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### Sustainable Integrative Framework for Biodiversity Conservation and Pastoralists' Resilience to Impact of Climate Change in Northern Tanzania Rangelands.

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**Keywords:**  
*SIBCPRF,*  
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*Resilience,*  
*Adaptation,*  
*Biodiversity,*  
*Conservation,*  
*Climate Change.*

This study aimed at developing a sustainable integrative framework for biodiversity conservation and pastoralists' resilience to impacts of climate change (SIBCPRF) The SIBCPRF was developed after assessing the impacts with a high rate on the pastoralists in northern Tanzania rangelands. The study used different approaches and methods for data collection: exploration of secondary information, observation, household survey, structured interview and focus group discussion. The sample included 312 respondents. The study revealed that climate change has impacted the biodiversity and pastoralists' livelihoods in many ways like shortage of water, death of livestock, the rise of conflicts, and migration. In turn, the study discovered that the pastoralists have been adapting and resilient to the impact of climate change by adopting various strategies like control of animal reproduction, use of by-laws, use of ingaron system (enclosure of a place for some time), and migration from one place to another with livestock for the search of pasture and water. However, the strategy seems to have shortcomings such as to cause of conflict with neighbours, farmers, separation of families, and death of livestock due to a long walk distance. The study concludes that it is important for the pastoralists' communities to resilient and adapt to impacts of climate change so as to conserve the biodiversity and for their well-being. This can only be done if there is a clear tool guiding them on how to sustainably resilient and adapt. It is from this perspective the SIBCPRF was developed to properly address the highest-rated impacts of climate change during dry seasons. The SIBCPRF to climate change developed considered Ecosystem-based Approach (EbA), Impact Specific Approach (ISA), and the Enclosure System (ES). The formulation of SIBCPRF assumes that it is the role of each community to address climate change risks by implementing the appropriate strategies and plans provided to them (pastoralists).

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## INTRODUCTION

Climate<sup>1</sup> is a fundamental facet of the continued existence of flora and fauna. The change of its distinctiveness in stipulations of temperature increase and rainfall deficiency may result in disquieting of the complete ecosystem. Over the last century, the global average temperatures have risen by 0.7°C and are predicted to continue rising. The Intergovernmental Panel on Climate Change (IPCC) predicts that temperatures are expected to rise by 1.1 – 6.4°C by the end of the twenty-first century relative to the 1980–1999 baselines (IPCC, 2013). Global average precipitations have increased by 2% in the last 100 years and are likely to increase in future (IPCC, 2013). The change in these climate parameters as resulted to climate change<sup>2</sup> which its' impact is currently affecting the biodiversity and human well-being especially to those who are a straight line depending on the natural setting for their livelihoods. The wellbeing of people such as pastoralists and hunter-gatherers are apparent to be pretentious greatly. This is due to the fact that climate change is one of the utmost problems of all nations across the world being developed or developing countries both are experiencing the trimmer resulted from the changing characteristics of prominent climate. The evidence is now

devastatingly persuading that climate change is obvious and takes place at an unparalleled rate (Bellard, 2012). Climate change impacts are severely affecting arid and semi-arid rangelands of the African continent as well as of other contents in the world (Galvin et al., 2001). Many of these impacts of climate change in arid and semi-arid rangelands are characterized by inconsistency in rainfall patterns and tremendous weather events such as persistent droughts, floods, and blustery weather storms (IPCC, 2013).

Climate change is both a cause and an effect of biodiversity and ecosystem change in Africa (Thomas et al., 2004). Along with anthropogenic stressors, the multiple components of climate change are anticipated to be the main drivers of biodiversity at all levels (Parmesan, 2006). Loss of biodiversity due to climate change have directly or indirectly changed the pattern and dynamics of energy flow and material circulation (Zhong & Wang, 2017), which greatly impacts on the ecosystem and ecosystem service.

Tanzania like other countries in the Africa is experiencing various impacts of climate change in all sectors of the economy, including livestock production (Sangeda & Malole, 2013; Kimaro et al.,

<sup>1</sup> Is a long-term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years (Waugh, 2010)

<sup>2</sup> It refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate Change may be due to natural processes or external forcing or to persistent anthropogenic changes in

the composition of the atmosphere or in land-use. This means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (IUCN, 2011).

2018). For instance, a mean annual increase of temperature of 1.0 °C was recorded since 1960 with decreasing rainfall at an average of 2.8 mm per month (TCAR, 2016; Magita & Sangeda, 2017). According to climate models for Tanzania, the climate change forecast show that the country's temperature is expected to increase by 3-5 °C by 2017 (VPO, 2003). Nonetheless, the effects of climate change are already devastating rural livelihoods across the various regions of Tanzania (Sangeda & Malole, 2013; Magita & Sangeda, 2017; URT 2007; Joseph & Kaswamila, 2017; Kimaro et al., 2018).

In this context, there is loss of biodiversity and domestic animals which are the innermost part of the livelihoods of the pastoralists<sup>3</sup> as they depend mainly on it for their livelihood either through direct use of domestic animal products or through the exchange of it in the local and intercontinental markets. With current climate changes and their effects, herders are required to transform the way of living and accept other strategies like livelihood diversification and migration with livestock for search of pastures for them to continue existing (Joseph & Kaswamila, 2017).

In Tanzania, for the last 30 years, climate change has negatively impacted pastoralists' livelihoods resulting poor health of livestock and decline of livestock production (Andrew, 2009; Joseph et al., 2017). Furthermore, climate change and its associated implications (e.g., floods, rainfall, temperature changes etc.) threatens and continues to threaten natural resources upon which many pastoralists depend for their survival, leading to loss of livestock, shortage of water, drying of crops and poverty (Joseph, 2011).

According to the National Environmental Action Plan (NEAP, 2013) droughts have a major impact on the environment and the lives of both human being and to other living organisms. For instance, the drought that occurred in 1993 affected 282,053 people in Arusha, Kilimanjaro, Kagera, and Kigoma regions in terms of the decline in crop yields and livestock loss (Joseph et al., 2017). Another acute

drought occurred in 1996 in 14 regions where about 3.9 million people were affected. This was followed by a severe drought that occurred in 1999 affecting 17 regions. Another severe drought also occurred between 2009-2010 which killed a total of 316,437 cattle, 236,359 goats and 92,640 sheep in Arusha region (Joseph, 2016).

Due to such devastations caused by climate change impact, various interventions such as providing climate change-related education, an appropriate framework for resilience and adaptation; and substantive measures to build adaptive capacity to the pastoralists' communities in northern Tanzania become essential. It is from this circumstance, the study sought it is important to find out the solution to the existing problems caused by climate change upon the biodiversity and pastoralists' communities in northern Tanzania rangelands by developing a sustainable integrative framework that can assist the pastoral community around the world to minimize the extreme of impacts in their livelihoods as well as of those of nearby biodiversity. The formulation and development of the sustainable integrative framework for biodiversity conservation and pastoralists' resilience and adaptation to the impact of climate change specifically during drought seasons to balance the capacity of the worlds' ecosystems which provide essential services to human communities become imperative.

