



Helping People and
The Planet Thrive



Final Report

Great Ruaha River Basin Climate Vulnerability and
Capacity Analysis (CVCA)

CARE-WWF Alliance in Tanzania

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Enormous thanks go to each and every member of the team of officials and experts who worked so hard to make this CVCA process a success. Your commitment and time given to the process was extraordinary, and Matt and I enjoyed meeting and working with you all very much. On behalf of the CARE-WWF Alliance thank you for your hard work and contribution Frida Mosha, CARE; Daniel Katebalila, CARE; Makfura Evergris, WWF; Martha Peter, WWF; Patrick Charles, Mbarali District Forest Officer; Anyubatile Seme, Mbarali District Community Development Officer; Noela Kessy, Mufindi District Community Development Officer; Shaban Adha, Mufindi District Forest Officer; Haule Maiko, Wanging'ombe District Community Development Officer; Rosemary Kapoma, Wanging'ombe District Community Development Officer; David Munkyalala, RBWB Hydrologist; Upendo Lugalla, RBWB Community Development Officer; Agness Ndanzi, Communications Officer; and Ebrahania Mlimbila, Environmentalist. Particular thanks to Makfura and Daniel for their support and friendship, and their incredible hard work on the logistics and looking after us all.

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The author hopes this report will be of value to the CARE-WWF Alliance in the design of future programming to have impact at scale on food and nutrition security and climate resilience for communities of the Great Ruaha River Basin, and that this CVCA process represents a first step in a longer-term partnership with these communities to support their adaptation to climate change. We hope that by making this report available to other actors and institutions working on water management, agricultural investment, land use planning, and service provision, it can be used to support future policies and investments to learn from the experiences of communities themselves.

This official report provides an overview of the findings of the CVCA process, however the individual village summaries have also been published as a companion to this report as unofficial 'grey literature' to support village level validation and work, and to make available a record of the detailed information collected to allow future processes to build on this and avoid duplication of effort. The companion paper 'CARE-WWF Great Ruaha River Basin Climate Vulnerability and Capacity Analysis (CVCA): Village Summaries (grey literature)', is available from the CARE-WWF Alliance.



EXECUTIVE SUMMARY

The Great Ruaha River, in south-central Tanzania, provides a critical source of water for a diversity of users, including large- and small-scale irrigated agriculture, livestock, hydropower, households, and biologically and economically significant ecosystems, such as the Usangu wetlands and Ruaha National Park. Since the early 1990s, the Great Ruaha River ceased flowing during the dry season, with consequences for the lives and livelihoods of the six million inhabitants of the basin. The CARE-WWF Alliance is embarking on an ambitious initiative to have impact at scale on food and nutrition security and climate resilience. Community-level Climate Vulnerability and Capacities Analysis were undertaken in the Mbarali and Ndembera sub-catchments.

What is climate change vulnerability?

Vulnerability is a consequence of the climate-related impacts communities are exposed to, how sensitive their lives and livelihoods are to those impacts, and their ability to cope and adapt to those changes.

What climate-related impacts are the Great Ruaha Basin communities exposed to?

The rainy season has become more erratic and unreliable. The rains are expected from November through to March, however now the rains often come early, late, end early, pause mid-season, or come in very heavy rainfall events. The El Niño of 1998, one of the strongest global episodes on record, caused heavy rain on a scale not seen before or since. This resulted in flooding, landslides, prolonged hunger, and water borne diseases including cholera. For many, drought and hunger followed in 1999, the consequence of the corresponding strong La Niña, and a one-in-ten year trend for significant hunger events was indicated.

Some communities reported increased temperatures in recent years, observed through the late arrival of snow, new crop opportunities, and malaria in areas it was previously not experienced. Increasing outbreaks of pests, crop diseases, and fungus were also linked to changing temperatures and rainfall patterns, as well as farming practices. Other key hazards were strong winds, landslides, and floods, often occurring together.

In what ways are communities sensitive to these impacts?

Rain-fed mixed-maize and Irish potato farming are key livelihood activities which are sensitive to unreliable rains, shorter rainy season, and increased incidence of crop diseases and pests. When crops fail farmers have less food and income, and the price of maize increases, combining to result in hardship. These key income sources have one annual cycle; therefore it can be a year or more before farmers recover from these losses.

