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Climate Change

The influence of climate change on migration drivers: a qualitative analysis

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This paper takes forward the knowledge frontiers regarding the influence of climate change on migration by answering the question why people do out-migrate in the semi arid areas of Tanzania. The paper explores ways in which climate change influences migration decisions among communities in very specific local scales with reference to Shinyanga District. The study is descriptive in nature. Data was collected through interviewing key informants, household survey, field observation and documentary review. Perceptions indicate that climate change manifests through erratic rains hence unpredictable seasonality; decreased storm size, reduced wet season, and prolonged dry season. Temperature is on a rising trend, and wind speed is on the increasing side. Frequent crop failure, reduced water resources, degraded soils, reduced fish resources, outbreak of non-common pests and diseases, disappearance of some animal and tree spices and reduced pasture all negatively impact the agricultural economic system, in turn, this compromises the community's social system. Search for more fertile land, pasture, waged labour in nearby villages and search for jobs in towns are some of the identified reasons for outmigration in response to the challenges posed by climate change on the agricultural economic system. The paper informs policy on the urgency of proper action against climate change and related stresses in the country. Food relief programmes and transformation of the agricultural economic system are highly recommended to support adaptation to climate change in the study area. The study also recommends facilitation of research work which thrusts to excavate the social, economic and environmental implications of climate change forced migration in destinations.

INTRODUCTION

Migration is not a new phenomenon, it has being there since time in memorial. Social, economical, political and environmental related factors have been the major driving force towards migration. However, currently, there is an argument that climate change is exacerbating human population displacement and migration around the world (See for example UNDP 2016). Wilkinson *et al.,* (2016) explains that between 2008 and 2015, climate change related disasters accounted for 85% of all population displacement cases.

Migration due to climate change has many implications on livelihoods and sustainable development. When people migrate due to climate change related disasters tend to part away from their well established livelihood systems in places of origin. This is mainly because climate related disasters tend to disrupt the different means that would otherwise support livelihood systems in places of origin (Wilkinson and Peters, 2015). In few hours, a severe storm, for example, can wipe off such assets as houses, farms, livestock and communication network, power and water supply systems etc despite the huge investment in terms of time and labour that local people would have committed in acquiring, establishing, nurturing and caring for such assets and systems. Likewise, with prolonged drought, farms and livestock tend to be at stake; as a result people tend to be left with less means to sustain life (Wilkinson and Peters 2015). Low-income countries are a particular concern as people in such countries have limited capacity to cope with the global environmental changes, for them, migration is the most common adaptation option (Wilkinson *et al.,* 2016).

Climate change is reported to seriously impact rain-fed agriculture - the major livelihood options for over 70% of the Tanzanian population residing in rural areas (URT, 2016). The country is reported to experience rising temperatures and decreasing rainfall (Wilkinson et *al.,* 2016). It is projected that by 2100 Tanzania will experience temperature increase of up to 2.2°C (Agrawala *et al.,* 2003). Changes in climate are leads to a significant reduction in crop yields (Rowhani *et al.,* 2011). Diversification to non-farm activities could be one response to the challenges posed by climate change on subsistence farming as suggested by Liwenga *et al.,* (2012). However, in rural areas of Tanzania diversification to non-farm activities suffer from low levels of education and poor infrastructure (Lanjouw *et al.,* 2001). Henceforth, migration is perceived to be an adaptation strategy to climate change among most rural populations in the country (Wilkison *et al.,* 2016). However, so far less has been explored on the interlink age between climate change and migration in the country.

There is ample literature in favour of the perception that the characteristic of the natural environment influences human decisions on whether or not to settle in a given place. Hippocrates and Aristotle, for example, were of the opinion that whether people decide to settle in a given locality or not depends on the status quo of that particular locality; and also that nature influences human behavior (McLeman and Smit, 2006). There is also a significant body of literature that indicates that throughout history human settlement and migration patterns had strong linkages to changes in climatic conditions, both shifts in norms and abrupt changes (see for example Yesner, 2001 and Huntley, 1999). Smit

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and Cai (1996) indicates that in china, nomadism was partly an adaptation strategy against climate change among pastorasts. Fixico (2003) on the other hand indicates that in North American Plains prior to European settlement the Lakota settlement patterns was significantly influenced by climatic condition. Lockeretz, (1978) narrates that population growth on the US Great Plains in the 20th century resulted from high levels of in-migration which were responses to agricultural favorable climatic conditions. In the 1930s, however, the US experienced a period of particularly unfavorable climate for agriculture that decade witnessed a migration of approximately 300,000 people out of the US southwest and thousands more displaced within the region (Gregory, 1989). The literature indicates that in Africa populations in rural areas have adopted strategies to cope with recurring drought that incorporate migration (See for example Meze-Hausken, 2000; and Ezra, 2001).

There are also few studies that provide an account on the link between climate change and migration in Tanzania. Liwenga *et al.*, (2012), for example, explains that there is a close relationship between rainfall pattern change and migration whereby in her three study villages' variability in rainfall pattern and especially prolonged drought lead to low farm productivity hence outmigration. She makes clear however that migration patterns vary across the three villages.

The body of knowledge pertaining environmental change and migration is substantial at global level. But literature explaining ways in which contemporary global change influences migration especially among specific communities in specific geographical localities in Tanzania is scant. The existing literature is limited to few specific case studies including Liwenga *et al.,* (2012). Case studies are known to provide best findings on selected cases but one of their major weaknesses is that findings may not be generalized. That been the case, it may be quite challenging to establish an affirmative position on ways in which acts of rural-rural and/or rural-urban migration are a result of the contemporary global climate change in the study area; this is why this study was undertaken.

This paper, therefore, discusses ways in which climate change is influencing migration in Tanzania with reference to Shinyanga District of Shinyanga region. The paper first examines climate change perceptions focusing on rainfall, temperature and wind patterns; findings are triangulated with findings from metrological records analysis based on existing literature. The implications of climate changes on the bio-geophysical, social, economic and political environments - also known as "migration drivers" and hence decisions to migrate or stay are there after inspected.

Foresight: Migration and Global Environmental Change (2011) established a framework to explain what drives migration (pull and push factors) and how global environmental change might influence these migration drivers in future (Figure 1). According to Foresight: Migration and Global Environmental Change (2011) environmental change is defined as "changes in the physical and biogeochemical environment, over a large scale, either caused naturally or influenced by human activities" (pg50).

Foresight: Migration and Global Environmental Change (2011) acknowledges that migration is already occurring in most parts of the world, as a result of a number of factors namely social, political, economic, demographic and environmental factors (Figure 1). The framework displays that there is no any migratory phenomenon which is attributable to environmental change only rather migration in most cases is caused by a combination of factors. According to the framework, it is the existence of variability in space and time in one or more of the five drivers of migration that creates the conditions for migration. The framework also advocates that the reasons for migrations may overlap in different ways in different places and time (Foresight: Migration and Global Environmental Change (2011). The framework further presents that it is not always a must that where conditions for migration exists that migration will actually take place, rather there is a number of intervening factors that also determines migration to occur or not to occur. The framework indicates for example that, apart from the five main migration drivers, even other factors, which might be seen as minor factors (e.g. individuals and households characteristics), have implications on migration decisions. Age, sex, wealth and levels of education for this case have all implications on migration decisions (Foresight: Migration and Global Environmental Change (2011). The framework's point of departure from the traditional migration frameworks is its ambition to examine ways in which environmental change may influence the universally known migration 'drivers' (i.e. environmental, social, economic, demographic and political factors) and hence (future) migration patterns.