## MATERIALS AND METHODS

### The Study Area

Longido District (7782 km<sup>2</sup>) which is administratively in Arusha region lies at an altitude of between 600 and 2,900 m above sea level. It is located between Latitude 2°20" and 3°10" South of the Equator and Longitude 36°00" and 37°30" East of Greenwich. It is bordered by Meru and Rombo Districts to the East, Ngorongoro to the West, Monduli and Arusha Districts to the South and Siha District to the South East. The district stretches from the western slopes of Mount Kilimanjaro in the East to Lake Natron in the West. Out of the total District

<sup>3</sup> Pastoralism is the branch of agriculture concerned with the raising of livestock. It is animal husbandry: the care, tending and use of animals such as camels, goats, cattle, yaks, llamas, and sheep. "Pastoralism" generally has a mobile aspect, moving the herds in search of fresh

pasture and water. Pastoralism is a successful strategy to support a population on less productive land, and adapts well to the environment (Waugh, 2010).

land area, 82.14% is grazing land, 13.6% is arable land and 4.7% is forest land (LDP, 2015).

Four villages namely, Sinya, Engikaret, Keserian, and Mairowa were involved in the study (Fig. 1). The study area is predominantly occupied by the pastoral Maasai community. The vegetation in the area can be described as mixed forest, bush lands, and grass lands (LDP, 2015). Agro-ecologically, the district has two distinct agroecological zones—highlands and low lands. The highland zone is characterized by a number of isolated mountains with an average altitude of 2000 m above sea level. It has mainly deep, freely drained loamy soils with natural fertility status. It is occupied by forests on top of hills. Major economic activities in this zone are livestock keeping and agro–pastoralists, where livestock keeping is practiced on a moderately large scale (LDP, 2015). The low zone is characterized by flat and rolling plains with altitude ranging from 600 m to 1,200 m above sea level. It has mainly deep, freely drained loamy soils with natural fertility status. It is occupied by forest on top of hills.

The major economic activities are extensive livestock keeping and tourism. Livestock keeping in this zone is practiced on a large scale; it includes cattle, goats, sheep, donkeys, and camels (on a small scale) (LDP, 2015). The district is one among the driest areas in Tanzania with temperature ranges from 20 °C – 35 °C. Rainfall ranges from less than 500 mm in low lands to 900 mm in high altitude. From year 2007, the district has been experiencing prolonged dry seasons.

### Data Collection Methods

Data were gathered through a questionnaire survey, Focus Group Discussion, key informant interviews, and field visits. This combination of the methods and techniques was used to evaluate data from different perspectives and to increase data validity and reliability.

The questionnaires consisted of both closed and open-ended questions. An open-ended question gives respondents' room to air their views without being influenced by the researcher. On other hand, closed-ended questions give respondents an option to choose within the predetermined range (Saunders et al, 2003). Such kinds of questions are good in collecting quantitative data, and hence they simplify

data analysis. The aspects included in the questionnaire were impacts of climate change on biodiversity and pastoral communities and pastoralists resilience strategies. Before household questionnaires were administered, the following major steps were followed: pre-testing for testing the questionnaire wording, sequencing, and layout; training of research assistants; and selection of sample frame. In each study village, 55 households were sampled from the village register using a simple random sampling method. Respondent (18 years of age and above) from each household was picked using a table of random numbers following the procedure described by Bouma (2000). A total of 220 responded to the questionnaire.

The key informant interview was conducted using interview guides. Purposive sampling was used to obtain Eight Village Extension Officers (two extension officers from each of the four villages selected for the study) and four District officers (two environmental officers and two District livestock officers) who were involved in key informants' interviews. The purposeful sampling was opted against other types of sampling due to the fact that purposeful sampling is a technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources (Patton, 2002). This involves identifying and selecting individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest (Cresswell & Clark, 2011). Therefore, a total of 12 key informants formed a sample of this study. Aspects covered during the interview were major climatic change impacts on biodiversity and pastoral communities' livelihoods, resilience strategies among the pastoral communities to the impacts of climate change and strategies to conserve the biodiversity in the changing climate.

The study also used focus groups discussion methods. Focus group discussion was employed to gain an in-depth understanding of social issues. The method aims to obtain data from a purposely selected group of individuals rather than from a statistically representative sample of a broader population. In this study the focus group discussion involved gathering people from similar backgrounds and experiences together to discuss the



following topics i) impacts of climate change on biodiversity and on pastoralists, ii) appropriate conservation and resilience strategies.

Direct field visits and observations were also used in this study. Field observation becomes a scientific tool and the method of data collection for the researcher, when it serves a formulated research purpose, is systematically planned, and recorded and is subjected to checks and controls on validity and reliability (Babbie, 2010). There are several merits of observation as a type of data collection method were; - (i) the researcher was able to record the natural behaviour of the group after the impact of climate change, (ii) the researcher gathered information that could not easily be obtained if he observes in a disinterested fashion; and (iii) the researcher was able to verify the truth of statements made by informants in the context of a questionnaire.

The observation method enabled a researcher to systematically select, watch, listen, read, touch, and record the behaviour of biodiversity and pastoralists impacted by the climate of living beings and objects. Through field study, the author was able to observe the effects of climate change impacts on biodiversity and at the same time meet people (local households) who have been affected by climatic change.

### Data Analysis

Data was collected using questionnaires which entailed both qualitative and quantitative attributes; while on other hand, interview; and focus group discussion methods both had qualitative attributes. Therefore, the nature of the data necessitated the use of qualitative and quantitative data analysis techniques. In this perspective, both qualitative and quantitative information were analysed separately to complement and supplement each other. For example, the qualitative data collected from Focused Group Discussions were analysed based on themes and content which covered objectives. The themes were classified whereby every answer was patterned in relation to themes. For Key Informant interviews, data was analysed through themes and content analyses. Subsequently, quantitative data were collected through questionnaires, and were analysed through a statistical analysis where data

were edited, coded, summarized, and analysed using the Statistical Package for Social Sciences (SPSS) version 16.

## RESULTS AND DISCUSSION

### Climate Change Impacts on Pastoralists

The field results indicate that the climate change have, in turn, led to various impacts such as loss of pasture, emergency of diseases, death of livestock, loss of income, shortage of water for livestock, resource use conflicts and emergency of some undesirable plant species which are poisonous to livestock. Mahonge *et al.*, (2014) revealed that in 2009 drought ravaged much of northern Tanzania regions, killing tens of thousands of livestock and left many families devastated and reduced to impoverished families struggling to survive. Jan and Anja, (2007), on other hand, state that changing wind patterns could affect the spread of certain pathogens and vectors, particularly the infective spores of anthrax and blackleg, the wind-borne paste despite's ruminants and dermatophilosis.

