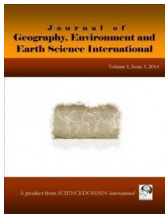

Journal of Geography, Environment and Earth Science International

12(2): 1-11, 2017; Article no.JGEESI.35259
ISSN: 2454-7352

Is Climate Variability a Problem in Semi-arid Eastern Kenya?

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JGEESI/2017/35259
Editor(s):
(1) Kaveh Ostad-Ali-Askari, Department of Civil Engineering, Isfahan (Khorasgan) Branch, Islamic Azad University, Iran.
Reviewers:
(1) Michael Adejare Adegboye, Federal Ministry of Agriculture and Rural Development, Jos, Nigeria.
(2) Cornelius Okello, University of Bologna, Italy.
Complete Peer review History: http://www.sciencedomain.org/review-history/21477

Original Research Article

Received 3rd July 2017
Accepted 27th July 2017
Published 19th October 2017

ABSTRACT

Aims: The study set to determine the extent to which climate variability is a problem in semi-arid Tharaka sub-county, Kenya.
Study Design: The study utilized a descriptive research. Specifically, focus group discussions (FGD) and interviews with key informants were used to generate both qualitative and quantitative data.
Place and Duration of Study: The study was conducted in four sites in Tharaka sub-county: Tunyai, Chiakariga, Marimanti and Kathangacini administrative units. This study was conducted in the period June–Sept 2010.
Methodology: Four focus group discussions (FGD) (N= 48) and interviews with key informants (N=24) were conducted in four agro-ecological zones. For each FGD, there were 11-13 participants. A participatory risk ranking and scoring method was used to rank and calculate incidence index (I), risk index (R) and severity index (S) of stressors as mentioned by individual respondents. While results from interviews and group discussions were descriptively presented.
Results: Results of incidence index show that lack of money (0.81), drought (0.73), bad health (0.71) and livestock diseases (0.71) were the most mentioned stressors. Lack of money (1.2) and water scarcity (1.24) were the most severe of the stressors. Stressors with the most acute risk were lack of money (0.71), lack of water storage facility (0.51), bad health (0.51) and livestock diseases (0.5). Climate related stressors – irregular rains (0.49) and drought (0.21) were regarded to present

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moderate and least acute risk respectively. The study further established variations in incidence index, severity and risk index by agro-ecological zones, gender and age. A comparison of individual and group ranking show that climate related stressors are more acknowledged at the later.
Conclusion: To improve climate change adaptation semi-arid lands, development agencies need to focus on poverty alleviation, provision of water storage facilities and health care, and prevention of livestock diseases.

Keywords: Climate variability; stressors; semi-arid; Tharaka.

1. INTRODUCTION

In a broad context, climate change and variability is acknowledged as a challenge to mankind. Intergovernmental Panel on Climate Change (IPCC) reports and regular Conference of Parties (COP) typify the existing global level efforts of addressing the problem of climate change. In sub-Saharan Africa, extreme climatic events – floods and drought, are common. The 1970s drought of the Sahel [1], the 1983-84 drought of Eastern Africa [2–3], the 1997/98 El Niño rains in Eastern Africa [4], the 2000 floods in southern Africa [5] are examples of major climatic events in sub-Saharan Africa. These have caused large scale loss of property and human suffering. Regional level efforts have been put in place to address vagaries of climate change. In West Africa, major projects such as West African Monsoon and RAINWATCH have contributed to the understanding of atmospheric processes and Sahel droughts and improved dissemination of early warning information [6]. In Southern Africa, several vulnerability assessments have been undertaken to aid policy and humanitarian interventions associated with climate variability [7]. In Eastern Africa, the Intergovernmental Authority on Development (IGAD) – a regional economic community of Eastern Africa - has established the IGAD Climate Prediction and Application Centre (ICPAC) to generate and disseminate early warning information to member countries. These research and institutional arrangements have improved the understanding of atmosphere – land - ocean interaction knowledge that has provided a foundation for the formation of regional Climate Outlook Forums. The Kenyan government on her part developed the National Climate Change Response Strategy (NCCRS) 2010 – a policy document that offer a framework to strengthen and focus nationwide actions towards climate change adaptation [8]. To operationalize NCCRS, the National Climate Change Action Plan 2013-2017 [9] and the Climate Change Act 2016 [10] have been developed. These national level efforts are further given impetuous by other support policies and institutional framework as articulated by [11].