Water and land shortages are widespread due to inward migration for agricultural opportunities; forced removal from other places; population growth; weak governance and planning; deforestation; perceived declining fertility of land; and local agricultural practices that degrade water sources. These shortages reduce farming productivity; limit options to adapt to climate change; cause conflict; and reduce domestic water supply. Unreliable rainfall patterns and increasing temperatures are exacerbating these existing challenges.

Drinking water sources are often contaminated by heavy rainfall events causing disease outbreaks (including cholera) as a result of poor public water and sanitation infrastructure, which is costly to communities and particularly women who carry the burden disproportionately.

Cutting trees for firewood, charcoal, timber, and clearing land for farming, as well as trees lost to fires caused by farming practices and conflict, have left villages less protected from strong winds and landslides.

In what ways are communities able to cope and adapt? What are the challenges and trade-offs?

Rice farming has grown in areas with natural flooding and where irrigation schemes have been established. These schemes are a lifeline for food production, income, and family subsistence in years with poor rains or floods. However, the profitability of smallscale irrigated farming is generally poor due to fees, expensive input needs, and poor market access; and farmers rarely have long-term security of land ownership.

Women have a high degree of flexibility in their income generating activities as a way to cope with hardship. In farming activities they delay planting even if rains come early (as the rains tend to stop before restarting),

and use faster maturing crops if rains are late or other losses are suffered. Women also engage in a wide variety of other income generating activities to provide household income when there is none from farming.

Natural resource managing is improving and Water User Associations are active in educating communities and protecting water resources by planting water-friendly trees, enforcing a national ban on cultivating within 60m of water sources, and replanting trees in degraded areas. However there are food and nutrition concerns regarding the implications of banning vinyungu – a key way communities manage crises. Whilst natural resource management and governance seems to be improving, it is not inclusive and equitable, and particular interests seem to be prioritised over others and conflict results. Pastoralists are particularly marginalised.

Recommendations

1: Investment is needed in smallscale rain-fed agriculture to address unreliable rainfall patterns: Rain-fed agriculture is inherently sensitive to changes in rainfall patterns, seasons, and temperatures, such as those now being experienced. Therefore investments are needed that support smallscale producers, such as through access to and use of seasonal forecasts.

2: Both productivity and profitability of smallscale agriculture needs to be addressed in the context of existing water and land shortages and stresses, and a changing climate: Even when farmers are able to produce enough, they struggle to make a profit, due to production costs and market instability. Environmental decline has led to increased use of expensive inputs, and is one factor in reducing profits.

3: Reducing food and nutrition security risks associated with one farming season a year is required to increase resilience: These communities are vulnerable to any disruptions to seasonal patterns, as this impacts on income and food and nutritional security for the whole year, and reduces farmers ability to invest long-term in livelihoods.

4: Farmers, NGOs, and governments must be more aware of, and better prepared for predictable inter-annual climate variability and its cumulative impacts: Actions must be taken in advance of strong El Niño and La Niña events, rather than afterwards when it is harder to reach people.

5: Programmes designed now must be forward-looking, considering climatic, demographic, and other changes over the next 5 to 30 years: Inward migration, changing farming practices and market opportunities, and climatic changes are changing access to and availability of resources. Ignoring changing conditions has led to the failure of public water systems in the villages studied, and must now be factored into all project design.

6: Food and nutrition security risks as a result of the ban on vinyungu must be addressed: The impacts of this ban on incomes and access to nutritious food – particularly in times of crisis – must be assessed, and investments made to ensure that food and nutrition insecurity does not become an unintended consequence.

7: Women's adaptive capacity should be harnessed and barriers to transformation removed: Women are highly adaptive in their approaches to managing periods of hardship, farming activities, and household budgets; however they face considerable barriers preventing them from using these skills to pursue longer term investments and for adaptation due to domestic violence, men's control over their assets, unequal burden of family economic and domestic responsibilities, and inadequate domestic water systems.

8: Smallscale producers face an uncertain future without secure land tenure and political prioritisation: There are many of examples of farmers losing land through land disputes and removal policies, and few smallscale producers have formal land title. Secure land ownership is important for adaptive capacity and enabling smallscale producers to plan for their future.

