	0	0.14	0	0.06
	The annual mean maximum temperature (1989-2012)			0.52		
	The annual mean minimum temperature (1989-2012)			0.46		
	Average annual precipitation (1989-2012)			0.26		
	Average annual hours of sunshine (1989-2012)			0.4		

Table 3 Major component values and Livelihood Vulnerability Index (LVI)

	Regions				
Major components	Gozm	Kaht	Jarob	Madan	Rochon
Socio-demographic profile	0.46	0.4	0.43	0.25	0.52
Livelihood strategies	0.53	0.56	0.63	0.58	0.73
Social networks	0.7	0.52	0.68	0.78	0.69
Health	0.69	0.61	0.53	0.66	0.69
Water	0.72	0.28	0.69	0.64	0.67
Food	0.52	0.52	0.63	0.64	0.61
Natural disasters and climate variability	0.5	0.49	0.47	0.44	0.49
Livelihood Vulnerability Index (LVI)	**0.584**	**0.494**	**0.578**	**0.57**	**0.63**

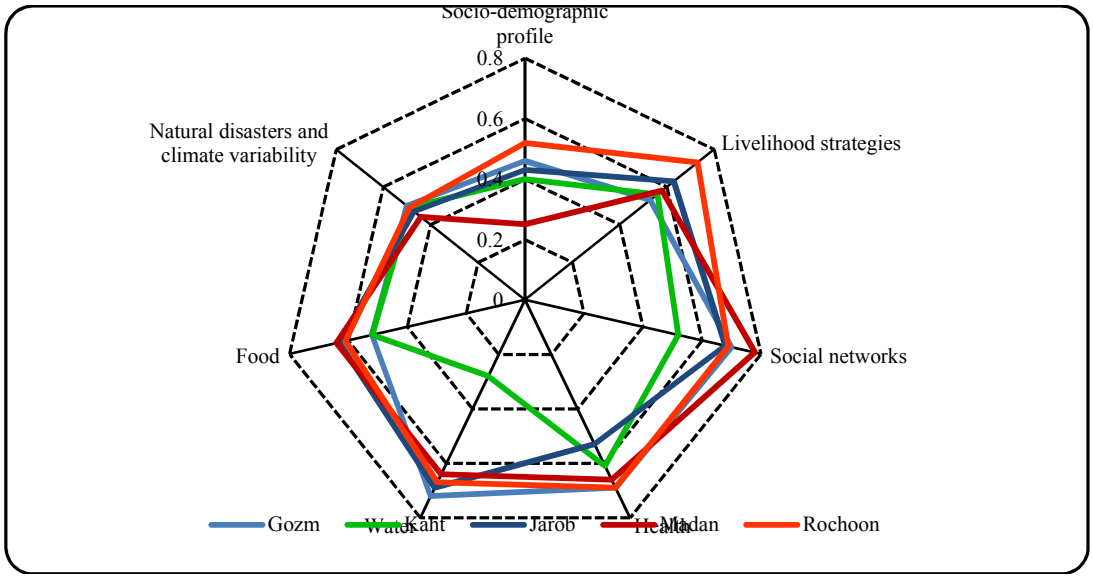

Fig 2 Vulnerability Spider Diagram of the Major Components of the Livelihood Vulnerability Index (LVI) for semi-pastoralist communities of five regions (Ghozm, Kaht, Jarob, Madan and Rochon) in Khabr area, Kerman, Iran.

Rochon community was the most (0.73) vulnerable in terms of Livelihood strategies, as well. According to local data, main Livelihood strategies of pastoral communities of Khabr area are animal husbandry, beekeeping and opportunistic agricultural activities. Many of these semi-mobile pastoralists, at the household level, produce crops that resist drier conditions on an opportunistic basis and in some cases collect rain fed crops. A higher percentage of Rochon households reported not having an income from agriculture and livestock which is reflected in livestock livelihood and agricultural livelihood diversification indices (1 and 0.92, respectively). In Ghozm region, however, the households had diverse livelihood strategies including agricultural activities, raising animals and beekeeping resulting in diverse income sources which made this community less (0.53) vulnerable to new challenges posed by environmental stresses such as climate change in terms of Livelihood strategies. In addition, Ghozm community had managed better access to local urban centers for selling goods and had storage facilities while other communities in other regions were mostly selling at roadsides and their tents where the prices were typically poor and sometimes to local businessmen at give-away prices. On the other hand, due to poor long-term storage and preservation facilities for their products, pastoralists of some regions had to sell their products at the same time or in a short period of time, hence supply exceeded demand and the price decreased.