During FGD one woman at Kiserian village (who preferred anonymity) had this to say on family separation

*“Climate change has left us distressed; it is a cause for our husbands to migrate and leave us and we are normally not sure of their coming back. They leave us with children who need food and milk but unfortunately, during drought, the situation turns sour due to unavailability or rocketing prices. All these things are not found and if they are found their prices are very high. Indeed, during drought period, the price of food is very high difficult for us to afford as we are poor. It is a tragedy that I do not want to remember, it was a worse calamity ever seen before”.*

Through focus group discussion it was observed that decrease of pasture affected livestock's health and later caused death to livestock. Despite the climate change being the cause for disappearance of pasture, discussants revealed other aspects associated with loss and /or decrease of pasture. These were overstocking, bush encroachment and expansion of agricultural activities into rangelands and the emergence of *Ipomoea hildebrandit* plant

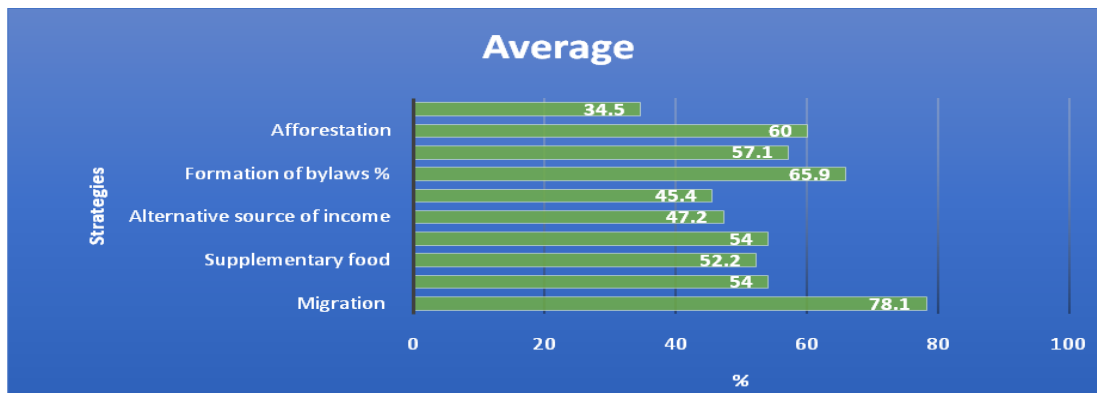
species (*ndelemeti*) which is argued by pastoralists as the cause of the disappearance of pasture. This plant species is believed to be poisonous to livestock

### Resilience Strategies

The results revealed several resilience and adaptive strategies are used by pastoralists in the study area. Overall, the primary adaptive strategy, in the order of importance, were migration to distant areas 78%, use of bylaws and forestation 65.9% (See *Figure 1*).

Other strategies include forest conservation 57.1%, dam construction 54%, income savings 47.2%, and use of supplementary foods 52.2%, income savings 54%, looking for alternative sources of income 47.2%, traditional climate forecast and involvement in poultry production. At the village level, it was evident that *migration* is still the central resilience and adaptive strategy to climate change used by villagers, except for Mairowa, in which they mainly use bylaws.

**Figure 1: Strategies employed by Pastoralists**



\*= Multiple responses

The findings indicate that the preferred adaptive strategy by pastoralists is to migrate to other places when water sources are depleted, and pastures are not enough to sustain their livestock in their areas. Households' interviewees, focus group discussants and critical informants revealed that since 1994 mobility has increased compared to the previous decades back. It was noted that since 1994 there had been an increase in erratic rainfalls, which support the growth of forage and thus create a shortage of water. The respondents pointed out that mobility is now done twice a year.

The pastoralists' migration can be classified into two categories; internal migration (that is done within the country) and external one (a migration that goes beyond the country's borders). Both migrations can be practised by an individual pastoralist or a group of pastoralists. Internally, pastoralists from Longido District usually migrate to Morogoro, Manyara, Tanga, Arusha and Kilimanjaro regions (See Table 1). Beyond the country's borders, the destination is Kenya which is presumed by pastoralists as being not very far, and it provides forage and water during critical dry periods. During migration, at some times, pastoralists hire Lorries instead of walking; this is the standard means of mobility.

**Table 1: Pastoralists Direction of Mobility**

S/N	Villages	Place of Destination during Mobility
1	Maira	Kenya, Ngorongoro, Babati, Monduri
2	Keseria	Kenya, Simanjiro, Meru, Monduri, Ngorongoro, Babati, Ngorongoro,
3	Engakareti	Ngorogoro, Morogoro, Monduli, Kenya
4	Sinya	Kenya, Tanga, West Kilimanjaro

The study also noted that the mainly used adaptive strategy is migration. However, several shortcomings are attributed to it. Migration has been a source of conflicts with neighbourhood villages, farmers, and the separation of families. Moreover, livestock deaths due to walking a very long distance (40km >) are evident. These shortcomings necessitate the development of the Sustainable Integrative Biodiversity Conservation and Pastoralist Resilience Framework (SIBCPRF) to overcome the problems imposed by climate change. The SIBCPRF allows the pastoralists to adapt to climate change without moving from their original places, avoiding conflicts, the death of livestock, and the movement of animals and pastoralists to farther distances.

#### **DEVELOPMENT OF SUSTAINABLE INTEGRATIVE BIODIVERSITY CONSERVATION AND PASTORALIST RESILIENCE FRAMEWORK (SIBCPRF)**

The SIBCPRF is entailed with different subsections as follows; overview of SIBCPRF, the premises of SIBCPRF (rationalization, approaches, and specificity), assumptions for SIBCPRF, the composition of the actors to implement the SIBCPRF, framework and its implementation, monitoring, and evaluation and lastly, sustainability phase.

##### **The Overview of SIBCPRF**

One of the specific objectives of this study was to come up with an integrative resilience and adaptation framework for the sustainability of biodiversity and pastoralists to climate change impacts. As such, the Sustainable Integrative Biodiversity Conservation and Pastoralist Resilience Framework (SIBCPRF) is anticipated. In this regards the SIBCPRF to climate change impacts is developed to enable pastoralists to withstand the effects while conserving the biodiversity and residing in their original places.

The SIBCPRF is the *impact-specific* stratagem as it concentrates on only those impacts imposed by climate change during drought seasons like shortage of water, pasture, and unexpected migration with herds. In this context, the SIBCPRF will help the pastoralists to understand how to conserve the

biodiversity and obtain all the necessities affected during drought seasons like pasture, water, and veterinary services, protecting their families while domesticating their livestock, and avoid unnecessary conflicts that emerge during migration caused by prolonged drought.

According to Folke et al. (2010), effective climate change adaptation will take place first and foremost locally in villages, wards, divisions, districts, and regions and at the national level supported by coordinated decision making on how to conserve biodiversity and pastoralist resilience. This pinpoint those changes start from a single person and later it is spread to the entire society. To resilience and adapt to climate change, impact must start at a local level then later to the entire world.

The capacity to resilience, mitigate, the cope is most limited, and thus sensitivity is high, where the flexibility of individuals to cope is proscribed livelihoods and the economy is based on a narrow range of assets that are easily damaged by climate hazards, with few alternate options or means of managing risk (Smith & Barchiesi, 2009; Nelson et al., 2007). Vulnerability is, therefore, especially high for the deprived in those 'hot spots' where impacts of climate change exacerbate exposure to climatic hazards such as floods and drought (Smith & Barchiesi, 2009). If vulnerability is a combination of exposure and sensitivity, then reducing vulnerability requires actions that will: - i) reduce exposure to hazards, ii) reduce sensitivity to their effects, and iii) build capacity to conserve resilience and adapt.