9: The marginalisation of pastoralists, and a culture of blame, undermines adaptation for all: Pastoralists are not assured access to the resources they are entitled to, are excluded from governance processes, and are scapegoated. Engagement of all stakeholders is required for effective natural resource management and to enable adaptation to climate change.

10: NGOs must learn the lessons from the failures of new 'opportunities': New opportunities for smallscale producers are important, but they come with risks which must be understood and managed if new activities are promoted, so that maladaptation is avoided.

1 INTRODUCTION

This report presents the methodology and findings of the CARE-WWF Alliance Climate Vulnerability and Capacities Analysis (CVCA) in the Great Ruaha Basin of south-central Tanzania, conducted in September 2017.

1.1 Context

The catchments of the Great Ruaha River provide a critical source of water for a diversity of users, including large- and small-scale irrigated agriculture, livestock keeping, hydropower generation, domestic use, and biologically and economically significant ecosystems, such as the Usangu wetlands and Ruaha National Park. Since the early 1990s, flow in the Great Ruaha River has reduced during the dry season, which has degraded freshwater ecosystems and the critical services they provide to the six million inhabitants of the basin, such as water for drinking, sanitation, and agriculture. Rain-fed and irrigated agriculture, pastoralist households, subsistence fisheries, wildlife tourism operators, and hydropower operators compete for the water resources of the catchment. Those located downstream are at a disadvantage, compared to upstream users. The resultant water stress has also led to conflict between water users.

Significant effort has been made to address the water issues of the Ruaha Basin. Decentralised water governance has been rolled out by national government and donors; a sub-office of the Rufiji Basin Water Office and Water User Associations (WUAs) have been established at the sub-basin and local level. Several large-scale projects have also been implemented, including the WWF Great Ruaha River Project which focused on improved governance, diversifying livelihoods, piloting water efficient rice production techniques, and contributing to efforts to restore dry season river flows and enhance wetland protection. However, the freshwater system of the Great Ruaha River remains under severe stress, with water shortages for livelihoods and ecosystems likely to continue or be exacerbated in the face of climate change.

Land converted to irrigated agriculture has expanded in recent decades, increasing from just over 10,000 ha to 40,000 ha between 1970 and 2000 (Kashaigili et al., 2006). The expansion of irrigated agriculture in Usangu was promoted by development agencies in the 1970s, and many immigrants moved to the area to grow rice on or around small irrigation schemes and farms run by a state-owned company, NAFCO. Large-scale agricultural production in the Usangu basin is one of the largest consumers of water, and as a result has the most significant influence on water stress, especially during the dry season. Studies have found that smallscale producers tend to use water more efficiently than large state-owned NAFCO farms, and overall productivity of rice per unit of water is higher or at least the same on smallscale farms (McCartney et al., 2007). Despite the mechanisms in place to manage water across the basin, water extraction is not effectively monitored and therefore enforcement of restrictions is not possible, as a result it is estimated that up to double the permitted amount of water is often withdrawn (McCartney et al., 2007).

The climate is characterised as having “*seasonal shifts and variable seasonal distribution with unpredictable onset and ending of rains and shortened growing seasons*” (Kangalawe et al. 2011). Some studies suggest a declining trend in annual rainfall and increasing temperatures in the Ruaha Basin, and suggest that climate change could exacerbate the trend for reduced flow in the Great Ruaha River (Kangalawe et al., 2011, Kashaigili et al., 2009). The Intergovernmental Panel on Climate Change (IPCC) predicts temperatures in Tanzania to increase by 2-4°C by the end of the century, with the interior of the country likely to experience the greatest warming and reductions in rainfall, resulting in prolonged dry seasons and an increase in the severity of periodic droughts. Data from Iringa weather station does indeed show that temperatures have risen between 1980 and 2009. Whilst climate change is not the dominant driver of declines in river flow, it is likely to be a severe challenge for the Ruaha basin and its water management in the future.