In research, the sub-field of climate change has received what would pass as adequate attention. Studies such as [12–15] have served to demonstrated drivers of climate variability; while others have served to assess the magnitude and impact of climate variability [16-18]. Climate change research has also entailed the socio-cultural context within which countries and communities are adapting. For instance, [19–21] and [7] have interrogated the role of institutions in supporting adaptation to climate change. Several others have examined community adaptation to climate change [22-25]. These set of researches show the dichotomy of knowledge in climate change - from the drivers of climate variability that seek to improve climate prediction skills, to identification of best practices and technologies to support adaptation.

But between climate change adaptation technologies and implementation, there still remains gaps. The end users rarely factor the existing knowledge and skills into decision-making. This has triggered perception studies in climate change, including an assessment of whether indeed end-users regards climate change as a problem. Studies by [26–28] reveal that climate change is not the most important concern among local communities. Communities are more concerned with socio-economic issues such as crime, employment and health. These studies underline the importance of tackling both climatic and non-climatic conditions in enhancing adaptation. Tharaka sub-county - a marginal and semi-arid sub-county in Kenya, has persistently experienced challenges of climate variability. Development agencies – government and non-governmental, have invested in the sub-county through programmes such as soil water conservation [29] and promotion of irrigation farming and effective natural resource management [30]. Despite these efforts, communities remain vulnerable to effects of

climate variability. This brings to fore the need to establish whether indeed climate change and variability is a constraint to resource exploitation. Determination of the place of climate change and variability as a problem will provide a context within which adaptation planning shall take place. The study is premised on the understanding that local perception (of problems or stressors) will reflect local concerns and, therefore, an avenue to design effective climate change adaptation strategies.

2. MATERIALS AND METHODS

2.1 Study Area

Tharaka sub-county is found in Tharaka Nithi County and covers an area of 1569.5km^2 and a population of 175,905 [31]. Tharaka sub-county is predominantly inhabited by Tharaka people - a subgroup of the larger Meru ethnic group [32]. The sub-county has four agro-ecological zones (AEZs): Lower Midland (LM) 4, Lower Midland (LM)5, Intermediate Lowland Zone (IL)5 and Intermediate Lowland Zone (IL)6 [33]. The people of Tharaka are predominantly agro-pastoralists, engaging in both livestock keeping and crop farming [34]. Tharaka sub-county comprises of low, hilly and sandy marginal lowlands. The hills in the sub-county have forest covers while the low lands are characterized by bush and shrubs.

Tharaka sub-county receives rainfall that range from 800 mm (in the driest AEZs) to 1100mm (in the wettest AEZs) [35] annually. The study area has a bi-modal rainfall – March-April-May 'long rains' and October-November-December 'short rains' – providing two growing seasons. Due to reliability and relatively high amount received in Eastern Kenya [36–37], farming households mostly rely on OND rains for farming. In Eastern Kenya, like most parts of the country, rainfall variability is influenced by the Inter tropical convergence Zone (ITCZ), ENSO, sea surface temperatures among others [38,15].