This study adopts the framework by Foresight: Migration and Global Environmental Change (2011) to examine the influence of the contemporary global climate change (one aspect of environmental change) on livelihoods and migration. The paper discusses first environmental changes that are taking place in the study area based on perceptions and thereafter it discusses ways in which such changes are influencing livelihoods and migration. The study focuses on three climate change variables namely rainfall, temperature and wind. The major assumption as discussed in Foresight: Migration and Global Environmental Change (2011) is that, changes in climate influences the ability of related ecosystems to provide expected services either negatively or positively. As such, communities that depend entirely on ecosystems for livelihoods tend to be affected, levels of such effects depend on the magnitude of climate change impact on the ecosystem in question; hence, the decision to move or stay also depends on the magnitude of the climate change effects on the ecosystem. Changes in rainfall regimes, for example, affects environmental factors of migration through influencing for example nature and occurrences of such extreme weather events as flooding and prolonged drought; seasonality variability i.e. variability in storm size, distribution, length and timing; all these affects farm productivity (Parry *et al.* 2009). Farm wages, forests and forestry resources; pastures, water resources, and land resources are also affected hence effects in the economy which in turn also affect social factors including availability, accessibility and affordability of such social needs as food, shelter, clothing, education, health, transport, water, sources of energy, e.g. fuel wood; pasture/folder, etc which all determine the decision to stay or move (Foresight: Migration and Global Environmental Change 2011).

Increases in temperature leads to increased extreme warmer/hotter conditions which lead to crop failure hence negatively impacting economic factors and social factors more or less in similar ways as the case is for changes in rainfall regimes described earlier. Increases in temperature may also lead to increase in chances of pests and wildfires outbreaks which affect agriculture and forests (Easterling *et al.* 2007).

METHODS

The study area

The study was conducted in Shinyanga region. The region is located is in the North Western part of Tanzania. Approximately the region lies between latitude 30 15" and 40 30" South of the Equator and between longitudes 310 30" and 340 15" East of the Greenwich Meridian (URT

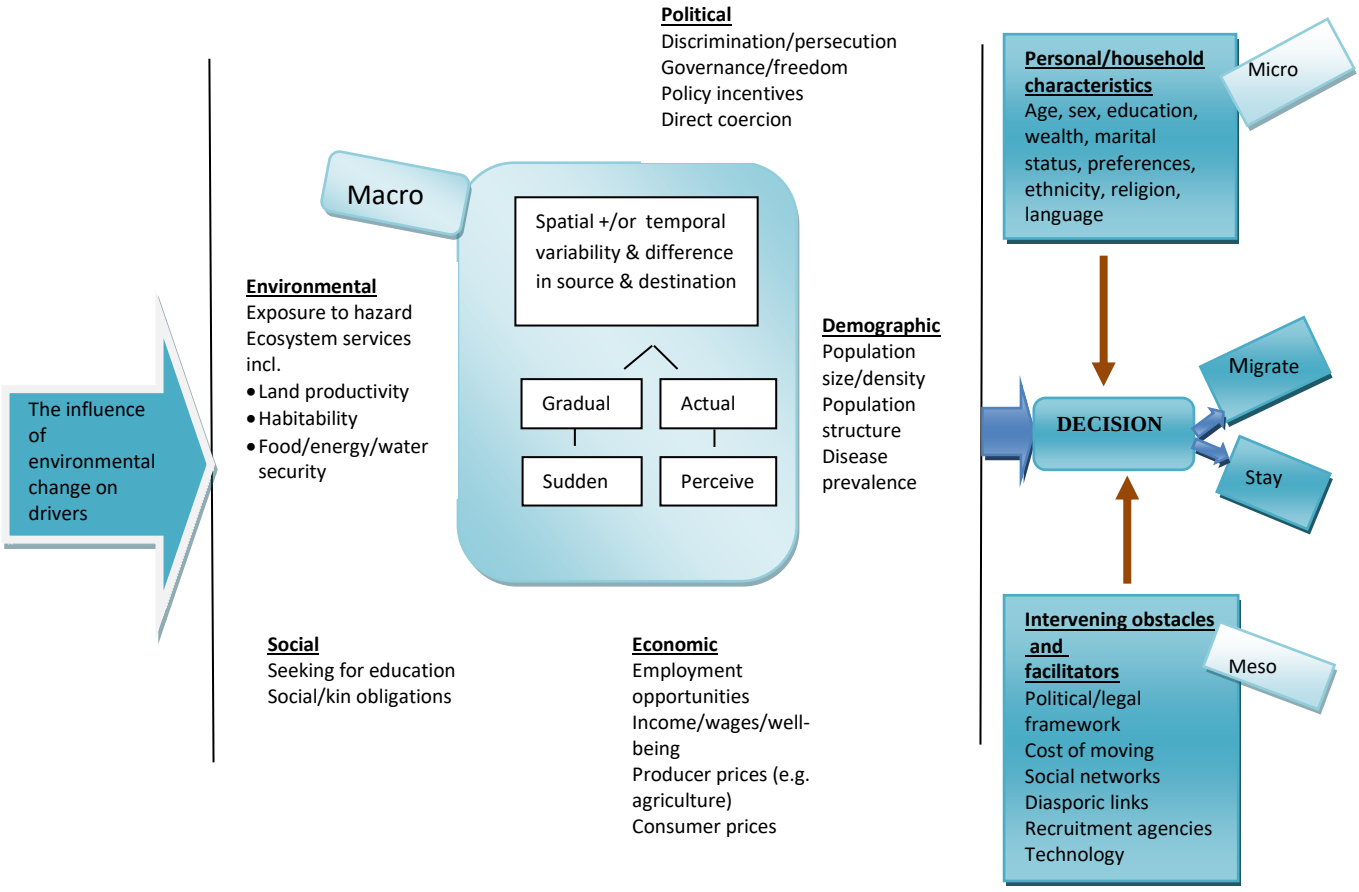

Figure 1 Conceptual framework: The influence of environmental change on migration 'Drivers'
Source: Foresight: Migration and Global Environmental Change (2011)

Table 1 Perceptions on rainfall

Perceptions	Isela Village			Mwalukwa village		
	%			%		
	Yes	no	Don't know	Yes	no	Don't know
Mean rainfall decrease	100	0	0	96	0	4
Mean rainfall increase	0	100	0	0	96	4
Increased wetter extreme events	41	59	0	0	96	4
Poor rainfall distribution	90	5	5	96	0	4
Rainfall amount increase	18	82	0	4	92	4
Increased drought extreme events	90	5	5	92	4	4
late on set of wet season	100	0	0	92	4	4
Longer wet seasons	5	95	0	0	96	4
Shorter wet seasons	95	5	0	96	0	4
Change in ending of wet season	77	18	5	92	4	4
Longer dry seasons	100	0	0	96	0	4
Shorter dry seasons	0	100	0	0	96	4

2013). The average rainfall of the region is 600-900 mm per annum (URT 2013) hence the region is categorized as one of the semi-arid areas in the country; semi-arid areas are commonly categorized as climate change vulnerable ecosystems (IPPC 2014). Administratively, the region is divided into 3 Districts namely Kahama, Kishapu and Shinyanga. The region has a total population of 1,534,808 people (URT 2013).

The Economy of Shinyanga is predominantly based on subsistence agriculture and livestock rearing. Farming is predominantly subsistence where use of hand tools and reliance on traditional rain-fed cropping methods and animal husbandry characterizes the sector. Main cash crops are cotton and tobacco, while the main food crops include maize, sorghum, paddy, sweet potatoes, millet and cassava (URT 2013). Keeping cattle, goats and sheep are other major activities in Shinyanga. The sector employs about 80 percent of the total labour force in the region (URT 2013). The other sources of the economy in the region include mining, trade and industry, forestry and fishing (URT 2013).