Nevertheless, climate variability and change is affecting local livelihoods. For example, the delayed onset of rains has made it problematic to follow traditional cropping calendars and has reduced farmer’s yields. One study found that 20 to 30 years ago potatoes were planted early November to be harvested in February, when beans could then be planted. Today that kind of staggered planting has largely disappeared with all crops having to be planted at the beginning of the rainy season to have sufficient time to mature before the rains end (Kangalawe et al., 2011).

Water politics and management failures have also played a part, with different stakeholders having contrasting views on the causes of water scarcity and the drying of wetlands and rivers, resulting in actions that have failed to address the causes. In 2006, the government evicted cattle herders and livestock from the wetlands of Usangu, after overgrazing was wrongly identified as the primary cause of the degradation (Walsh, 2012). TANESCO, the company operating the hydropower plants, also promoted the view that irrigation and overgrazing cattle were the causes of the electricity shortages in the 1990s and later. However research has found there was no significant connection between changes in the flow of the Great Ruaha River and grazing, and that power shortages from the Mtera/Kidatu stations were likely to have been caused instead by the mismanagement of reservoir storage. Despite this evidence, unfounded narratives about environmental degradation being the cause still pervade publicly (SMUWC Project, 2001, in Walsh, 2012).

The Rufiji Basin Water Office is a government agency tasked with water resource conservation, planning and conflict resolution, the granting of water rights, and freshwater ecosystem management. Its allocation of water rights has been criticised for allowing rights that exceed available water in the dry season, thereby legitimising over-abstraction, but not increasing rights sufficiently during the wet season. WUAs are the primary institution for water management at a local level in Tanzania, however they lack adequate funding. Their roles are to conserve and manage water catchments sustainably; increase the usage of water for economic and social improvements; develop sustainable and responsive institutions; resolve conflicts on water use; and monitor water availability and use.

1.2 Project overview

The CARE-WWF Alliance is embarking on an ambitious initiative in the Ruaha Basin to have impact at scale on food and nutrition security and climate resilience. Given the context outlined above, undertaking a CVCA with communities in the catchment is critical to effective project design and implementation. This CVCA is intended to be one of three integrated assessment tools that will contribute to a CARE-WWF Alliance approach to markets, ecosystems, and social vulnerability in the context of a changing climate.

1.3 CVCA methodology

In order to ensure that development programmes reduce women and men's vulnerability to climate change, analysis must be undertaken to understand who is vulnerable and why, and used to inform the design, implementation, monitoring and evaluation of activities. The CVCA methodology is a tool that enables organisations to understand the implications of climate change for the lives and livelihoods of the people they work with. CVCA also provides a framework for dialogue within communities, as well as between communities and other stakeholders, and the results provide a foundation for the identification of practical strategies to facilitate community-based adaptation to climate change.

This CVCA combines a desk-based literature review (Annex 1), community Focus Group Discussions (FGDs)¹, and Key Informant Interviews (KIIs). The community approach was participatory, and FGDs were undertaken separately with women and men in order to understand gender differentiated vulnerabilities and capacities. The CVCA team comprised staff from CARE and WWF, local officials, and two international consultants. The CVCA team trained together in Mafinga (Mufindi District), before dividing into two teams to cover Ndembera and Mbarali sub-catchments. FGDs were undertaken with approximately 15 women and 15 men from each village, who participated in all steps of the process. Village Leaders were requested to invite village members who represented the range of livelihoods, ethnicity, and wealth groups within the village. KIIs were carried out separately with Village Leaders.

1.4 CVCA locations

The following criteria were used to select the villages in this CVCA:

- To include a balance of communities from Mbarali and Ndembera sub-catchments;
- To include a balance of upstream and downstream communities;
- To include adequate representation of all the major livelihoods in the area;
- To cover a variety of agro-ecological zones;

¹ Detailed in the accompanying *CARE-WWF Alliance CVCA Facilitation Manual, August 2017*.

