International Journal of Disaster Risk Reduction 21 (2017) 223–230

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

Livelihood vulnerability to drought: A case of rural Iran

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ARTICLE INFO

Keywords:
Livelihood vulnerability
Drought
Climate change
Adaptation strategy
Farm families
Iran

ABSTRACT

Agriculture as the main source of livelihood for rural residents of the developing countries is inherently sensitive to climate variability and change. Among different climatic events, drought is frequently identified as a major threat to agricultural systems and livelihood security of farm families, in many arid and semi-arid regions of the developing world. The negative impacts of drought are further intensified by the threat of climate change. In order to mitigate the negative impacts of drought on livelihood, increasing adaptive capacity of farm families is imperative. If rural livelihoods are no longer secure, farm families are finally forced to abandon agriculture. Therefore, the objective of this study was to investigate the livelihood vulnerability of farm families to drought. It was also intended to determine the drivers of livelihood vulnerability in the context of drought. A survey of 274 farm families of Fars province, selected through a multistage stratified random sampling technique, indicated that drought is the main threat to livelihood security meantime the interaction between drought intensity and its duration leads to more vulnerability. Additionally, results revealed that different adaptation strategies were used by the low, medium and high livelihood vulnerable families in order to adjust drought impacts. Tree analysis also illustrated that livelihood vulnerability is a product of the complex set of financial, physical, social and natural capitals. Some recommendations are offered to reduce the livelihood vulnerability of farm families to drought.

1. Introduction

Agriculture as a dominant form of global land use [40] is the main source of livelihood for more than 2.5 billion rural residents of the developing world [47]. It is also a mainstay of economy in most developing countries and highly contributes to their GDP [21]. Because of its nature, agriculture is inherently sensitive to the vagaries of weather and is among the most vulnerable sectors to the risks and impacts of climate variability and change. Therefore, for the vast majority of rural families, who are principally dependent on agriculture for their livelihoods, climate-induced extreme events pose a risk that can critically affect livelihood context [34].

Among different climatic events, drought is frequently identified as a major threat to livelihood security of rural families [37, 3]. Drought as an insidious, slow-onset and multi-dimensional natural disaster [39] creates substantial costs for farm families and affects their agricultural systems extensively [18].

Although short-term global droughts have remained relatively constant across the world, many intense or long-term droughts have been observed in arid and semi-arid regions since the 1970s [8]. For instance, in the last 50 years, Iran has experienced about 27 drought events [2] that has led to loss of agricultural productions and food shortage in combination with inadequate socio-economic entitlements and exacerbating vulnerability of rural households [20]. The negative impacts of drought are further intensified by the threat of climate change [40] that is projected to increase the frequency, duration and severity of droughts in many arid and semi-arid regions [16].

Moreover, climate change-induced events such as droughts are expected to put further pressure on natural resources. For instance, it is estimated that the average annual runoff in Pishin (southeast Iran) and Zayandeh-Rud (center of Iran) basins will decrease by 33% and 40–70% around 2040, respectively [24, 30]. Changes in the availability of water resources can greatly affect the total income and consumption pattern of farm families, which would result in greater costs for accessing irrigation water. Also, droughts are expected to severely reduce productivity of many crops. With this regard, it is projected that if Iran's temperature increases by 2.7–4.78 °C, then the rain-fed wheat yield will reduce about 18.0% and 24% by 2025 and 2050, respectively [32]. These variable, unpredictable and extreme environmental conditions require flexible and adaptive utilization of natural resources [14, 25, 36].

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http://dx.doi.org/10.1016/j.ijdrr.2016.12.012
Received 20 August 2016; Received in revised form 16 December 2016; Accepted 16 December 2016
Available online 18 December 2016

Negative impacts of certain risks on livelihood security can be mitigated by appropriate livelihood management strategies [45, 29]. However, in some cases (e.g. Iran's 2007–2011 drought) the impacts of drought are exacerbated by its proximity to the previous drought (1999–2002), so that farm families lack the opportunity to recover [20]. As a result of such recurrent droughts, rural livelihoods can fall increasingly at risk [13, 20, 44] and some livelihood options may diminish. Therefore, communities and households, which depend more on climate-sensitive natural resources, are likely to be the most severely affected people by recurrent drought impacts [18, 5].

Meanwhile, resource poor families (i.e. smallholder farmers) are often considered as the most vulnerable to drought effects, due to their limited infrastructure and inputs to serve as a buffer against that exposure and their limited resources to adapt [26]. Under such conditions, if rural farmers reach to the point that their livelihoods are no longer secure, then they will be forced finally to abandon agriculture [18]. Therefore, it is imperative to analyze the livelihood vulnerability of farm families to drought.