The study employed a descriptive research design. Ethnographic methods were used to collect and analyse data. This is the most common approach, consisting of interviews or small sample questionnaires covering populations under threat, privileged inhabitants and other local data which leads into provision of vital input to generate better models pertaining environmental change, livelihood systems and migration (Piguet, 2010).

Two villages from Shinyanga district were randomly selected for the study, these are Isela and Mwalukwa. A sample population making 5% of the total households in each of the study villages was selected for a household survey. Therefore in Isela village 22 households were randomly selected for the study out of 440. In Mwalukwa village on the other hand, 25 out of 491 households were randomly selected for the study. Six key informants were selected from each village; these included professionals in agriculture and experienced people; the assumption was that these could give the best insight on climate change and migration given their long life experiences. Hence only those who stayed in the study villages for over 40 years were considered for inclusion. Gender balance was observed. Data collection included in-depth interviews with key informants, questionnaire administration, desk review, as well as field observation. A structured questionnaire was used to collect numerical data; this was administered to the prior selected heads of households. The other data collection tool was a checklist of questions for in-depth interviews. A Field observation checklist was used during field observation; this was also prepared prior to field visits. Rainfall, temperature and wind pattern change analysis based on existing literature. Qualitative data was analyzed thematically. The study presents verbatim quotes from interviewees narratives to "...offer readers greater depth of understanding; it is believed that people's spoken words sometimes show the strength of their views or the depth of feelings or, on the other hand, their passivity and lack of engagement in ways that the researcher's own narrative could not" (Corden and Sainsbury 2006 pg 13). Photographs are displayed to present articulated visual statements of the community under study and thereby to enrich the analysis and interpretation; this approach is highly advocated by Wilbert (2010). Excel computer software was used to analyze numerical data. Differences within and across areas of studies among different variables are given attention.

RESULTS

Climate change Perceptions

Rainfall

Perceptions indicate that in the past October used to be the start of wet season and June used to mark the end of the season. Contrary, nowadays wet season starts towards the end of November, in some cases it starts as late as December and it ends in April. Hence, while in the past May and June used to experience wet weather, today the two months tend to experience dry weather. In both villages year 2018 is perceived as deviant case from the recent experience since rains extended to May a situation which is perceived to be abnormal. One key informant in Isela village narrated as follows:

> "...nowadays rain season delays...it mostly starts raining in December instead of October...in the past we knew for sure by first November till tenth November we would be planting but nowadays Christmas may pass and no one has done anything!...worse enough it ends too early nowadays...nowadays we are not surprised with May being dry and windy....it is only this year that we are surprised as this is May yet it is still pouring as you can see by yourself, we have already forgotten this kind of rains since 1980s ...yes...except in 1991 where it poured heavily for long... the gone to school called it *elinino* (El-Nino) rains, otherwise these days May is always dry as I was saying"

In Mwalukwa village wet season started in September and ended in May. Today rainfall start around November and it ends as early as March. However, as the case was in Isela, in Mwalukwa village too, year 2018 was perceived as deviant case as rains extended till May. Year 2017 was cited as the worst case scenario where rains ended in January. An informant in Mwalukwa had the following to say:

> "...in the past...I mean years before 1980s...rain season started in September and went on till June, it paused a bit in January then it continued till June... but these days it starts mostly in November and rarely in October...in fact these days one cannot even predict when it will start raining...surprisingly it also ends so early, say mostly it nowadays ends in April...last year was even worse, by January it was almost already dry. This year (2018) we are wondering...it is still raining and this is May... for sure it is just confusion"

Table 1 also suggest that most respondents are of the opinion that there is a change in start and ending of wet season. Generally, it is perceived that wet season is now getting shorter than it used to be in the past. Poor rainfall distribution in recent years is perceived as opposed to past experiences. Incidents of dry spells are frequently experienced amid wet season and mean rainfall have decreased. The following verbatim quotes from key informants in the study villages i.e. Isela and Mwalukwa respectively summarize perceptions on rainfall distribution in the two villages:

> 'Distribution is a big problem, this year wet season started in November ... as you may see, this is May yet it is still raining...in fact it is pouring heavily more than it did in December where we usually expect heavy storm, it is damaging crops in farms, rice is at stake, heaps of maize are at stake, groundnuts, cotton, the legumes...this is because in recent years there has been no rains in May, no rains at all, May has long been a month for harvesting crops...now as it is raining the little crops that we could harvest this year is getting rot in farms, there is little hope, come September no household will have food in store...so what I am saying is that unlike in the 60's and 70's (1960s and 1970's), these years rainfall has no consistent pattern, for us farmers, it has turn into a kind of betting, if you are lucky you win if not you lose, no one is sure how rains will behave during a given season, farming thenceforth is been done on trial and error...it is difficult to tell when peak rains will fall when it will cease a bit for weeding...it is just chaos really" (Key informant from Isela village 18/05/2018)

> "Rainfall can start in November, heavy rains, but it may surprisingly go off just towards December till March where it rains just for a month then it gets completely dry and that makes the end of the season...in fact it may rain heavily at times that we don't need it and it gets dry at times when we need it ...I mean when crops are at critical stages that water is important it goes off...this year for example it has been wet till this May which is so bad for our crops" (Key informant from Mwalukwa village 23/05/2018).

Findings from interview with key informants are highly supported by findings from house hold survey where a questionnaire was administered to establish ways in which respondents perceive climate change. Different variables were listed on the questionnaire and respondents were required to indicate whether they agree (ticking 'Yes') or they disagree (ticking 'no') or they don't know about what was happening as far as a given variable was concerned. From Table 1, considering all variables, there are very minimal incidents where respondents voted "don't know", this indicates that most respondents had clear perceptions on what was going on as far as the different rainfall variables were concerned. It may be clearly noted from the table that all respondents in Isela Village agreed that rainfall is on decrease and not increase; it is also poorly distributed, characterised by increased drought extremes, longer dry seasons, and late onset but with early ending. Though not the majority, but there is a significant number of respondents (41%) who perceived increased wetter events. This is much contradicting with the fact that 90% of all respondents voted in agreement that there was increased incidents of drought extremes. One explanation on this contradiction would be that, perceptions on increased wetter events may have been influenced by late ending of wet season in year 2018 whereby by the time the survey was conducted in May it was still wet a situation which was in contrast with recent past experiences.

Temperature

Perceptions on temperature are mixed up; although majority perceive warmer weather in recent years yet there is a significant proportion of those who perceived a cooler weather and a few who voted not to know what was happening with temperature. One key informant from Isela explained as follows:

> "I cannot say weather is warmer or cooler, however, sometimes during night weather has been too warmer, it has been so especially since 2000's...last year (2017) was even worse, from January till February you could not sleep really...it was terribly hot! "
>
> Although the key informant started buy indicating that he was not sure on whether or not it is getting warmer yet down the line he seem to suggest that weather is skewed towards a warmer trend; this is reflected in his phrase ...*it has been so especially since 2000's*...this phrase suggests a continuing behaviour i.e. weather that is on a warming trend since that time to date. The following quote from one of the key informants in Mwalukwa village, however, shows that the informant was quite sure that weather is warmer these days as compared to the past as she provides a clear citation on health conditions that could be experienced through living against nature in the past vs. today; the quote indicates that even food culture or rather eating habits are changing with weather change; she says:
>
> In the past one could not afford eating leftovers (without warming it) from last night's meal in June and July, it was too cold! Eating such leftovers during those days could lead to one suffering from an ailment locally called *sagida* "cold in stomach" leading into vomiting and eyes flowing with tears. But nowadays we just eat it (leftovers) with no problems, no warming kids nowadays they just eat it cold as it is and they head up to school and they are okay...yes it seems weather has changed, it is warmer than it used to be in the past...If I remember well in the past warm weather started in September and ended in November".