The latter attribute, building conservation strategies, resilience and adaptive capacity enables communities especially the pastoralists communities in northern Tanzania rangelands to mobilize the decisions and resources needed to reduce vulnerability and adapt to climate change (Nelson et al., 2007). Building a sustainable integrative framework to enable adaptive capacity means intensifying the attributes including the availability of information and skills, access to technologies, access to economic resources, and the effectiveness of institutions (Munasinghe & Swart, 2005).

## The Premises of SIBCPRF

### *The Rationalization of SIBCPRF*

The proposed SIBCPRF to climate change impacts has been developed based on the following information: -

- Field results which were obtained from the pastoralists and other stakeholders' views on how to mitigate climate change impacts such as migration to distant areas, use of bylaws and a forestation, forest conservation, dam construction, income savings, use of supplementary foods, income savings, looking for alternative sources of income, traditional climate forecast and involvement in poultry production.
- A thorough review of past literature on the experiences of pastoralists in developing countries and how these communities have been coping with climate change impacts. Examples are Yanda and Mubaya (2011) in *'Managing a changing climate in Africa'*, Mubaya (2010) in *'Farmers' Strategies towards Climate Variability and Change in Zimbabwe and Zambia'*, Ph.D. Thesis by Mahonge et al. (2014), *Policies Issues for Enhancing Pastoralists' Resilience to Climate Variability Versus Reality in Longido District Tanzania*, FAO and OECD(2012) in *'Building Resilience for Adaptation to Climate Change in Agriculture Sector, Workshop Report.'* FAO(1999) in *'A Framework for Analyzing Institutions Incentives in Community Forestry, Forest, Tree and People, Community forestry note number.'* Christensen and Krogman(2012) in *'Social Thresholds and their Translation into Social-Ecological Management Practices.'* AMCEN(2011) in *'Addressing Climate Change Challenges in Africa.'* and Gill et al.(2010) in *'Mitigating Climate Change: The Role Of Domestic Livestock.'*

Other literature sources read were *'Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change'* by CBD (2009), *'Ecosystem-based Adaptation: A natural response to climate change'* by

Colls et al. (2009), and Ecosystem and Livelihoods Adaptation Network ELAN (2012) approach.

- Experience obtained from Maasai traditional adaptation and resilience methods during the research such as Ingaron adaptation approach.
- A review of existing policies and registrations, for instance, the Tanzania Livestock Modernization Initiatives of 2015; National livestock policy of December 2006; Aligning and harmonizing the livestock and land policies of 2011 and livestock and livelihoods in rural Tanzania national panel survey 2012
- Understanding of approaches needed for developing an appropriate and sustainable integrative framework which focuses on restoring the biodiversity and enabling the resilience of the pastoralist (Ecosystem-based Approach (EbA) and Impact specific Approach (ISA) and
- The researcher's expert knowledge about climate change.

### **Approaches Adopted in SIBCPRF**

The SIBCPRF to Climate Change was developed by considering two main approaches namely the Ecosystem Based Adaptation Approach (EbA) and Impact Specific Approach (ISA).

#### ***Ecosystem Based Adaptation Approach***

The EbA is an approach that works with nature to assist vulnerable communities to build the resilience of their ecosystems and livelihoods being threatened by impacts imposed by climate change (See *Figure 2*). This approach generates significant multiple benefits like carbon sequestration and other social, economic, and cultural benefits (ELAN, 2012). Healthy ecosystems and their services provide opportunities for sustainable economic prosperity while providing defence against the negative effects of climate change upon biodiversity and pastoralists (UNEP, 2010).

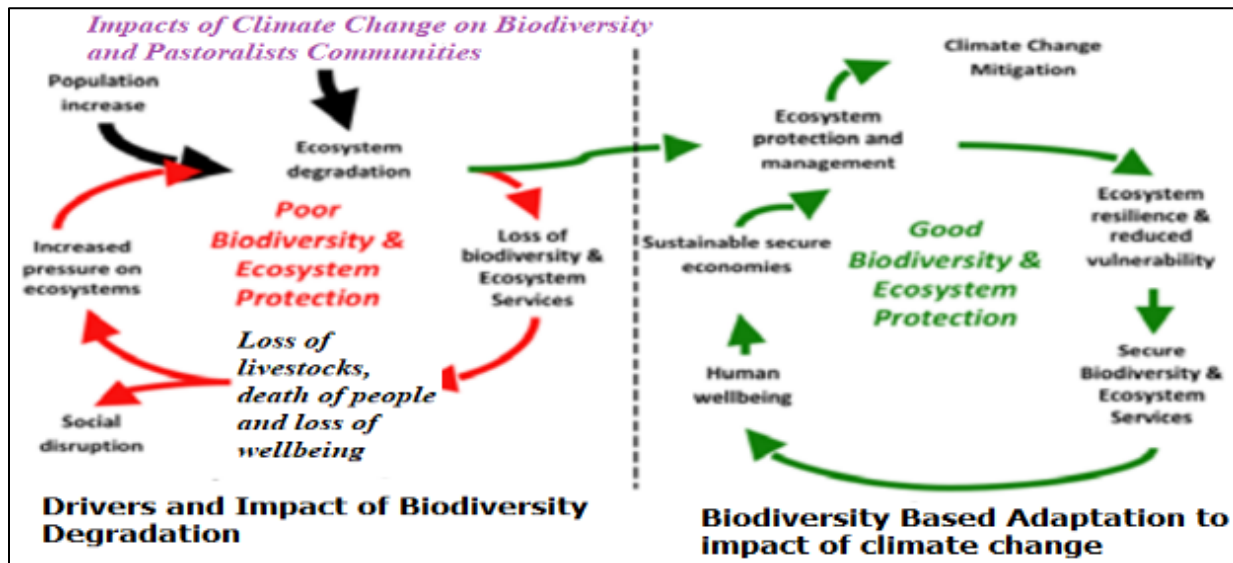
In this perspective, the EbA was considered in this study as it focuses on and promotes the climate change adaptation response of the affected communities. The EbA concentrates on how to



support human wellbeing through sustained biodiversity and ecosystem services provision, and ii) climate change mitigation through ecosystem carbon sequestration capacity (UNEP, 2010). The EbA includes sustainable management, conservation, and restoration of ecosystems as part of an overall adaptation strategy that takes into account the multiple social, economic, and cultural co-benefits for local communities (Colls et al.,

2009; TNC, 2011). It aimed at maintaining ecosystem services by conserving ecosystem structure and functions such as forest restoration, sustainable forest management, wetland restoration, green infrastructure development, forest fire management, integrated water resource management, organic farming, integrated soil, and nutrient management (CBD, 2009; ELAN, 2012; Rajendra et al., 2014).