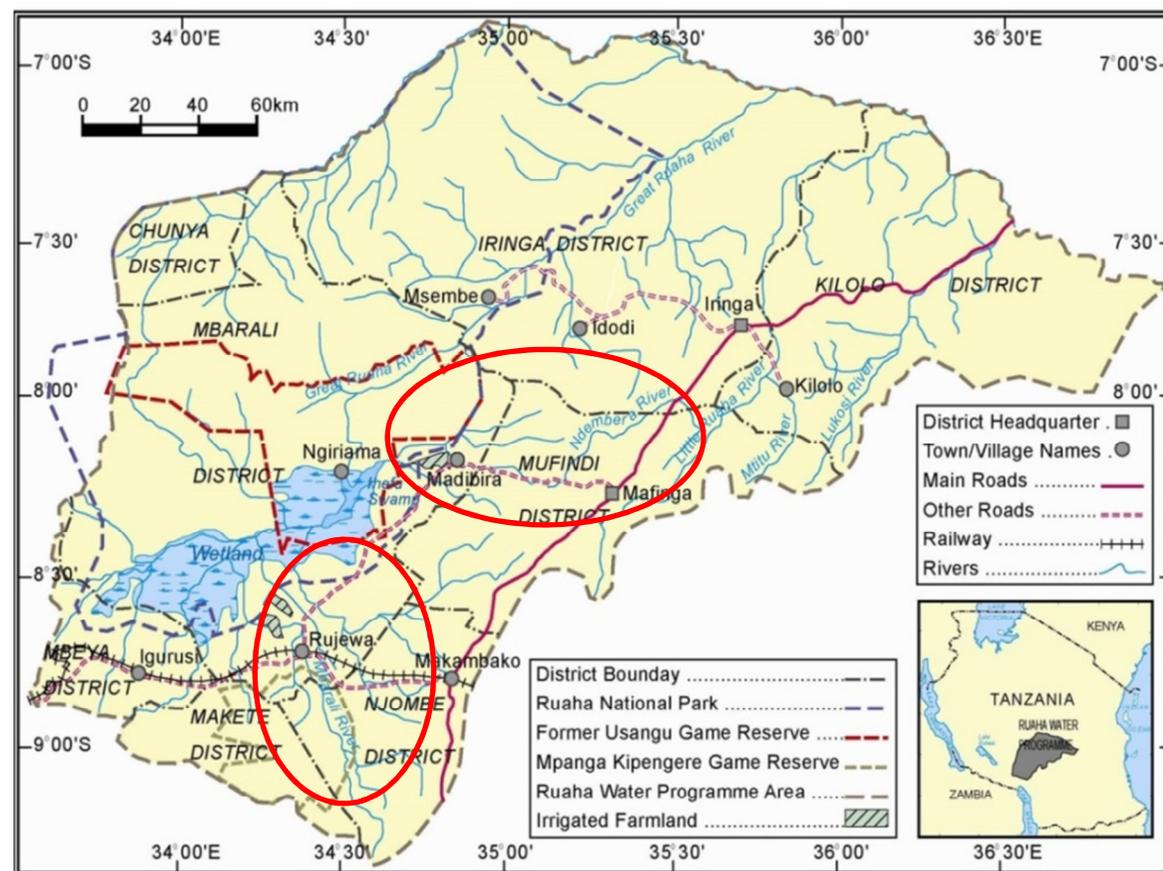
Table 1: CVCA field team.

CVCA Team			
Team 1 / Ndembera sub-catchment		Team 2 / Mbarali sub-catchment	
Catherine Pettengell (International Consultant) Frida Moshu (CARE)		Matt Fortnam (International Consultant) Patrick Charles (Mbarali District Forest Officer)	
Women's FGDs	Men's FGDs	Women's FGDs	Men's FGDs
Noela Kessy (<i>Mufindi District Community Development Officer</i>) Agness Ndanzi (<i>Communications Officer</i>) Upendo Lugalla (<i>RBWB Community Development Officer</i>)	Haule Maiko (<i>Wanging'ombe District Community Development Officer</i>) Makfura Evergris (<i>WWF</i>) David Munkyalu (<i>RBWB Hydrologist</i>)	Anyubatile Seme (<i>Mbarali District Community Development Officer</i>) Rosemary Kapoma (<i>Wanging'ombe District Community Development Officer</i>) Martha Peter (<i>WWF</i>)	Ebrahania Mlimbila (<i>Environmentalist</i>) Shaban Adha (<i>Mufindi District Forest Officer</i>) Daniel Katebalila (<i>CARE</i>)

Table 2: CVCA field process.