The third major component in our analyses was Social network which consisted of three sub components. In terms of approaching the local authorities for work and receiving help, Ghozm, Madan and Rochon were similar and had not received government help at all. Among the three regions, Jarob households that lent money more than they borrowed were less (0.68) vulnerable. These results were consistent with that of Madhuri *et al*. (2014) and hahn *et al*. (2009). Good social network between households help them recover from effects of fluctuations in environmental conditions which is common in pastoral lifestyle. Overall, Madan community was the most (0.78) vulnerable and Kaht community was the least (0.52) vulnerable on the Social Network component. Kaht community was the least vulnerable in terms of Social Network due to the network and trust between households and the governmental assistance, comparing to other regions.

Ghozm and Rochon communities had the highest (0.69) Health vulnerability score in the Khabr area as a result of high percentage of households with family members unable to work due to illnesses and low access to healthcare facilities. These two semi-mobile pastoralist communities had higher average time to reach the healthcare facilities of neighbor towns than the other regions especially during periods of moving from place to place in search for efficient rangelands. The lack of operational roadways connecting these communities to nearby towns was also an important problem in the area. In addition, they had low access to facilities to deal with biting insects and the duration of exposure to biting insects was relatively long. Jarob pastoralists had the least vulnerability to stress and climate change impacts due to better strategies to avoid biting insects and closeness to healthcare facilities provided by government in the neighborhood.

Generally, pastoralist communities of dry lands become more vulnerable during the dry season in which natural water sources become scarce. Rainfall is the most important factor determining the quality and quantity of pasture and water (Nassef *et al*., 2009). In this area, the semi-mobile pastoral communities, except Kaht, have no reliable supply of permanent water and have to move their livestock according to shifting availability of pasture and water. Pastoralists of Kaht region had subterranean water source in the area which made them the least (0.28) vulnerable community in terms of Water component. Regions other than Kaht, had to collect water from natural sources. Ghozm was the most (0.72) vulnerable to stresses in terms of water availability.

The vulnerability index for Food component which was comprised of four sub components had the highest score (0.64) for Madan due to higher number of households struggling to find food and higher percentage of households that do not save crops. The pastoralists in this region mostly rely on livestock production while agricultural activities are on the opportunistic basis. Ghozm and Kaht were the least (0.52) vulnerable regions in terms of Food. Food security is a significant component which makes the pastoralist households resilient to stresses such as climate variability (Etwire et al. 2013).

The last major component was Natural disasters and climate variability. Based on the average number of floods and droughts, the percent of households who did not received any warning about happening natural disasters and the percent of households who faced disaster injury, the most (0.5) vulnerable region was Ghozm and the least (0.44) vulnerable was Madan.

The spider diagram in fig 2 represents the overall major component of LVI. The vulnerability spider diagram ranges between 0 (least vulnerable) to 0.8 (Most vulnerable). This diagram provides helpful information on which components contribute most to climate change vulnerability in each region. Rochon had the highest (0.63) LVI showing relatively the greatest vulnerability to climate change impacts mostly in terms of Socio-Demographic Profile, Livelihood Strategies and Health while Kaht had the least (0.49) LVI showing relatively the smallest vulnerability to climate change impacts mostly in terms of Social Networks, Water and Food.

The results of this study suggested that level of vulnerability in these five regions varied in terms of different determinants. Thus, it is required to provide adaptive practices such as livelihood diversification, healthcare and food according to the specific determinants of each region. The impacts of global climate change on pastoralists in each region can be addressed by either changing the driving forces to minimize the environmental processes or by reducing the harmful effects after they occur. Policies should focus on providing funding for basic services, mobile healthcare centers and schools, different kinds of insurances, road upgrading and improving disaster warning systems.

The livelihood vulnerability index (LVI) developed by Hahn *et al*., (2009) was used in this study to understand the level of vulnerability to climate change in semi-mobile pastoralist communities of Khabr area in Iran. The index is used for vulnerability assessments in diverse communities (Makondo et al., 2014; Shah et al., 2013; Etwire et al., 2013; Dhakal et al., 2013). This vulnerability assessment tool has used a range of components which can be used in different pastoralist communities in Iran and around the world. In addition, it provided a means of incorporating local factors influencing vulnerability to climate change. Some of the subcomponents used by Hahn *et al*., (2009) were revised and fitted to the particular context of semi-pastoralist communities of arid and semi arid rangelands of Iran (Table 1). The LVI provided criteria to be used by development organizations and policy maker agencies to identify vulnerable pastoralist communities and understand the factors contributing to vulnerability at region or community level. Furthermore, this revised LVI had the benefit of minimal time and effort posed on respondents and at the same time was easily understood. Eventually, the indicators (sub-components) provided by this study are important for decision making toward managing sources of vulnerability in arid and semiarid pastoralist communities. The results can be used to guide the development of adaptation policies.

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