Table 2 clearly suggests that most respondents were of the perception that weather is on a warming trend where 86% of all respondents voted yes on the idea that mean temperature has increased. Perceptions were divided on whether temperature is predictable or not although those who voted for unpredictable temperature lead by margin i.e. 45% vs. 41% of those who said they did not know and 14% of those who said temperature was not predictable.

Wind

Perceptions indicate increase in wind speed, otherwise no change in direction, no incidents of wind storm, no increase in incidents of storm surges, and also no increase in incidents of dust storms (Table 3). Likewise most key informants' perceived increase in wind speed buy they did not perceive any change in any of the remaining wind aspects.

Literature on metrological records analysis supports these qualitative findings. A recent study by Matata *et al.*, (2018 up-coming) used data from Tanzania Meteorological Agency (TMA) to examine rainfall anomaly and seasonal variability for Kishapu district for the period1985-2016. The reason why the findings are found relevant to this study includes that fact that Kishapu District borders Shinyanga district. Formerly most part of the Kishapu district was under Shinyanga rural district, the district covered the current study area. It was until recent where there had been a restructuring of the administrative borders of Shinyanga region which led to the formation of Shinyanga and Kishapu districts (and the resolve of the then Shinyanga rural district). Therefore part of the area that formed Shinyanga rural district falls under Shinyanga district and the remaining area falls under Kishapu district. However, metrological records are not affected by administrative divisions; hence the findings by Matata *et al.*, makes a great contributions in understanding the objectivity of the perceptions in this study.

Regression results by Matata *et al.*, (2018 up-coming) showed rainfall variability by R2 = 0.186 implying that about 1.86% of the changes in rainfall in the study area are associated by changes in weather variables. The study also revealed change of months with most rains and a general rainfall and temperature decreasing trend and a minimal annual rainfall variability increasing trend (Matata *et al.*, 2018 up-coming). Table 4 shows high standard deviations implying inconsistency in rainfall patterns in each month. December shows to own the highest amount of average monthly rainfall followed by January,

Table 2 Perceptions on temperature

Perceptions	%					
	Isela			Mwalukwa		
	yes	no	don't know	yes	no	don't know
Mean temperature increase	86	9	5	96	0	4
Mean temperature decrease	9	86	5	0	88	12
Temperature extremes	68	5	27	73	0	9
Temperature fluctuations	82	14	5	92	0	8
Unpredictable temperature	45	14	41	72	12	16

Table 3 Perceptions on wind

Perceptions	%					
	Isela			Mwalukwa		
	yes	no	Don't know	yes	no	Don't know
Increased wind speed	86	14	0	72	12	16
Decreased wind speed	5	95	0	16	72	12
Change in wind direction	18	77	5	52	32	16
Longer windy season	36	59	5	56	24	20
Increased incidents of wind storm	45	50	5	28	60	12
Increase incidents of dust storms	41	50	9	28	48	24

Table 4 Description of monthly rainfall from 1985-2016

Moth	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness	Kurtosis
January	28	25.30	328.40	116.5857	59.70766	3565.005	1.587	4.818
February	29	20.30	171.10	95.6034	37.61550	1414.926	.140	-.522
March	29	63.10	230.70	136.7138	37.29866	1391.190	.295	.531
April	29	11.90	213.40	109.4241	50.70094	2570.585	.179	-.731
May	29	.00	130.80	33.4000	31.59972	998.542	1.453	2.189
June	29	.00	8.20	.9828	2.30079	5.294	2.611	5.798
July	29	.00	.00	.0000	.00000	.000	.	.
August	29	.00	12.60	.9621	2.63458	6.941	3.700	14.598
September	29	.00	37.40	6.0690	9.62119	92.567	1.918	3.260
October	29	.10	159.90	34.4483	43.50720	1892.877	1.695	2.012
November	29	12.10	215.90	97.4655	57.27208	3280.091	.686	-.276
December	29	10.40	449.70	141.3552	83.27899	6935.390	1.784	5.743
Total	29	2592.20	3809.60	3051.272	273.18319	74629.058	.600	.662
Average	29	42.80	102.20	67.7793	13.24741	175.494	.732	1.088

Source: Matata et al., (2018 Up-coming)

March and April (141.35mm, 116.59 mm, 136.71mm and 109.42mm respectively); February, May, October and November on the other hand indicates to own the lowest average rainfall (95.6mm, 33.4mm, 34.4mm and 97.47mm, respectively) (Matata *et al.*, 2018 up-coming).

The spatial distributions of precipitation indicate low rainfall reliability with the maximum average of 102.20mm (Table 1). Table 1 also shows statistical evidence that the monthly rainfall variance in the seasons decreases from 6935.39 in December to 2570.56 in April (Matata et al., 2018 in press). This means in most cases the study area is characterized by high incidences of droughts; this is in line with the qualitative findings presented earlier. The Table also shows a distinctive decrease in the amount of rainfall in April which suggests an earlier ending of the wet season; thus, again, the findings supports the perceptions that the study area is experiencing shorter wet seasons.

Figure 2 indicates highest rainfall variability during crop growing season i.e. variability in amount of rains in the months of October, November and December (Matata *et al.*, 2018 in press). This indicates that the onset and end of rainfall during the growing period has become more erratic and unpredictable; this is in congruency with findings from perceptions. Findings by Matata *et al* (2018 in press) on rainfall variability and decreasing trend are in line with Kangalawe and Lyimo (2013).

Matata *et al* (2018 up-coming) reports that ttemperature highly vary with an increasing trend. October and December are the two months that indicate the highest temperature, throughout the period between 1985 and 2016(Table 5), while the lowest temperatures are in April, July and August ranging from 31.5°C to 33.6^0 C throughout the period under consideration (Matata *et al* 2018 in press). The daytime temperature data are negatively skewed to the left (-0610), indicating that there are variations on temperature between months. These findings are in line with Kangalawe and Lyimo (2013).