Tool/Process	Outputs
Community Map	<ul style="list-style-type: none"> - Identify important resources, water sources, and biophysical features. - Identify any agricultural development or water management activities. - Identify hazards affecting the community, and their causes. - Identify factors in the landscape causing or exacerbating hazards.
Vulnerability Matrix	<ul style="list-style-type: none"> - Identify priority hazards for different livelihoods. - Prioritise livelihood resources by different people. - Identify causes of hazards, variability, and water stress. - Understand how they impact on important livelihood resources. - Understand how people manage the impacts.
Historical Timeline	<ul style="list-style-type: none"> - Identify impacts on community over recent past and emerging trends. - Understand role of village changes and investments on impacts and trends. - Gather women and men's perspective on causes of changes and trends. - Understand implications on coping strategies and managing hazards.
Seasonal Calendar	<ul style="list-style-type: none"> - Identify seasonal calendar including times of stress. - Gather women and men's observations of changes to seasonal patterns. - Understand role of agricultural, water, or landscape developments in managing variability, seasonal change, and water stress.

Figure 1: Map of CVCA locations showing both sub-catchments / CVCA areas.



- Travel accessibility; and
- WWF programming locations / existing community relationships to facilitate visits.

Seven communities were selected in Mufindi, Mbarali, and Wanging'ombe Districts. Logistical constraints related to travel times and costs prevented the inclusion of villages in Makete District, leaving a gap in the overall picture for the programme area, and it is recommended that CARE-WWF undertake further CVCA with villages in Makete District and any other areas not adequately covered by this initial sample.

1.5 Limitations of the CVCA

CVCA is a very time and resource intensive process, and there are constraining or limiting factors in any CVCA. CVCA was designed to be part of a process of long-term engagement with communities, and not as a one-off information gathering process. In an ideal situation a CVCA would be conducted with communities as part of on-going programmatic activities, form the basis of two-way dialogue between the programme team and the community, provide an opportunity for education on climate change, and lead to the development of a Community Adaptation Plan for the benefit of the community.

In this process, using a CVCA as a standalone assessment to inform a future project design process, the CVCA was scaled back in order to not be too time consuming to participants. The institutional mapping exercise was cut from the process, and instead the consultants undertook KIIs with Village Leaders to try to capture relevant information relating to this. Because the CVCA was not part of current programmatic activities, it was necessary to select villages where WWF had previously implemented to gain access, which influenced findings as attendees had often been involved in those previous activities.

The in-country team had no previous experience of CVCA, or training in participatory research methods, and received just three days training as part of this process. Whilst some team members were experienced community facilitators, their expertise lay in educating, and found the transition to the different skill set required to solicit the sharing of communities' own knowledge and experiences an understandable challenge. Even those team members who had previous experience with some of the tools (such as seasonal calendars) noted that they had not used them before to generate discussion and collect such detailed information. Many of the team members were local officials, known to the CVCA communities, which can sometimes inhibit how freely and honestly community members speak about challenges they are experiencing. In order to manage these issues, to the extent possible, officials from Ndembera sub-catchment conducted fieldwork in Mbarali sub-catchment, and vice versa. This was also intended to benefit them professionally, since they had the opportunity to learn first-hand about differences, similarities, and inter-linkages across different communities.

Translation was a significant factor that may have limited the quality of the CVCA. The process was conducted in Swahili with villages, so support could not be given by the English-speaking consultants during the FGDs, which was a challenge with an inexperienced team. This was managed through training at the start and on-going coaching throughout. The process of translating into English put a considerable time burden on the team as none of the four facilitation teams were able to translate and input the data themselves, so each had to sit with their lead consultant and go through every FGD in detail, translating together as a group. As a result some of the distinctive 'voices' from communities were undoubtedly lost in a process where information may have been generalised to simplify and shorten, given the strain the teams were under of very long days fieldwork as well as long days of data translation.

The CVCA was also constrained by the local cholera outbreak. As a result the teams were based in major towns some distance from the CVCA villages, taking between two and three hours to travel to each village and back each day. This meant that the CVCA could not cover such as even spread of the overall project area, as some travel times were impractical. As a result the CVCA did not gather information from as many upper sub-catchment locations as lower, and did not reach any villages in Makete District.