**Figure 2: The impacts of climate change and how resilience will restore the biodiversity**



Source: Modified to fit the study from UNEP, 2010

**Impact Specific Approach**

The second approach considered in developing the SIBCPRF is that of the Impact Specific Approach (ISA). The ISA approach focused on how to lower vulnerabilities to specific anticipated climate change impacts (CCI). This begins with the assessment of vulnerabilities and rating the risks so as to understand the most severe consequences to be given priority when addressing the climate change impacts. It concentrates on the Actions required to promote the ability of local people to resilience and adapt to these impacts as they are identified. ISA to climate change adaptation is based on the logic of planning on how to resilience and adapt to CCI by the affected communities. Given a set of needs, what actions are needed, and which have the highest priority.

In this context, the ISA approach was considered as it encourages climate change resilience actions by taking logical planning on how to adapt to CCI after a full examination of the major impacts imposed on the affected community. The CCI encourages building resilience for a system. CCI stresses highly adaptive systems promoted by advances in the social and ecological sciences. This knowledge, combined with ‘learning-by-doing led by IUCN in demonstrations of river basin management in Latin America, Africa and Asia, points to practical components of resilience (IUCN, 2011) ecosystems, economics, and social change are all important. Experience suggests then that resilience is built by integrating four components.

According to Folke et al. (2010), climate-resilient communities will thus take impact-specific action for adaptation, but they will also make sure they organise their institutions, infrastructure and

economy in ways that are highly adaptive. As both expected and unexpected impacts of climate change unfold, it is in these locations that development and poverty reduction will most likely continue to progress, as people will have higher capacities to cope with shocks and when necessary, re-adjust and rebuild or transform according to new realities.

The ISA pinpoints that resilience is built by integrating four components as follows: - i) diversity of the economy, livelihoods, and nature (Nelson et al., 2007). This is to say that the biodiversity ensures the availability of ecosystem services needed to buffer climate change impacts; ii) Sustainable infrastructure and technology - portfolios that combine both engineered and 'natural infrastructure', as well as adaptable and sustainable technologies for their management that reduce vulnerabilities (Smith, 2011); iii) self-organization (a critical characteristic of resilient, highly adaptive systems that is implemented in practice through participatory governance and empowerment of people in adaptive institutions; and iv) learning - ensuring that individuals and institutions can use new skills and technologies needed to adapt and make effective use of better climate information and adaptation strategies as they become available (Smith, 2011; Nelson et al., 2007).

### Specificity

The developed Sustainable Integrative Biodiversity Conservation and Pastoralist Resilience Framework (SIBCPRF) is specifically for guiding pastoralists on how to conserve the biodiversity and become adaptive to the impacts of climate change in semi-arid rangelands, especially during prolonged and extreme drought associated with risks such as inadequate pasture, shortage of water and eruption of diseases. This is because a species' adaptive capacity that is, the potential for resistance and resilience to environmental change arises from the flexibility in its ecological relationships. On first consideration, such flexibility with respect to climate is tied to the breadth and shape of physiological response curves such as with respect to interacting thermal, moisture, light, chemical (nutrients, salinity), and other climate-linked environmental conditions. Broad physiological optima will support species resistance; while

species with narrow physiological limits are subject to catastrophic responses (e.g., tropical organisms with little freeze tolerance). In addition, physiological tolerances change with a life stage in many species (Harley et al., 2006). So that vulnerability may be linked to a critical time or may shift among factors during an organism's lifespan.

### Assumptions for SIBCPRF

The SIBCPRF is developed based on the following assumptions:

- The pastoralists in semi-arid rangelands are in need of the framework as a tool to guide them to conserve the biodiversity and buffer the impact of extreme droughts in their area. This is due to the fact that genetic diversity within populations allows adaptation through evolution to changing biophysical conditions. Genetic diversity is important in determining the resilience of species because a diverse array of genes is more likely to include those enabling adaptation to new climatic conditions (Yanda, & Mubaya, (2011). Individual organisms have micro-climate tolerance limits that are directly affected by climate change organisms can die, move to new areas within their tolerance limits, or if suitable mutations arise, adapt to the new conditions through natural selection. Depending on various physiological, genetic, and ecological conditions, some species may adapt quickly enough to projected climate change while others cannot, leading to a "winners and losers" situation detrimental to overall biodiversity and ecological integrity of forests and other ecosystems (Smith, & Barchiesi, 2009).
- The Framework will be initiated and implemented by different actors (such as village leaders, villagers, CBO's/NGOs/FBOs, experts at district level) to promote pastoralists' livelihoods;
- Availability of resources to be utilized before and during the implementation of SIBCPRF at village level;
- Village disaster and preparedness committee will be the initiators and implementers of SIBCPRF'

- Each village will set aside land for grazing zones and;
- District councils and central government will give monetary and technical support to experts and pastoralists at village level.

### **Composition of the Actors to Implement the SIBCPRF**

The SIBCPRF is a participatory framework that paves a way for local communities (pastoralists' communities) to be involved from the initial stages up to its implementation. The Framework puts villagers at the centre of all processes and steps required: preparedness and planning, implementation, monitoring and evaluation, and sustainability of the framework. Furthermore, the Framework states clearly the stakeholders required to make SIBCPRF sustainable, namely; villagers, CBO's, NGOs, district officials for technical advice, village leaders, and local institutions within the community. In this perspective, every organ or group in pastoralist communities is in a position to understand exactly the main responsibilities to undertake in respect of its status before, during, and after the implementation of SIBCPRF.

### **The Framework and its Implementation**

The Sustainable Integrative Biodiversity Conservation and Pastoralist Resilience Framework (SIBCPRF) has been formulated based on five premises as described in section 5.1 and takes into account six assumptions as highlighted in subsection 5.2.2. The Framework (see Table 2) which is summarized in Fig. 5 consists of four main phases which are preparedness and planning, implementation, monitoring and evaluation, mitigation, and sustainability. The details are described hereunder.

**Table 2: Sustainable Integrative Biodiversity Conservation and Pastoralist Resilience Framework**

<b>Phase One: Preparedness and Planning</b>			
<b>Activity</b>	<b>Stakeholders</b>	<b>Output</b>	<b>Time Frame</b>
<b>Holding Village Assembly to discuss SIBCPRF implementation – formulation of village disaster preparedness and response committee and human and financial resources mobilization</b>	Villagers, Village Leaders, and other invitees e.g., CBOs, NGOs and FBOs representatives, and Ward Livestock Extension Officer (WLO).	Selection of the Preparedness and Response and Resource Planning Committees (6) Villagers’ sensitization and awareness strategy Strategies for obtaining financial resources Minutes of the meeting Selection SIBCPRF Advisory Team	One -two Months
<b>Phase Two: Implementation for SIBCPRF</b>			
<b>Activities</b>	<b>Stakeholders</b>	<b>Output</b>	<b>Time Frame</b>
<b>Activity 1 SIBCPRF Participatory Resource Mapping and Zoning into Non restricted, moderate restricted and highly restricted zones</b>	Village Disaster Preparedness and Village Resource Planning Committees, Local organization representatives WLO	Grazing zones Bylaws for each zone	2 years
<b>Activity 2 Holding Village Assembly to present and Discuss Zoning and associated bylaws for endorsement</b>	Villagers, village leaders, invited local Organization and Extension Officers	Endorsement of agreed upon zones Endorsement of bylaws	
<b>Activity 3 Construction of livestock infrastructures in each grazing zone</b>	Selected Contractor Village Village Disaster Preparedness Committee	Dips and dams constructed, Factory for supplementary feeds for use during critical times	
<b>Phase Three: Monitoring and Evaluation for SIBCPRF</b>			
<b>Activities</b>	<b>Stakeholders</b>	<b>Output</b>	<b>Time Frame</b>
<b>Activity 1 Preparation of checklist as a tool to be used during monitoring and evaluation</b>	Village disaster prepare and response committee WLO	Monitoring and evaluation checklist in respect to each activity	On going