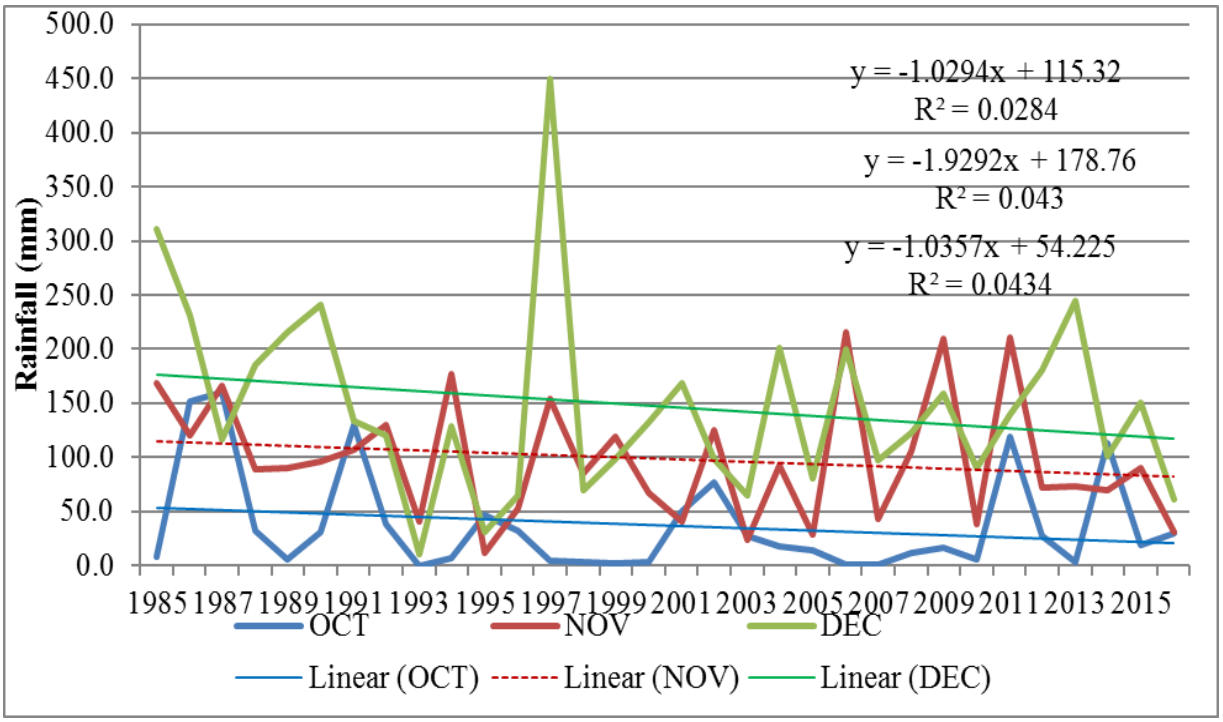

Figure 2 Rainfall trends during growing season October to December
Source: Matata et al., (2018 up-coming)

Table 5 Monthly maximum Temperature (°C) in Kishapu District (1985 to 2016

Month	N	Range	Min	Max	Mean	Std. Dev	Variance	Skewness	Kurtosis
Jan	29	6.60	26.10	32.70	29.4931	1.34215	1.801	-.344	.995
Feb	29	4.40	28.40	32.80	30.1241	1.28276	1.645	.558	-.510
March	29	4.40	28.40	32.80	30.1828	1.12029	1.255	.634	.063
April	29	3.20	28.20	31.40	29.7414	.90811	.825	.107	-.906
May	29	3.80	27.70	31.50	29.8414	.93140	.868	-.593	.055
June	29	2.10	28.90	31.00	30.0276	.47048	.221	.006	.103
July	29	1.70	29.20	30.90	29.9345	.44503	.198	.569	-.373
Aug	29	1.80	29.70	31.50	30.8724	.43416	.188	-.648	.570
Sept	29	2.00	31.50	33.50	32.3931	.50351	.254	.639	.299
Oct	29	3.50	30.10	33.60	32.6897	.74563	.556	-1.853	4.531
Nov	29	9.50	24.00	33.50	31.0172	1.85030	3.424	-1.918	6.350
Dec	29	6.80	26.80	33.60	29.7931	1.62831	2.651	.610	.476
Avrg	29	1.90	29.50	31.40	30.5103	.41606	.173	-.069	.484

Source: (Matata et al., 2018 up-coming)

Table 6 Observed climate change influence on hydrology

Influenced hydrology system	Isela		Mwalukwa	
	%	Explanations	%	
Mean river flow below normal	100	If you go to the river at 4am you will get water early at least by 7am you will be at home but if you go there at 7am you will be back at 12noon because you will have to wait for long.	80	There used to be three rivers in the past namely Ng'oho, Kadoto, and Mwajigunya. Presently the then river valleys have been turned into peoples' farms.
		We used to catch lots of fish but no fish is available because there is no water in the rivers		We used to fetch fish in the rivers but since rivers have dried up there is no more fish.
		We had a dam here for our livestock but it has gotten dry and we think it is because of rainfall deficiency.		Because of rivers drying up we decided to construct some dams (locally called Malambo).

Decrease in fresh surface water	91	These years we buy water from Nhelegani (nearby village) because here there is no water, all the two rivers have been dried up. Both rivers are almost dry.	72	Since rivers have dried we have no option other than buying drinking water from Old Shinyanga. If go there you pay Tsh 100 per 20liters; but if someone bring the water from there to this village he/she sells at Tsh 500/- per 20liters. The situation gets worse from August to November because even dams go dry during that period. My 22 years old son will be puzzled if you ask him about rivers in this village because by the time he was born all rivers had already dried off.
Decrease in amount of fresh underground water	72	Water pumps do not give us enough water one has to wait for some time to fill up one bucket but in the past one could fill up drams and drams in a couple of minutes. In the past we drilled very few meters for water last year I had to go drilling more than 100 meters to get water and that coasted me a lot of money.	84	We used to have water in our local water wells throughout the year but these days there is no water at all.
Poor water quality	82	Currently water from local wells is salty while in the past it was fresh, some people get stomach upset when they consume the water. Because of water scarcity we sometimes share water with our livestock including cattle, donkey, goats and sheep. We have to buy water from Nhelegani because water from our local wells are no longer clean enough for domestic use.	76	It is totally dry.
River sedimentation	59	There is no more water in the two rivers we used to have, most parts of the rivers valley have been turn up to horticultural projects.	52	All places that used to be rivers are peoples' farms for now.

Table 7 Climate change influence on soil and terrestrial ecosystem

Perceived influences	Isela		Mwalukwa	
	%	Associated explanations	%	Associated explanations
Soil moisture decrease	82	In most cases rainfall is not sufficient hence soils are dry at times when moisture is required. There is frequent crop failure	88	In the past during wet season one could see soils drizzling water for long, the water is locally called 'jinere", this was very useful for sweet potato production. These days no "jinere" is no longer there; sweet potatoes growing depends on main rain season. (Informant in Mwalukwa) Harvests has been on a decrease trend over the years unless one applies manure or fertilizer.
Change in plant varieties/species and abundance	77	In the past we used to grow such trees as mango trees, pawpaw and plantain; these you cannot see today as weather is not supportive. There were also a lot of wild fruits as ntalali (Vitex mombassae), furu (Vitex doniana) ngubaru, mpelemese, bukoma, and miyuguyu. Today the only remaining wild fruits are baobab trees and tamarind. Some indigenous trees are no longer seen around, but there are trees by the name of miyegeyege, these are new in these village they were brought during the grow more tree campaigns in 1990s the will probably dominate in the area over such local trees as migu in the near future as they seem to do better with the	79	We have almost same tree species but the abundance has decreased significantly because people cut trees for charcoal and the situation is alarming.

		current climate.		
		There is a new weed though no one could name it, it looks similar to one locally called lugobi		
Change in animal abundance and species composition	91	In the past there used to be such wild animals as elephants, giraffes, lions, wild pigs, hyenas, antelopes, rabbits *and one locally called nsogipya* (looks like goats); there also used to be such birds as vulchers and a bird species locally called *makone.* Of all these the only remaining ones are hyenas	87	There used to be vultures, antelopes, monkeys, giraffe, and elephants; these are no longer there today.
Habitat degradation (e.g. desertification)	68	There environment is so degraded through human activities as a result it cannot support most animals and some trees that used to be seen in this village.	60	There are good pastures to support even wild games apart from our livestock.