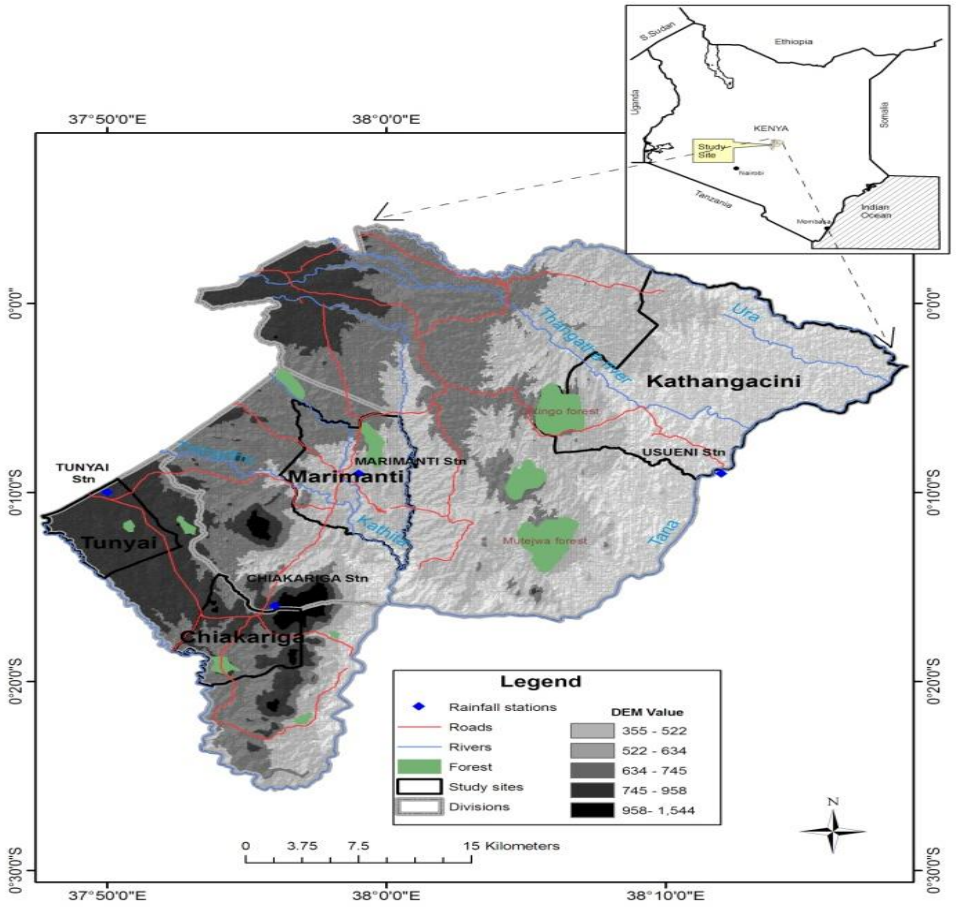

Fig. 1. A map of Tharaka sub-county and the study sites

As a semi-arid marginal sub-county, Tharaka has several challenges including climate change and variability. These affect the livelihood support system of the people. The choice of the sub-county was therefore based on a need to establish the extent to which climate variability is perceived as problem as a way of strengthening adaptation.

2.2 Data Collection

The target study sites were four agro-ecological zones; namely, LM4 (Tunyai), LM5 (Chiakariga) IL5 (Marimanti) and IL6 (Kathangacini). Selection of study sites was informed by variation in production domains [39]. These are mixed farming (LM4), rain-fed cropping (LM5) and marginal mixed farming (IL5 and IL6) [40]. Focus group discussions (FGDs) were carried out in each of the four study sites and the sample distributed as shown in Table 1. Respondents were purposively sampled based on level of economic status ('poor', 'fair' and 'well off') as classified by the Department of Arid Lands in Tharaka sub-County. The FGDs were carried out with the assistance of field monitors working for the Department of Arid Lands, Marimanti. A questionnaire was administered to FGD participants at two levels - individual and group levels. Individual participants were first asked to fill the questionnaire and return to the researcher. This was followed by a group discussion and filling of one questionnaire. At both individual and group levels, respondents were asked to list ten (10) stressors in their lives. For the group discussion, participants were to discuss and agree on the ranking of the listed stressors. The approach was aimed at establishing the difference, if any, in the ranking of stressors between individuals and groups. The main aim of the FGDs was to collect data that would assist in evaluating the perception of climate change and variability as a problem in relation to other socio-economic factors.