In addition the CVCA did not capture all the experiences of different people relevant to a holistic understanding of vulnerabilities and capacities in the Ruaha Basin. The most significant limitation of this CVCA is the absence of pastoralist communities. Despite requests for their participation it was not facilitated by an approach that organised community engagement through Village Leaders only, and located them within village centres. It is also generally advisable in CVCA to have a third focus group specifically for female-headed

households to capture the differences in their vulnerabilities and capacities, compared to women with husbands. Due to understandable limitations on budgets, human resources, and logistics, it was not possible to have the additional people in the team, or additional time in communities, to have added this group to the CVCA. It is also noted that no disabled people participated in any of the FGDs.

Therefore the findings here are neither complete nor robust by academic research standards; however despite these many challenges the team did a truly remarkable job, and the CVCA does capture well a sense of what communities are experiencing, and broadly the barriers and opportunities they are facing. Ample testimony has been gathered on how the communities are experiencing climate change which can be compared to the climate science. This report, and the accompanying village reports, provides a wealth of information to support the design of further research, engagement, and programmatic activities.

Please note that the findings presented in this report are as faithful as possible to what the communities told us and how they perceived things, and therefore may contain inconsistencies or statements that might not seem to be 'correct' to some readers. CVCA's are not intended to gather 'facts', rather they are intended to gather 'real' perceptions and lived experiences. This is because it is important to understand the reasons why different people report things or experience things differently (as this can relate to such things as power, access to resources, and adaptive capacity), and the differences between what people observe in particular locations and what scientific knowledge tells us generally, is often important too. An example from the CVCA is the findings that women and men reported an annual hardship period to be at different times. It is not for the CVCA to conclude that one is right and one is wrong, rather it's important to reflect on why these differences have been reported, and while this could have been data collection errors it could also uncover some interesting findings about gendered roles and responsibilities, and intra-household power (and some thoughts on this are offered in the analysis). Where readers feel that perceptions are 'wrong', it is important not to dismiss these, and instead consider how this relates to specific vulnerabilities and capacities.

Table 3: Summary of CVCA villages.

Ndembera sub-catchment	Mbarali sub-catchment
<p>Ifunda Village</p> <ul style="list-style-type: none"> - Upper section of Ndembera sub-catchment. - On the Lyandembera River and the main road linking Dar es Salaam to Zambia. - Mixed-maize rain-fed farming, trees for timber, vinyungu, and pastoralism, and Silverland commercial farm. 	<p>Wangama Village</p> <ul style="list-style-type: none"> - Headwaters of Mbarali River. - Surrounded by forested hills. - Near Kipangu Nature Reserve. - Irish potato, mixed-maize farming, vinyungu, domestic livestock keeping, pastoralism, and avocado.
<p>Nyakadete Village</p> <ul style="list-style-type: none"> - Mid/lower section of Ndembera sub-catchment. - Borders the Ruaha National Park. - Rain-fed mixed-maize and rice farming. - Irrigated rice farming in Madibira rice scheme. - Pastoralism. 	<p>Igima Village</p> <ul style="list-style-type: none"> - Mid-section of the Mbarali sub-catchment. - Kibena Tea Company irrigated tea plantation. - TANWAT wattle plantation. - Rain-fed agriculture. - Irish potato and avocado for export market.
<p>Mahango Village</p> <ul style="list-style-type: none"> - Lower section of the Ndembera River. - Near Madibira town. - Highly dependent on irrigated rice farming at the Madibira rice scheme - Rain-fed rice and mixed-maize farming. - Pastoralism. 	<p>Mwankagama Village</p> <ul style="list-style-type: none"> - Lower section of Mbarali River. - Mixed-maize farming and Irish potato, and irrigated rice. - Pastoralism.
<p>Igoma Village</p> <ul style="list-style-type: none"> - Lower section of the Ndembera sub-catchment. - Rain-fed and irrigated mixed-maize and rice farming. - Pastoralism. 	

2 VULNERABILITY

Vulnerability to climate change is defined as “the degree to which a system [natural or human] is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.”²

Figure 1: Representation of the relationship of exposure, sensitivity, and adaptive capacity to vulnerability.