<b>Activity 2</b> <b>Field Visit for Monitoring and Evaluation exercise</b>	Village disaster preparedness and response committee Resource Planning Committee- WLO	M & E Report	On going
<b>Activity 3</b> <b>Holding of village assembly to share M &amp; E findings and make amendments where possible</b>	Village leaders Disaster preparedness and response and Resource Planning Committees Representative of local organizations Extension Officers	Assembly resolutions	On going
<b>Phase Four: Sustainability for SIBCPRF</b>			
<b>Activities</b>	<b>Stakeholders</b>	<b>Output</b>	<b>Time Frame</b>
<b>Activity 1</b> <b>Capacity building to pastoralists</b>	Village disaster prepare and response and resource planning committee	Knowledge and skills among pastoralists	1 Year for moderate restricted zone and 8 – 10 years for highly restricted zone to allow high biomass to be used during extreme drought
<b>Activity 2</b> <b>Construction of more livestock infrastructures in each zone</b>	Contractor(s) Representative of Village Livestock Officer	More livestock infrastructure in relation to number of livestock	high biomass to be used during extreme drought
<b>Activity 3</b> <b>Destocking campaigns</b>	Councillor Livestock officers Village leaders	Awareness among pastoralists	

The details for each phase are described below; -

- Preparedness and Planning for SIBCPRF

This involves conducting community needs assessment by using rapid rural appraisal, resources mobilization for CCI adaptation, and formation of community-based groups for resilience and adaptation strategies in semi-arid rangelands.

- Implementation for drought adaptation strategies in semi-arid rangelands by using Sustainable Integrative Biodiversity Conservation and Pastoralist Resilience Framework

This phase will solve perceived critical climatic impacts accelerated by prolonged drought in semi-arid rangelands such as deterioration of biodiversity, loss of pasture, water, mobility, pastoralists' family separation and livestock diseases (see subsection 5.3). This is because it is in this phase where grazing zones will be designated into low, moderate, and highly restricted zones. The high restricted designed zones will allow the accumulation of biomass/pasture that will sustain livestock during prolonged drought. In the highly restricted zones, water reservoirs such as dams will be constructed and protected ready to be used in extreme drought. The designed zones will solve the mobility of livestock and pastoralists as they will be moving within the zones as the presence of water will retain them. Some livestock diseases will be easily treated as livestock infrastructures such as dips will be constructed in every grazing zone and also medicines will be provided.

- Monitoring and evaluation for SIBCPRF
- Mitigation and sustainability.

### ***Phase One: Preparedness and Planning***

In this phase, holding Village Assembly to discuss SIBCPRF implementation – formulation of village disaster preparedness and response committee and human and financial resources mobilization will be aspects that have to be taken care of (See *Table 1*).

#### **Holding Village Assembly**

Holding of village assembly to discuss SIBCPRF implementation which will go hand in hand with

formulation of village disaster preparedness and response committee and realization of financial resources mobilization is very important. The village assembly will comprise of all villagers, CBO's representatives, NGO's representatives and one District Livestock Officer for advisory purpose at the meeting. In this particular meeting, the village Chairperson will lead the meeting while on the other hand the Village Executive Officer will be taking note (minutes of the meeting). The agenda of the meeting will be spelt out in a transparent way which will go hand in hand with sensitization on the SIBCPRF, its importance and how it will be implemented in the village.

In this context, pastoralists at village level shall be sensitized about SIBCPRF and be informed that this framework is an extension of the traditional strategy (*ingaron system*) for drought adaptation. The different between *ingaron strategy* and SIBCPRF is that, the SIBCPRF integrates the traditional *ingaron system* and the modern drought adaptation strategies e.g., water reservoirs construction aiming at buffering climate change impacts in the pastoral societies. In this perspective, the sustainable SIBCPRF will be implemented by focusing on restoring pasture for extreme and prolonged drought, making availability of water for livestock within the highly restricted zone by building large dams, promoting medical plants within the restricted zones and construction of livestock infrastructure (dips). Moreover, the villagers must be informed that the SIBCPRF is a community-based framework and not otherwise.

It is the requirement of the SIBCPRF that every village should segment/designate their grazing land (as per village land use map) into three main landscapes; i) unrestricted zone; ii) low restricted zone and high restricted (*sustainable*) zone. This will be done in collaboration with technical expertise from the district level for technical advice to the community. The advice will include to do resource mapping, understand livestock number present in that area and, to approximate the number of livestock available in the years to come (*after almost 5 years is when the high restricted grazing zone will be grazed*), and quantify the biomass needed for pastures in eight years to come. During the sensitization period, pastoralists have to be informed that the adaptation strategy will involve

four phases of which in each phase there will be critical activities to be done to make possible for the sustainability of climate change adaptive strategies.

### **Formulation of Village Disaster Preparedness and Response Committee (VDPRC)**

During the village general assembly, the formulation of Village Disaster Preparedness and Response Committee (VDPRC) shall be done. The compositions of the Committee shall be community representatives, local organization representatives, village local government representatives. The VDPRC will be working under the framework of District Disaster Preparedness and Response Committee. The role of VDPRC will be coordination and facilitation of all planning and implementation activities. The committee shall be chaired by the Village Chair Person.

### **Human and Financial Resource Mobilization**

The financial and human resources mobilization shall be done during the Village General Assembly Meeting. Resource mobilization shall focus on designating village grazing zones into three zones namely unrestricted, moderate restricted and high restricted and the entities to include in each zone. Also, the resources should focus on the payment of contractors. In this respect, sources of funds for implementing SIBCPRF should be signified with locally available resources and cost-effectiveness. Planning for resource gap filling will be conducted, what is there and what is needed will be clearly indicated.

### **Phase 2: Implementation of SIBCPRF**

The implementation is a phase whereby “inputs are converted into outputs/ visible aspects as set out in the Sustainable Integrative Biodiversity Conservation and Pastoralist Resilience Framework”. The phase involves a series of activities, namely; resource mapping and zoning into non-restricted, moderate restricted and highly restricted zone, holding village assembly to present and discuss zoning and associated bylaws for endorsement, construction of livestock infrastructure, utilization of human and financial resources which will be accompanied with resource allocations, and the operation of the SIBCPRF (see

Table, 2). This phase will involve the following actors; i) local community, Community Based Organizations CBO’s and No-governmental Organizations’ NGO’s, Village Local government, WLO, Village Disaster Prepare and Response Committee, Resource Planning Committee, District livestock Representatives for technical and advisory task and Extension Officers.