The study also interviewed key informants who were mainly practitioners from diverse areas of interest implementing development programs in Tharaka sub-county. The target areas were food security, agriculture, livestock, water resources and administration. A total of twenty-four practitioners were interviewed - 19 from government institutions and 5 from the private sector. Interviews with practitioners sought to validate household data on constraints to resource exploitation in Tharaka sub-County.

2.3 Data Analysis

Using a participatory risk ranking and scoring method, data from FGDs was used to rank stressors at individual and group (also referred to as 'community' in this study) levels. The procedure of ranking stressors was carried out as discussed in [26]. However, there were differences in sample procedure and composition between [26] and the present study. In this study, the sample population consisted of household representatives only while [26] included extension officers. For this study, practitioners were asked separately to identify constraints in resource exploitation in Tharaka. Participatory ranking entailed calculation of incidence index (I), risk index (R) and severity index (S) of stressors as discussed in [41]. Incidence index (I) was calculated as the measure of proportion of respondents who identified a particular stressor. Incidence index ranges from 0 (not mentioned) to 1 (mentioned by all).

Thus;

$$I = s/T \quad (1)$$

Where:

s was the total number of respondents, who mentioned a stressor,

T is the total number of FGD respondents.

Table 1. Sample population of participants in focus group discussion

Administrative unit	Agro-ecological zone	Cluster of well-being*			Total
		Poor	Middle	Well-off	
Marimanti	IL5	4	4	3	11
Kathangacini	IL6	3	5	4	12
Chiakariga	LM5	3	4	5	12
Tunyai	LM4	5	5	3	13
Total		15	18	15	48

**Well-being: Classification based on Department of Arid and Semi-Arid Lands, Tharaka sub-county*

Severity index measured the severity of risk of each problem on a scale of 1 (most severe) to 2 (least severe). Severity index (S) was calculated using the equation:

$$S_j = 1+(r-1)/ (n-1) \quad (2)$$

Where:

S_j is the severity index value of a problem,

r is problem's rank based on the order in which it was mentioned by the respondent,

n is the total number of problems identified by that respondent.

Lastly for each problem, a risk index (R) was calculated to indicate the most acute risk and was calculated as:

$$Rj = Ij/Sj \quad (3)$$

Where:

I_j is the incidence index,
S_j is the severity index calculated above.

Risk index ranges from 0 to 1. It is instructive to note that higher values for I_j indicate higher incidences and lower values for S_j indicate more severity. Thus, R_j increases with the overall risk associated with each type of problem.

Data was coded, entered and analysed using the Statistical Package for Social Scientists (SPSS) version 20.0. The incidence index was calculated by running a frequency table to determine the total number of respondents who mentioned a particularly stressor. S and R values for each respondent were computed using the above equations in the SPSS software. Thereafter, the risk incidence index was plotted against the severity to produce a risk map.