Several studies have focused on livelihood vulnerability of rural families to climate change or extreme climatic events such as drought e.g. [5, 12, 23, 38, 40]. Nevertheless, livelihood vulnerability of rural households to drought is not well documented in Iran. A lack of recognition about negative impacts of recurrent droughts on rural livelihood is a barrier to obtaining knowledge about what livelihood management strategies might be appropriate. Without this information, it is difficult to increase rural welfare in the context of drought. To fill the gap, this study addresses the following questions: (1) Are severe droughts affecting the livelihood vulnerability of farm families in arid or semi-arid regions? (2) What are the determinants of the livelihood vulnerability under drought? (3) What are the major adaptation strategies of farm families in the context of drought?

In this paper, first, the impacts of drought on livelihood assets are reviewed. Then, analytical frameworks to understand livelihood vulnerability to drought are explained. The focus then shifts to study design, which is followed by an analysis of the results and the concluding remarks.

1.1. Livelihood assets and vulnerability to drought: The case of Iran

Lack of adequate water is a major limitation for agricultural development in Iran, meantime, the demand for water consumption has increased during the recent drought (2007–2011). In the early stage of this drought, the water levels of temporary water bodies and rivers dropped to critical levels. As drought continues, many internationally renowned lakes and natural perennial sources of water were completely dried up [19]. Also, most of groundwater resources in the central, eastern and southern regions have experienced significant decline [4]. Furthermore, the current prolonged drought has negatively influenced crop yields. With this regard, production of rain-fed (i.e. wheat and barley) and irrigated crops has significantly reduced. That is why under current drought, some farmers have changed their cropping pattern and favored certain drought tolerant crops over others [18].

Also, drought has caused substantial negative impacts on physical capital of rural households. Some farm families sold their agricultural machineries and home appliances due to the reduced production capacity under drought. Moreover, loss of physical capital compounded with a declining financial capital have impacted rural livelihoods and reduced their access to safe food [20]. Changes in food availability and affordability have reduced the adaptive capacity of farm families and increased their sensitivity to the impacts of drought [21]. Also, loss of on-farm income have influenced the household expenditure on education, which especially affected younger members of families [20].

1.2. Asset-based analytical frameworks to assess livelihood vulnerability to drought

Various approaches are used in order to assess vulnerability to extreme natural hazards. While vulnerability assessments do often take into account livelihoods or required assets for a sustainable means of living, the number of frameworks which definitely analyze the livelihood vulnerability to natural hazards are limited [6]. The sustainable livelihoods framework, which typically consisted of natural, social, financial, physical and human capitals [7], is particularly the most relevant to understand vulnerability to drought. It comprises the key components that create livelihoods and the contextual factors that externally influence household asset base such as shocks, trends and seasonality [9, 12]. Therefore, the sustainable livelihoods framework incorporated the issues of climate exposure and household adaptive capacity [12].

Although the sustainable livelihoods framework offers many useful insights about micro-level details of household's livelihood and considers the wider context in which those livelihoods operate, it has a number of limitations. These include its inability to take into account the dynamism in capital assets over time, inadequate consideration of the higher levels of governance and insufficient attention to the complex ecological consequences of livelihood adaptations [41].

The ecosystem services framework is another relevant analytical structure to assess the vulnerability of livelihoods to drought. Proponents of this approach argue that livelihoods are basically dependent upon ecosystem services of natural capitals. Therefore, in order to reduce livelihood vulnerability, critical levels of natural capital must be provided. Also, long-term viability of ecosystem services should be ensured [10]. Based on this framework, ecosystem goods and services include: provisioning services such as food, water and fiber; regulating services that affect climate, soils and water quality; and supportive services such as soil formation, photosynthesis and nutrient cycling [28]. Although this framework conceptualizes the complex links between ecosystem services and livelihood, it only focuses on natural capital and "does not consider the role of adaptation strategies based on human, physical, social and financial capitals" to support household life in the context of drought [34]. In order to comprehensively assess livelihood risks resulting from drought, a new analytical framework is imperative that integrates climate exposures, household sensitivity and adaptive capacity [12].

Relying on the IPCC [15] working definition of vulnerability as a function of exposure, sensitivity and adaptive capacity, Hahn et al. [12] developed the livelihood vulnerability index (LVI) to evaluate climate change vulnerability in the two districts of Mozambique. The LVI applies multiple indicators of socio-demographics, livelihoods, social networks, health, food, water security, natural disasters and climate vulnerability to examine livelihood vulnerability. Also, Reed et al. [34] integrated sustainable livelihoods framework with the ecosystem services framework, diffusion theory, social learning, adaptive management and transition management to investigate the rural livelihoods vulnerability to climate change. This integrated analytical framework explains livelihood vulnerability to climate change through determining the level of exposure to climate change and its interactions with existing or future stresses, identifying the sensitivity of capital assets and ecosystem services to climate change and considering adaptation options and factors influencing decisions to develop or adopt different adaptation strategies.

Among the various analytical frameworks in livelihood vulnerability, this study applies the integrated analytical framework (developed by Reed et al. [34]) as a basis for analysis of the livelihood vulnerability of farm households who face drought (Fig. 1). To the best of our knowledge, this framework has never been applied empirically.