Table 8 Climate Change influence on agriculture

Perceived influence	%	
	Isela	Mwalukwa
Crop failure due to disrupted crop growing calendar	100	88
Frequent crop failure due to prolonged drought span	100	92
Frequent crop failure due to unpredictable weather	86	100
Decrease in crop productivity due to erratic rains	95	100
Soil degradation related reduced crop productivity	91	96
Crop failure due to increased outbreak of pests and diseases	95	92
Outbreak of non common pests and diseases	77	86
Increased seed prices due to frequent crop failure	82	68
Decrease in farm wages due to poor economic status	77	44
Low purchasing power for farm implements due frequent crop failure	72	52

The influence of climate change on migration drivers

Climate change and the bio-geophysical environment

a) Hydrology

Most respondents were of the opinion that mean river flow has significantly decreased, fresh surface water and fresh underground water was not available; poor water quality; rivers bank sedimentation and mean river flow below normal. Table 6 presents a summary of findings from household survey as well as key informants verbatim quotes explaining perceptions on ways in which respective hydrology system has changed due to climate change. There are two rivers in Isela village called Isenegeja and Isela. Loss of fish, time taken to fetch water and buying water from a neighboring village which is connected with running water from Lake Victoria were major indicators supporting the perception that rivers flow were below normal. Likewise decrease in fresh surface water was evidenced by drying up of a dam as well as drying up of both rivers in the village. The perception that underground fresh water was reduced was associated by time taken to fill up a bucket of water from water pumps, key informants were of the opinion that these years it its longer to fill up a bucket than it used to be. As far as water quality was concerned, the current situation is considered to have poor water quality and that was the reason why water has to be purchased from neighboring village. But in addition, people and animals share sources of water was considered to lead into poor water quality. Perceptions that rivers were sedimented were associated with an observation that there is almost no water in the rivers and that valleys that were formerly covered by water are currently turned up for horticulture, in other words if the valleys not sedimented they could not support such horticultural activities.

Soil and terrestrial ecosystem

Perceptions indicate that there is a decrease in soil moisture due to reduced amount of rainfall that translates into crop failure. Climate change is perceived to have caused a change in plant varieties and abundance. Mango trees, pawpaw and plantains are especial tree varieties that are hardly found in the study villages and reason being that climate is no longer supportive on such trees. Some wild fruits which were plenty in the past as they could not get along with current climate, these include ntalali (Vitex mombassae), furu (Vitex doniana) and miyuguyu. New tree species locally named miyegeyege seem to spread in the area and seem to cope well with the current climate; these were introduced in the 1990s under the afforestation national campaign. A new weed was also reported that had never been there in the past; respondents associated it with climate change, it is such a sturbon weed which competes highly on food with crops, it is perceived to highly contribute to crop failure.

Elephants, giraffes, lions, wild pigs, hyenas, antelopes, rabbits and one locally called nsogipya (looks like goats) were common wild animals in the study villages in the past but since late 1980s this has not been the case, these animals can no longer be seen in the study villages. Climate change that is perceived to have reduced forage is associated with the disappearance of such animals although population increase over the years may also have contributed to it. Vulchers and a bird species locally called makone were common birds in the past but are currently rare found. 68% of all respondents associated disappearance of some animal and plant species with environmental degradation caused by warmer temperatures and prolonged drought (Table 7).

Climate change influence on economic systems

Agriculture

Respondents mentioned a number of issues that they perceived to be the impacts of climate on the agricultural system, one being disruption of the crop growing calendar. While for example November used to be the planting time for maize, and weeding in December for the same, today, there is no specific time for crop growing rather it now depends on how

rains will behave in a given year. As a quote from a key informant presented earlier indicates, crop growing may not be done even until after Christmas; that means growing may be as late as December. In Table 8, all respondents (100%) agree that climate change has disrupted the formerly established growing calendar. All respondents (100%) also agreed that they experienced frequent crop failure and that they associated such crop failure with prolonged drought span. Frequent crop failure was also associated with unpredictable weather by most respondents (86%). Climate change has also led to decrease in crop productivity (95%); most key informants however insisted that it is not only decreases in crop production rather total crop failure due to seasonality variability where by erratic rains and unexpected dry spells usually lead to such crop failure. Soil degradation was perceived to be another cause for crop failure by 91% of all respondents. Climate change was also perceived to a major cause for increased outbreak of crop pests and diseases some of which are non common all which lead to crop failure. This year maize failure was associated by a worm locally called somi. The worm was explained not to be new rather its spread this year 2018 has been wider and hazardous on maize. In the past the worm could be combated using local medicines as well as modern farm sprays, this year either of the two could stop the worm from being destructive. Also in the past the worm was much observed in early cultivars but you could not see it in late cultivars but this year the worm had been there throughout the growing season, hence there was no way farmers could get away with it, this had led to massive crop destruction and ultimately crop failure. On the other hand, a new pests was reported to destruct sorghum, no one had the name for the pest even the villages agricultural extension officers could not name it; the reasons for the outbreak of the pest was not known but most informant associated it with climate change. A significant number of respondents as indicated in Table 8 (72%) voted that climate change has led to outbreak of new weeds which in turn led to crop failure. Climate change also has led to increased seed prices, decrease in farm wages and low purchasing power of farm implements (Table 8).

Forest

Climate change was perceived to have led to change in forest cover, reduced forest products and poor forest products quality (Table 9). Key informants divided forest cover change into three phases, first the period prior to 1970s to late 1970s, the second phase is one from late 1980s to 1990s and the third phase is the one from 2000s to date. The phase prior to 1970s was perceived to be the period that had dense forests. The period between 1980s and late 1990s was perceived to be the period where forests had been massively cleared in the course of growing cash crops especially cotton. The last phase i.e. 2000s to date was perceived to be the period of recovery where the number of trees has been increasing gradually. However, most trees today are not from natural regeneration rather planted ones; they are also mostly not indigenous rather newly introduced exotic trees among them are miyegeyege and lucina. Some of the forest products that were perceived to have been decrease included wild fruits (as described in the previous section), medicinal plants, bee products and fodder.

Pastoralism and fishing

Decrease in pasture was perceived a problem where fodder was perceived diminished significantly. Among major reasons for such fodder decrease was mentioned to be prolonged drought and reduced wet season. Due to prolonged drought cattle herders from neighbouring villages especially those with large number of cattle such as Masengwa run out of pastures completely hence they moved in the study village (Isela) where they rented portions of land for fodder, with time fodder was also diminished in Isela village. Pasture shortage in Mwalukwa village on the other hand is caused by large number of livestock within the village; most households are livestock keepers especially cattle, sheep and goats and poultry unlike Isela where most households are engaged in crop farming only. due to shortage in pasture in Mwalukwa village every cattle keeper has their own areas dedicated for cattle rearing; at times every cattle keeper has to pay for pastures in a piece of land for a specific period. One informant explained he had to pay a total of Tsh 1,3000,000/- to feed 200 cattle for a period June -November (six months). When asked that amount of money could cost him an equivalent of how many cattle he said 6cattle meaning each cattle could be sold at approximately 217,000/- (that is approximately $ 99/-).

Climate change was also perceived to be a major reason for a decrease in livestock productivity where milk is very scarce and most households cannot afford milk in their daily food intake unlike in previous years where milk was plenty. In Mwalukwa village, it was explained that in previous years milk could be offered for free to any passerby who could complain to be thirst but today, especially during dry season, even with cattle keeping households milk is being kept aside to be served to only children especially the under 5s simply because there is no sufficient milk to feed entire family. In dry season, livestock tend to lose weight significantly and in some years livestock have been dying in large numbers due to lack of pasture; during such incidents both livestock and associated products such as meat and milk tend to be scarce and of low quality. Outbreak of uncommon livestock diseases was reported to affect livestock adversely. Periods with excessive wetter conditions as what has happened this year has led to deaths of livestock especially cattle.

As mentioned in earlier sections, climate change was perceived to cause rivers drying up and hence disappearance of fish. In previous years, fishing was considered another significant economic activity in the two villages where fish was fished for domestic consumption as well as for selling. Catfish were common fishes available in the rivers and was plenty especially for the period prior to late 1990s, the situation has been worse from 2000s to date in both villages. Today catfishes are not available at all in such rivers; most households have to buy fish from Shinyanga town whenever need arise. Table 10 summarizes findings on the influence of climate change on pastoralism and fishing systems where all aspects under scrutiny were voted for by over 70% of all respondents which indicates highest levels of agreement that climate change influences respective aspects.