### **Participatory Resource Mapping and Grazing Zone Designation**

#### **Resource Mapping**

Resource mapping will be carried out by the village community to map their village and indicate which places and which resources will be used in the implementation of SIBCPRF (customary use). These maps demonstrate the scope of indigenous in the village towards the implementation of the framework and illustrate the significance and importance of the village and associated resources for the lives of indigenous and local communities. The village leaders should support and facilitate participatory resource mapping processes. With the help of district officials, the community members are trained to use GPS and GIS technology and then employ these skills in the field in combination with the knowledge of resource users or elders who know the village potentialities and landscapes at every corner of the village. Data and locations are collected and all information is compiled into documents and, where possible, sketch maps should be provided. All technology is set up at the local level and adapted to local needs and circumstances.

Furthermore, in combination with village-level capacity building in land and resource rights issues, participatory mapping provides a basis for an effective implementation of the sustainable integrative biodiversity conservation and pastoralist resilience framework by all villagers as a strategy toward extreme drought. This is especially important in cases where outside actors aim to contribute much on enhancing the implementation of SIBCPRF. The maps can support communities in dialogue and negotiation processes. Therefore, resource mapping shall comprise the following stakeholders; Village Disaster Preparedness and Response Committee and Village Resource Planning Committees, Local organization

representatives, WLO and technical official from district level.

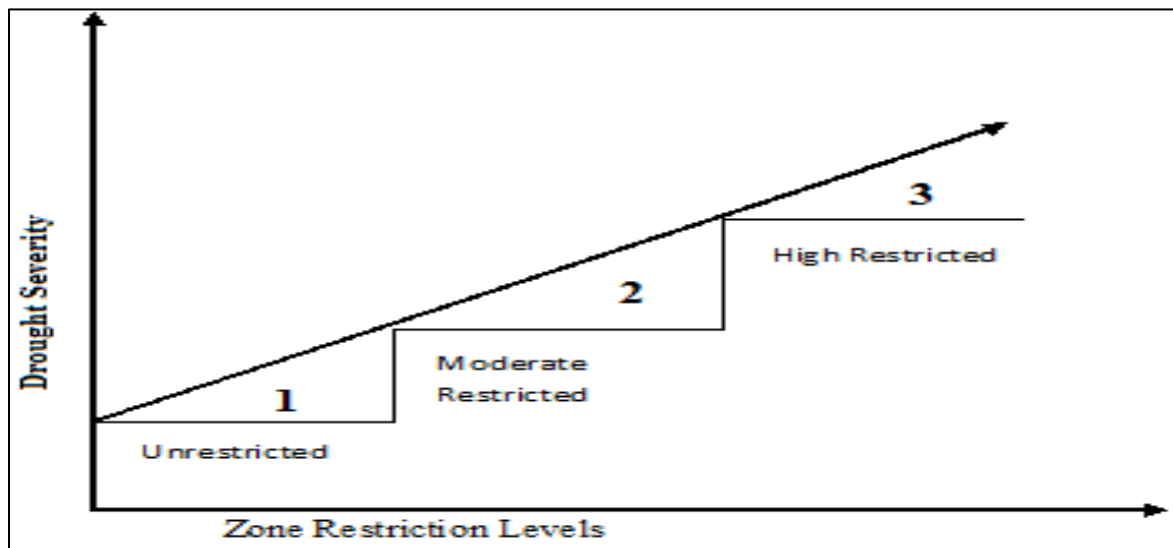
**Grazing Zones Designation plan**

Grazing zone designation plan will be prepared during preparedness and planning phase. Participatory planning is more preferred where all key stakeholders such as pastoralists, CBO’s, local government, NGOs, and the district council will be involved in the preparation of the grazing zone plan. The plan shall involve three main zones, namely, unrestricted, moderate restricted and high restricted grazing zones. The VDPRC, together with the village leaders, will be responsible for the preparation of the grazing zone designation plan.

**General Management Plan of the Designated Sites**

In order to have an effective management of designated sites, a participatory management plan of the sites will be prepared which will include the role of different actors in the management of the sites. During planning, by-laws will be set that will regulate resources use in respective to each level of grazing zone (see Fig. 3). Resources needed during implementation will include a planning team which will be part of VDPRC and planning facilitator and financial resources. The facilitators will compose a group of experts from district level for advisory and technical issues.

**Figure 3: Levels for Grazing Zone Transitions**



**Holding of Village Assembly to Present and Discuss Zoning and Associated By- laws Endorsement**

Village general assembly will be led by village chairperson; the meeting will discuss zoning and associated bylaws endorsement. During this particular meeting, it has to be noted that in principle the process of by-laws formulation and its implementation at village level should abide with the Tanzania governing policies and also should not be a cross-boundary bylaws. In the context of decentralization, local governments should ensure that there is an involvement of local communities in

decision making including participation in Natural Resources Management Policy Reforms and by-laws. Formulation and implementation will take place at village level.

At village level, bylaws will be filtered and selected for further processing. It is at this stage that the proposed bylaws will be tabled at the Village General Meeting (VGM) which shall be attended by all villagers. The draft of bylaws approved by the VGM will be forwarded to the Ward Development Council for discussion and consideration and then pass them to the District Lawyer who will ensure that the bylaws are well written and do not contradict the core laws stated in the Constitution.



The district lawyer will forward the proposed by-laws to the village general assembly for endorsement. Once approved, the bylaws will be returned to the respective villages where the Village Executive Officer is required to present them to the VGM and post them in the village notice boards for not less than 30 days before they become legally binding. Copies of the bylaws will also be availed to the nearest primary courts, police stations, councillors, and divisional and village offices for the respective officers to refer to them when they are implementing their duties in enforcing the bylaws. The bylaws must be appropriate and supportive to SIBCPRF, that is to say, each grazing zone shall have its own bylaws. Therefore, village leaders, villagers, representatives of local organizations will be the main actors in this activity.

### **Allocation of Resources**

The resources of an organization consist of people, materials, equipment, knowledge, and time. Most of villages typically have limited resources. As such, resources allocation plan is an important tool in the effective implementation of SIBCPRF at village level. A resource plan, will describe the types of resources needed and the timing of the needed resource which is very critical aspect for effective resource management at village level. If time and schedule change, the resource plan must also be flexible enough to adjust as these changes occur. The allocation of resources should be appropriate to the activities to be implemented in each grazing zone designated.

### **Construction of Livestock Infrastructure**

In this context, rehabilitation of critical holes, construction of water reservoirs (dam, water tanks), building of dips and restocking and landscape regeneration system (Improved *Ingaron System*) are activities to be implemented at this stage as a pathway towards promoting pastoralists' resilience and adaptability against drought. Therefore, to make the construction of livestock infrastructure possible, the following items should be in people's mind.

- **Resources needed for the construction of Livestock Infrastructures:**

the major resources needed include financial resources, human resources, and physical resources.