3. RESULTS AND DISCUSSION

In focus group discussions, respondents were asked to state stressors in their lives as individuals and as a community. Fig. 2 shows the results of identified stressors by individuals. Results of incidence index (I) show that lack of money (0.81), drought (0.73), bad health (0.71) and livestock diseases (0.71) were the most identified stressors. Other stressors that had a higher incidence index (I> 0.5) were poor soils, lack of pasture, lack of farm inputs, low quality food, low agricultural productivity, cost of education, irregular rains, lack of employment and water scarcity. In terms of severity, water scarcity (No. 24) and lack of money (No. 9) scored the least (1.2), thus, the most severe of the stressors. Problems such as irregular rains, lack of employment, lack of pasture, livestock diseases and bad health presented medium risk. All medium to severe risk stressors also recorded a higher incidence index. Table 2 shows the total risk index and risk index by agro-ecological zones, gender and age. Overall, stressors with the most acute risk were lack of money (0.70), need for water storage facility (0.51), bad health (0.51) and livestock diseases (0.50). Irregular rains (0.49) - a climate related stressor, are ranked moderately. When the risk index was analysed by agro-ecological zones, gender and age, lack of money emerged as the stressor of acute risk. Although lack of money and scarcity of water are stressors under acute risk in the four agro-ecological zones, there are differences in perception of the other stressors. The high ranking of drought and irregular rainfall in LM4 can be attributed to mixed farming that characterizes the zone [40]. Thus, in LM4, households suffer from agricultural drought where there is little or no soil water to support pasture and crops [42]. People in agro-ecological zone IL6, who largely depend on pastoralism, are more stressed by drought and livestock diseases. Lack of pasture in times of drought is usually a recipe for conflict especially along the Tharaka-Tigania border. The harsh climate of IL5 (Marimanti) makes rain-fed farming difficult. This is complicated further by the growing population which has led to land fragmentation.

To people in IL5, access to employment opportunities or other income generating opportunities is a major concern. There were no significant gender differences in perception on lack of money, drought and water scarcity as stressors of acute risk. However, men were more worried about the risk of livestock diseases and irregular rains than women. Adults perceived irregular rains as a major threat, while the youth considered drought and water scarcity as the most threatening stressors.

In each study site, FGD participants, as a group, were asked to rank 10 main stressors that concern the community. Results of this ranking are presented in Table 3. It is observed that irregular rainfall (IL5), droughts (LM4) and water scarcity (IL6 and LM5) were ranked top stressors. It is also instructive to note that bad health (LM4) and lack of money (IL5 and IL6)

were ranked as the second most severe stressors. A comparison of individual and group ranking of stressors shows that climate related stressors - drought and irregular rainfall are more acknowledged at the group level than at an individual level. Divergence in perception among groups to climate change and adaptation was also cited by [24] where farmers were more focused on addressing risks associated with climate variability, while agricultural experts and extension agents emphasized management options to reduce current and future vulnerabilities. There was however a convergence of thought between practitioners and individuals as illustrated by the high incidence index for lack of money and poverty, as constraints to adaptation. The desire to have money was largely informed by high levels of poverty - a product of the difficult environmental (read climate) and developmental challenges that affect Tharaka. [43] attribute this state of affair, particularly in less favoured areas of the arid and semi-arid tropics, to unfavourable policies, lack of markets and institutional structures that prevent smallholder farmers from undertaking profitable resource-improving investment. Lack of infrastructure and basic social amenities has exposed the people of Tharaka to climate risks and weakened their livelihood support system. It was evident from the analysis that whereas rainfall variability was an acknowledged constraint to resource exploitation and a stressor at the community and individual level, it is not the severest. This relate to [44] and [27] studies which established that despite widespread concern about climate change, it is of secondary importance in comparison to other issues in people's daily lives. The prominence of non-climatic factors in affecting household wellbeing makes public investment in rural infrastructure and education a priority [23] This means that to address adaptation to climate variability in semi-arid Tharaka sub-county, there is need to first address the high poverty levels, and improve the state of infrastructure and education. The Kenyan government, through the Development Strategy for Northern Kenya and Other Arid Lands has put in place a policy framework to address development challenges of arid lands [45]. Addressing challenges of semi-arid through expansion of education & employment opportunities, favourable tax policy and strategic investment (in semi-arid lands) and participation of the people will potentially bring about equitable and inclusive growth. Specifically, it will address the feeling of marginalization among the tharaka people [46] and strengthen the community's adaptive capacity to climate change.