The influence of climate change on social system

Findings from both household survey and interview with key informants indicate that, food social system was severely impacted by climate change (Table 11). There had been food shortage for the last twelve years (2007-218), however, the situation has been even worse during the last five years (2014-2018). Food shortage had been associated with erratic rains, prolonged drought, unpredictable seasonality and outbreak of pests and diseases. One key informant had the following to explain:

Food shortage has been a problem for long time now I can say more than ten years now food has been food shortage and that has been due to frequent crop failure particularly due to unpredictable weather and diseases. One evidence that food had been a problem is that the government have been sending us some assistance. In most cases the assistance has been 10kg per person; we were given that for 300Tsh but poor families were given that for free. The problem has been crops

Table 9 The influence of climate change on forestry

Perceived influence	%	
	Isela	Mwalukwa
Forest cover change	95	96
Decrease in forest products	100	92
Decrease in forest products quality	91	92
Increased frequency in forest fires	5	4

Table 10 The influence of climate change on pastoral and fishing systems

Perceived influence	%	
	Isela	Mwalukwa
Decrease in pasture	95	88
Decrease in livestock productivity	95	84
Increased livestock disease	91	88
Low livestock quality	73	80
Increased incidents of livestock deaths	77	84
Fish stock decline	95	96

Table 11 The influence of climate change on social system

Social systems	Observed Influence	%	
		Isela	Mwalukwa
Food	Food shortage	95	100
	Hunger	91	96
	Increased food price	86	60
	Increased incidents of malnutrition	68	32
Shelter	House damage/destruction	82	52
	Domestic property damage/loss	82	52
Health	Incapable of paying for health facilities	55	12
	Diseases	59	60
Infrastructure	Dam breakage due to overflowing	64	72

Table 12 Maize price over years for January

Year	Price/20kg	
	(Tsh)Isela	Mwalukwa
2012	14,000	12,000
2013	12,000	13,000
2014	21,000	18,000
2015	7,000	8,000
2016	9,500	9,000
2017	22,000	22,000
2018	20,000	18,000

Source: Established during field survey 2018

Table 13 Climate change Influences on demographic and political systems

Demographic system	Perceived influence	%	
		Isela	*Mwalukwa*
	Population size decrease	68	52
	Population structure change	64	80
	Disease prevalence increased	59	72
	Increased mortality rate	23	28
Political system	Governance control of freedom to adapt to changes	55	24
	Persecution	27	24
	Direct coercion	18	22

Table 14 Reasons for migration

Reasons	Isela	Mwalukwa
	%	%
Food shortage	100	100
Lack of pastures	77	100
Frequent drought spells	100	100
Frequent crop failure	100	100
Search for fertile land	95	100
Search for casual labour in other villages	77	64
Outbreak of diseases	27	20
Search for job in urban areas	77	56
Search for education	14	12
Better life in cities	14	24
Family issues	36	13
Poor communication network	0	8

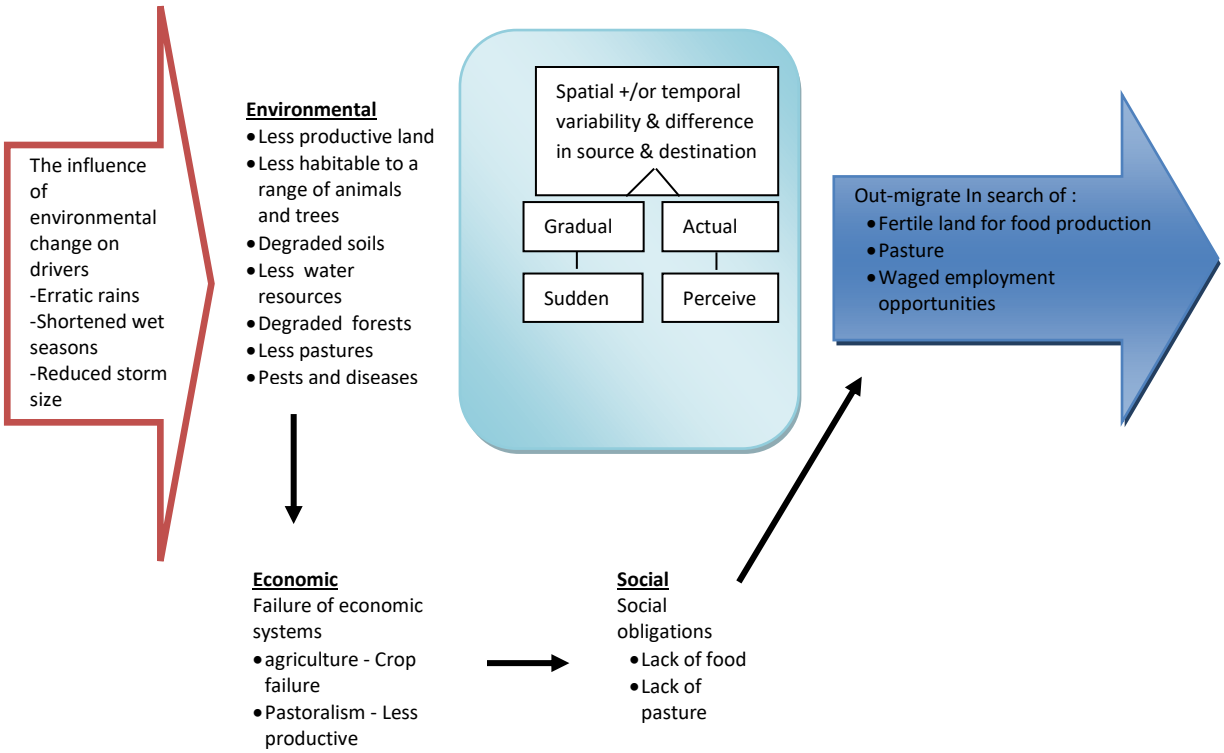

Figure 3 Revisited Conceptual framework: The influence of environmental change on migration 'drivers'
Source: Modified from A Foresight: Migration and Global Environmental Change (2011)

cultivate early fail due to unexpected dry spells; crops that are cultivated late in the season tend to be affected by pests and diseases, worse enough nowadays pesticides are not effective as do not work on pests this has been leading into total crop failure and hence food shortage every year (informant from Isela village).

Increased food price was reported to be a problem for many years and that that had contributed to food shortage and hunger in most cases. Table 9 shows that 86% of all respondents were in agreement with the observation that climate change had contributed to the increase in food price. Table 12 presents maize price (January price) since 2012 (the longest respondents could recall) to 2018. Usually January experiences food highest price especially for maize and rice, the major staples in the study areas. Cleary the price has been high throughout given the fact that most rural Tanzanians live at less than $1 per day. An average household size in the study area is 6people , this can consume up to 4kg of maize flour for two meals a day, this being the case every 5days such a household had to part away with 22,000 ($10) in year 2017 for example, which is on higher side. It is worth noting here that in some years the Government of Tanzania banned selling food crops outside the country, although that had multiple implications especially on local farmers income yet during field survey most informant commended the action arguing that if the Government could not take such action likely a good number of people would had died of hunger especially in year 2017. The findings also indicates an increase of cases of malnutrition in the study area partly due to the effects of climate change which has been causing crop failure and food shortage over years.

Year 2017 was specifically recalled to have had too windy weather which leads to removing roofs for a good number of houses in both Isela and Mwalukwa villages. Year 2018 on the other hand was cited to be too wetter that had lead to demolition of up to 50 houses in Isela village. In both incidences, apart from house damage also different households' property damages were experienced including furniture, kitchen utensils, mattresses and clothing. Dam breakage was reported in Isela village by 64% of all respondents (Table 11).