Financial resource will enable the community to purchase the needed material for the construction of the livestock infrastructure, resources mapping, and payments for people at different capacities. The sources of the financial resources may vary from one village to another depending on the institutions available in each village but the main sources will be from the pastoralists themselves, support from district council and NGO's, while human resources will offer both labour support and technical support.

- **Coordination for the implementation of Livestock Infrastructure Construction**

In this context, the implementation of SIBCPRF needs coordination (community-based management). It refers to applying various tools to ensure coherent support for pastoralists' regulations and programs, coordination between institutions that are implementing adaptive programs. This involves putting together available physical, human and financial resources for implementing pastoralists' drought recovery process.

- **Time Element and Value;** In the implementation phase, time value is very important.

Therefore, the proposed time for each activity to be implemented for enhancing pastoralists' adaptation strategies should follow the planned schedule. The time frame developed should be understood as the critical path. Any operations outside this critical path will lead to possibilities of poor quality, extra costs, delays, losses and failure of adaptation.

### ***Phase 3: Monitoring and Evaluation***

In this particular phase, the activities implemented are monitored and feedback is shared among pastoralists' communities and other stakeholders. The monitoring team will be the VDPRC, Village leaders, representatives from CBO's and NGO's and also will include representatives from village livestock office and district livestock office for advisory task. The output of monitoring is to evaluate the priorities aligned with the set activities that emerged during implementation and produce reports which will be discussed in the village assembly. At this stage, monitoring needs to assess if the constructions of livestock infrastructures are

appropriately undertaken as it was planned in the initial stages (planning and implementation).

The effective monitoring of the whole process of building resilience and adaptation capacity will be done by using a prepared check list of the enlisted items/ activities to be placed for the implementation of adaptation strategies. The monitoring team should make fields visit where implementation of SIBCPRF is taking place and share the findings obtained to the village general assembly meeting. Monitoring and evaluation are aimed at ensuring that the adaptation initiatives are operational at the same time determine whether changes or refinements are needed to respond to new conditions in relation to climate change resilience and adaptation.

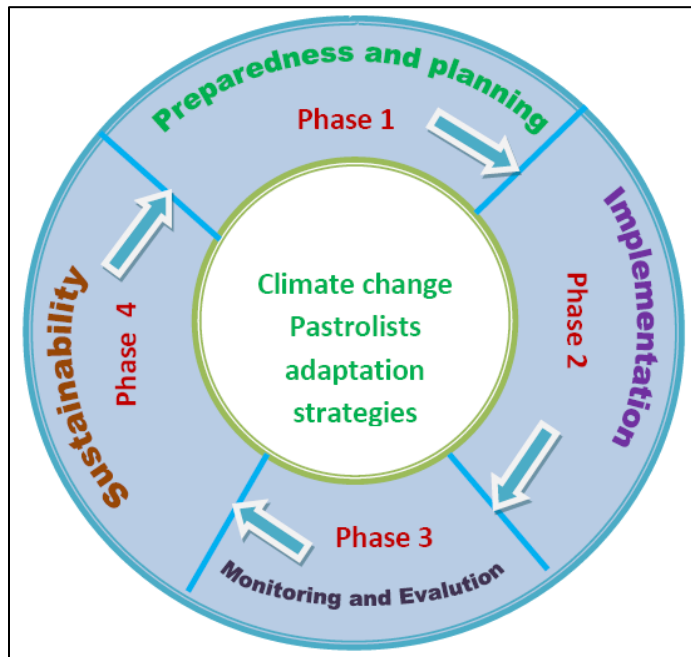
**Phase 4: Sustainability**

In this particular phase, the communities have implemented all the possible programs to enable sustainable adaptation to take place. To make the pastoralists more resilient and adaptive to extreme drought in semi-arid rangelands, recovery systems should be strengthened by developing more livestock infrastructures, promote more income

generating activities, capacity building on how to mitigate climate change impacts, provision of education for livelihood diversification, establishment of forestation and reforestation, destocking, collection of supplementary feeds, provision of livestock officers by the district council to assist the pastoralists, more research institutes on livestock health should be placed. It is in this stage that the external supporters and institutions should start to scale down financial resources while the local communities up scaling the resources for climate change adaptation. In this particular stage, strengthening of community capacity to withstand while implementing adaptive strategies is an integral aspect. The main actors in this phase include Village Disaster Prepare and Response Committee, Resource Planning Committee, Contractor(s), representative of village livestock Officer, and village leaders.

The figure below is a summary that describes how pastoralists’ climate change resilience and adaptation framework can be implemented in a circle form while maintaining its four phases namely; preparedness and planning, implementation, monitoring and evaluation and later sustainability of SIBCPRF.

**Figure 4: A Circle for Sustainable Integrative Biodiversity Conservation and Pastoralist Resilience Framework (SIBCPRF)**



The development of SIBCPRF to climate change impact considered multiple approaches with inclusivity of four components of a 'Climate Resilience plan' which reflects what action is needed and how it should be implemented to build resilience and adaptation. The experiment will be to use such a resilience thinking paradigm to direct mutually realistic action and the development of strategies and policies that are coherent across agriculture, pastoralism, and wildlife sectors.

## CONCLUSIONS

Longido district being in northern Tanzania rangelands is dominated by pastoral Maasai is experiencing global climate change impacts for nearly five decades now; the most indicators being drought, erratic rainfall, floods and rise of temperature. It had been also evident from this study that the most important climatic challenges facing pastoralists' livelihood include shortage water, pasture stress, eruption of livestock diseases and death of livestock. To mitigate such impacts, pastoralists are using several adaptive strategies. The most important ones include migration to areas rich in pasture and water, dam construction, use of supplementary feeds, and use of traditional bylaws. Others include herd splitting, traditional prediction, herd diversification and building social networks. In order for the pastoralists to continue addressing global climate change impacts, the study proposes SIBCPRF framework and recommends the following:

- Efforts should be made to test the framework to enable its scaling up in areas of similar socio-economic and environmental settings. This could be done by the pastoralists after enough and appropriate assistance from the district livestock extension officials and other stakeholders.
- The District Livestock Officer should explore the choices and benefits for mitigation strategies within the livestock sector, particularly where there are opportunities to access carbon finance payments, and identifying synergies between productivity and environmental benefits, as an example through reduced methanogens (lower methane

reduction resulting in increased feed conversion efficiency), reforestation of rangelands, manure management, or restoration of degraded rangelands;

- Pastoralists' capacity building on global climate change resilience and adaptation should be done by NGOs, CBOs, and therefore the District livestock officials. The initiation and therefore the establishment of programs intended to consolidate the adaptability of global climate change upon the pastoralists should promote the techniques of a way to buffer the impacts resulting from climate change;
- The district livestock officers should promote innovative approaches to local breed development that are driven by the environmental exigencies of livestock keeping groups, specializing in the event of local breeds, and moreover the promotion of 'exotic' breeds from comparable environments that display more locally-appropriate attributes like drought survival and disease resistance; and
- To integrate sectors through interventions that concentrate on pastoralists' resilience and adaptation by integrating meteorological organs, academic research and other developmental activities through civil society and community-based organizations may be the foremost important pathway for resilience and adaptation to global climate change impacts in semi-arid rangelands.

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