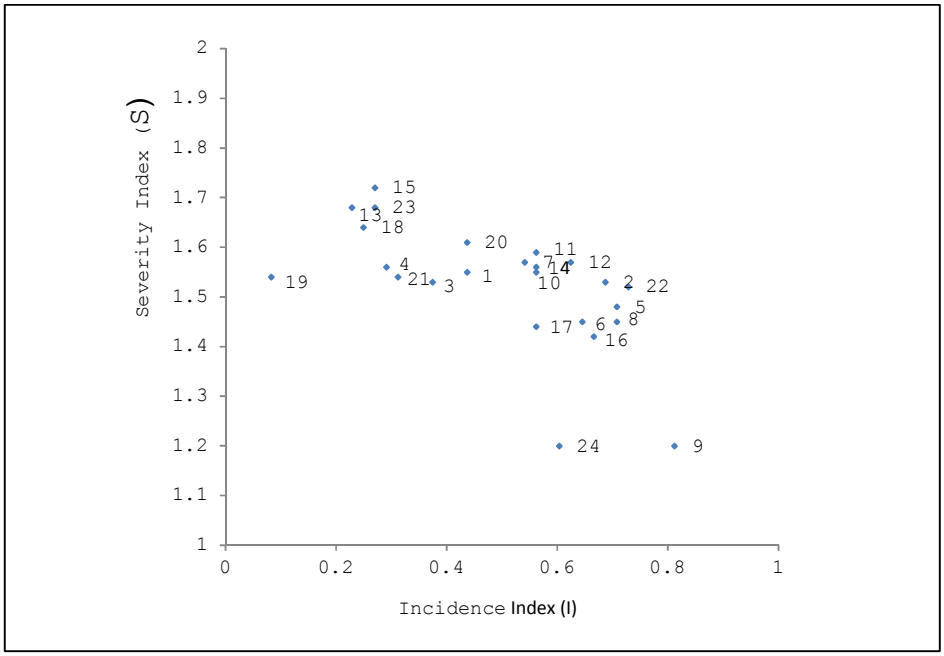

Fig. 2. Risk index map (overview refer to Table 2 - column 1 & 2 to infer the codes and description for each stressor)

Table 2. A Subjective Risk Index (R) by agro-ecological zones, gender and age. The index ranges from 0 (no incidence of risk) to 1 (most severe risk)

No	Stressor	Risk index (I)	Main agro-ecological zone				Gender		Age	
			LM4	LM5	IL6	IL5	Men	Women	Youth	Adult
1	Deforestation	0.29	0.30	0.33	0.25	0.28	0.29	0.29	0.29	0.29
2	Poor soils	0.47	0.44	0.49	0.44	**0.52**	0.46	0.47	0.49	0.45
3	Conflict	0.26	0.24	0.32	0.28	0.23	0.25	0.28	0.26	0.26
4	Pollution of rivers	0.19	0.22	-	0.18	0.15	0.22	0.17	0.19	0.19
5	Livestock diseases	**0.50**	**0.51**	0.47	**0.52**	0.48	**0.52**	0.49	0.47	0.52
6	Lack of pasture	0.46	0.46	0.47	0.47	0.46	0.48	0.45	0.45	0.47
7	Lack of farm inputs	0.36	0.34	0.40	0.35	0.35	0.37	0.34	0.35	0.36
8	Bad health	**0.51**	**0.52**	0.42	**0.53**	0.49	0.45	**0.55**	**0.52**	**0.50**
9	Lack of money	**0.70**	**0.72**	**0.62**	**0.58**	**0.79**	**0.66**	**0.76**	**0.72**	**0.69**
10	Deficient/low quality food	0.37	0.34	0.37	0.41	0.41	0.34	0.40	0.38	0.36
11	Food insecurity	0.37	0.36	0.41	0.35	0.36	0.37	0.36	0.39	0.35
12	Low agricultural productivity	0.41	0.44	0.44	0.37	0.39	0.43	0.39	0.42	0.41
13	Lack of seeds	0.14	-	0.14	0.14	0.13	0.13	0.14	0.13	0.14
14	Cost of children education	0.37	0.35	0.40	0.37	0.38	0.36	0.38	0.32	0.39
15	Skill acquisition /training	0.16	0.14	0.17	0.17	0.16	0.16	0.16	0.17	0.16
16	Irregular rains	**0.49**	**0.55**	0.47	0.48	0.48	**0.50**	**0.49**	0.46	**0.51**
17	Lack of employment/work	0.41	0.42	0.39	0.41	0.41	0.42	0.40	0.42	0.39
18	Scarce social amenities	0.16	0.13	0.15	0.18	0.15	0.15	0.16	0.16	0.15
19	Poor infrastructure	0.06	0.25	0.30	0.23	0.32	0.04	0.06	0.04	0.06
20	Poor roads	0.28	0.25	0.30	0.23	0.32	0.29	0.28	0.25	0.30
21	Poor housing	0.28	0.18	0.21	0.23	0.21	0.22	0.20	0.19	0.22
22	Drought	0.21	**0.64**	0.40	**0.51**	0.47	**0.53**	**0.50**	**0.53**	0.48
23	Water storage facility	**0.51**	0.14	-	0.16	0.17	0.18	0.16	0.16	0.17
24	Water scarcity	0.16	**0.54**	**0.51**	**0.53**	0.40	**0.51**	**0.50**	**0.52**	**0.49**
	Sample size	**48**	**12**	**12**	**12**	**12**	**21**	**27**	**20**	**28**