Climate change has affected peoples economy in the sense that reduced crop and animal production has translated into households failing to meet costs for such social services as health. Table 11 shows that 55% of all respondents were incapable of meeting costs of health. Also 59% of all respondents were in support of the assertion that climate change has led into outbreak of some diseases. Stomach upsets due to consumption of unsafe water especially salty ones was commonly reported by different informants in both villages of study.

Climate change Influences on demographic and political systems

Climate change has impacted population size in the study area as the number of people is diminishing due to outmigration. There is also population structure change where more young men are moving to other places in search for better jobs especially in urban centres leaving behind elders and children. Diseases prevalence was also mentioned to be one of the impacts of climate change; stomach ache was the most common cited kind of diseases. Much as people would like to move into other areas but they had to seek for clearance from places of origin so that their landing in destinations would be smooth.

Climate change and migration

In both villages records show significant outmigration. In Isela village the period 2013 to 2017 experience outmigration of 300 people in 50 households. In Mwalukwa migration is on higher number compared to Isela. It was estimated that between 2013 and 2017 a total of 200 families had out-migrated; in year 2017 alone 50 households moved out of the village. Following this records the study inquired for reasons for such migration; findings are summarized in Table 14. In both villages food shortage, frequent drought spell and frequent crop failure were voted to be reasons for outmigration. In Isela the other reasons that were voted to be reasons for outmigration by 100% were lack of fodder, and search for more fertile land. In Isela village search for more fertile land was voted by 95%. The findings show a significant difference on lack of fodder as a reason for outmigration between the two villages. While Isela indicates a vote of agreement by 77% Mwalukwa on the other hand voted it by 100%. However, possible explanations for this would be the fact that crop cultivation is dominant in Isela, less people keeps livestock while in Mwalukwa both crop cultivation and livestock keeping weigh almost same. Also in Mwalukwa there are large number of livestock i.e. cattle, goats and sheep than the case is in Isela village; this may mean the competition for pasture is stiff in Mwakwa that the situation is in Isela. But all in all the factor remains to be an important factor for outmigration in both villages. There is a notable difference on search for job in urban areas between Isela and Mwaluka villages; while Isela voted it by 77%, in Mwalukwa same was voted by 56%. Again the possible reason for this difference would the fact that Isela is located closer to Shinyanga municipal compared to Mwalukwa hence people in Isela has more access to the township than the case is for people in Mwalukwa village. But again, given the number of votes in each village, the factor seems to be important for outmigration in for both villages. Outbreak of diseases, Search for education, better life in cities, family issues, poor communication network were voted by less than 30% of all respondents in either villages meaning that the factors are less important as far as outmigration is concerned.

DISCUSSION

Climate change influences migration in the study villages in that it triggers conditions that affect migration decision. There are two major livelihood systems that seem to be impacted by climate change, these are crop cultivation and pastoralism. Climate change is demonstrated through frequent drought, prolonged drought spells, poorly distributed rains, unpredictable seasonality, reduced storm size, reduced water resources and increasing warmer conditions; all of which contributes in disrupting the formerly well established crop growing calendar hence frequent crop failure.

Higher temperatures in the study area can increase evapo-transpiration that in turn can have an effect on surface and underground water and moisture for plants. Hence, the argument by respondents is that outmigration a response to frequent crop failure and lack of pasture is justifiable. Reduced water resources, lack of pasture (which implies poor livestock productivity) and crop failure, for example, suggests a failing/failed economic system (i.e. agricultural livelihood system failure). A failing economic system will obviously affect the respective social system meaning that households will fail to provide for the basic needs including food hence a decision to out-migrate. Search for more fertile land emphasizes the observation that people move out of the two villages due to crop failure and hence food shortage. Kangalawe and Lyimo (2013) found similar results where they noted that the major cause for a decline in crop production in Shinyanga rural was drought. Search for causal labour in other neighbouring villages and search for jobs in towns on the other hand stamps failure of the existing economic system and hence the impacts on the social system as demonstrated through lack of food. Same applies for the second livelihood system i.e. pastoralism. Climate change has led into a trend where wet season has been shortened and dry spell has been prolonged; climate change has also led into reduced storm size. Both prolonged dry spells and reduced storm size have contributed into lack of pastures and water shortage; both conditions are not favourable for pastoralism as they negatively affects production in the sector. Lack of pasture and water may lead to mean reduced production and productivity in the sector. Reduced production in pastoralism definitely affects pastoralists' households' economies; such families are likely to find it difficult to provide for the social needs including food as this study has revealed. Therefore, although the identified reasons for outmigration in the study area may seem to be more of social-economic nature, the truth is that, to a great extent all of them have their roots in climate change.

The disappearances of some animals and plants have likely aggravated lack of food. Wild pigs, rabbits, antelopes and impalas are some of the animals that could otherwise back-up households at times where crop failure is severe. Wild fruits and other forestry products are good sources of food and they supplement households especially where harvests turn to be poor in a given season, hence their disappearance exacerbates food shortage. The environment is no longer supportive to such trees as mango and pawpaw trees which could otherwise add on the little available food. Likewise plantain which was grown in the past could support households especially because plantains are a perennial crop. Fish is no longer available in due to drying up of the rivers; this also is likely adding on food shortage in the study area.

Revisiting the applicability of the analytical framework by Foresight: Migration and Global Environmental Change (2011), (Figure

3), it may be noted that the influence of climate change on migration drivers starts with impacts on the environment, the impacted environment then impacts the economic system which then affects the social systems, the affected social system finally influences reasons why people move out of the study area. The environmental, economic and social system makes up three out of the five “drivers" of migration identified by Foresight (2011). The remaining two, i.e. demographic and political systems could not feature out very clearly in this study; this means the two are less important factors for migration in the study area as far the framework is concerned. Climate change leads to both gradual and sudden systems changes (i.e. environmental, economic and social systems) changes that form the spatial and temporal variability and differences in source and destination (although this study did not focus on destinations, however the assumption is that, at times where the environment is not supportive, people would always move to better places; the "none supportiveness" and "supportiveness" forms the differences between the source and the destination temporary and spatially. Gradual changes manifests through land degradation, forestry degradation, habitats degradation, reduced plants and animals’ species as well as diminishing water resources. The changes are also both perceived and actual since findings from perceptions, observations and documentations were triangulated to established the noted findings.

CONCLUSIONS AND RECOMMENDATIONS

Climate change has influence on migration drivers in the study area. The gradual changes are turning the environment unsupportive to livelihoods hence creating an ecosystem which is less suitable for human settlements. These calls for government intervention to support communities in affected areas adapt sustainably. Food relief programmes should be prioritized to save lives at times where crop failure is rampant. Agricultural transformation from rain fed crop farming, for example, to irrigation agriculture should be considered. Rainwater harvesting through different approaches including dam construction s should be prioritized. Modernisation of livestock keeping should also be promoted to strike a balance between livestock herds and available resources within the ecosystem. In line with Matata *et al.*, (2018 up-coming), district authorities should support crop and livestock adjustments in buffering from the impacts of rainfall and temperature variability. An assessment of the implications of immigrations in destinations socially, economically and environmentally is crucial. The role of intervening factors as presented by Foresight: Migration and Global Environmental Change (2011) are yet to be explored. However, exploring such roles of for example gender, age, level of education, wealth, marital status, ethnicity and religion may inform policies for improvement; same applies to intervening obstacles and facilitators as political/legal framework, cost of moving, social networks, diasporic links, recruitment agencies and technology.

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