Table 3. Group ranking of major stressors

Stressor	Stressor ranking by agro-ecological zones			
	LM4 (Tunyai)	LM5 (Chiakariga)	IL5 (Marimanti)	IL6 (Kathangacini)
Deforestation		8	10	
Poor soils		4		
Conflict				10
Livestock diseases	10		6	4
Lack of pasture	5	5		
Bad health	2			8
Lack of money			2	2
Food insecurity	4	3	8	
Low agricultural productivity	6		7	

Stressor	Stressor ranking by agro-ecological zones			
	LM4 (Tunyai)	LM5 (Chiakariga)	IL5 (Marimanti)	IL6 (Kathangacini)
Lack of seeds				9
Cost of children education	9		5	6
Skill acquisition/training		6		
Irregular rains	**8**	**2**	**1**	**3**
Lack of employment/work		7	3	7
Poor roads	7	9	4	
Drought	**1**	**10**		**5**
Water storage facility	3			
Water scarcity		**1**		**1**
Lack of banking facility			9	

4. CONCLUSION

This paper has presented results of climate variability as a problem in semi-arid Tharaka sub-county. Overall, lack of money, bad health, livestock diseases and lack of water storage facilities are the most acute risks, while irregular rainfall and drought were moderately rated as stressors in Tharaka sub-county. There are variations across agro-ecological zones, gender and age in the perception of the three indices analysed in this study; incidence, severity and risk. The study further established that perception of stressors varied among individuals and groups/community. For instance, climate variability stressors were more acknowledged at group level than at individual and practitioner levels. The variations in perception of climate variability as a problem among individuals and group present a dilemma for stakeholder participation in climate change adaptation planning. Efforts need to be directed in understanding the socio-cultural lenses that inform conceptualization of climate change as a problem. To meaningfully engage communities in adaptation to climate variability, development agencies need to focus on poverty alleviation, health care, water services and prevention of livestock diseases in semi-arid areas.

ACKNOWLEDGEMENT

The author acknowledges financial support from the African Climate Change Fellowship Programme — a programme of International SysTem for Analysis, Research and Training (START) for a study fellowship award to the author and fieldwork support from the EU Water Facility Project (No. 9 ACP RPR 50/11). I further acknowledge the valuable support of the Department of Arid Lands – Tharaka sub-county and the receptive people of Tharaka who participated in the survey, without which this study would not have been possible.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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