Exposure to climate variability and change is primarily a result of geography. For example, communities located closer to a river will have higher exposure to flooding than communities located further away from waterways. People and ecosystems in the Ruaha Basin are exposed to climate risks according to their location, and the local topography and hydrology.

Sensitivity is the degree to which the community is affected by climatic stresses and changes. For example, a community dependent on rain-fed agriculture is much more sensitive to changing rainfall patterns than one where mining is the dominant livelihood. Sensitivity is also a product of environmental health. For example, a coastal community buffered by a healthy mangrove forest is less sensitive to storm surges than a coastal community living adjacent to a deforested mangrove area.

Adaptive Capacity is defined as “the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.”³ For communities (human systems), we can consider adaptive capacity to be people’s potential to be actively involved in the processes of change, in order to minimise negative impacts and maximise any benefits from changes in the climate. This is therefore about people’s access to and control over natural, human, social, physical, and financial resources; and it is influenced by external factors such as policies, institutions, governance, and power structures. As a result, adaptive capacity can vary considerably between different groups of people, and different people within groups.⁴

In understanding the vulnerability of a community - or in this case a village which is an administrative unit - it is important to understand that communities are not homogeneous, and not everyone who lives in the same village faces the same challenges, or has the same priorities or capacities to adapt. It is also important to be aware that communities’ actions are not isolated to their locality or administrative unit, they are part of a landscape (environmental, social, political, economic, etc.), and there are consequences of their actions across the larger systems of which they are part. A community’s actions can have far reaching impacts in other places and on other communities, through such systems as river catchments and sub-catchments, social systems, and the local economy.

In general, the world’s poorest people are also the most vulnerable to climate change. In part, this is because of their exposure and sensitivity (the majority farm the most marginal land), but in large part this is because

² Intergovernmental Panel on Climate Change (IPCC) Working Group 2 (2001), Third Assessment Report, Annex B: Glossary of Terms.

³ IPCC, as above.

⁴ This report uses the term adaptive capacity in its broadest sense as used in climate change adaptation literature, rather than the more narrow definition adopted by resilience literature which separates out what used to be all encompassed under ‘adaptive capacity’ into separate absorptive, adaptive, and transformative capacities.

they have limited access to those resources that would facilitate adaptation to climate change. Women are often more vulnerable to the impacts of climate change, not because of any physical difference or weakness, but due to their roles and responsibilities, and the often limited opportunities available to them. Women tend to have the largest burden of responsibilities in the home and in providing for the family, and they often have very limited access to information, resources, and services compared to men. Other groups, such as mobile communities, persons living with disease or illness, and the elderly, may also represent people with lower levels of adaptive capacity and higher vulnerability because of limited access to information, resources, or services. Different wealth groups in a community can have very different priorities and concerns, but also different levels of influence over decision-making processes and different levels of access to critical resources and services that affect their chances and opportunities in a changing climate.

Climate change adaptation is defined as *“the actions that people and institutions make in anticipation of, or in response to, a changing climate. This includes changes to the things they do and/or the way they do them. In order to minimise negative impacts and maximise any benefits from changes in the climate.”*⁵ Climate change adaptation therefore is a deliberate and holistic process to **reduce exposure, reduce sensitivity, and increase adaptive capacity**, so that people can thrive in spite of a changing climate.

The terms “adaptation” and “coping” are sometimes used interchangeably, leading to confusion about the similarities and differences in these two important concepts. Coping is important for short term shocks that people can ride out, sometimes referred to as absorptive capacity; but when conditions are changing coping is not enough in order to move from surviving to thriving. Coping is often short-term survival strategies motivated by crisis. They are often actions that can actually degrade assets and resources, and therefore their benefits are short term. They are often prompted by a lack of alternatives, and are not part of a continuous process. Whereas adaptation is oriented towards longer term livelihoods and natural resource security, and is part of a continuous process of sustained results. Adaptation requires efficient and sustainable resource management, and flexible and forward looking planning, in order that people can thrive now and in the future.

Therefore not all actions that people take in response to a changing climate are helpful, and indeed many can make the situation worse. Whilst coping strategies may not be too damaging if used infrequently and on a temporary basis, more damaging are long term reliance on coping strategies and investments that are not appropriate in the emerging conditions, or actions that increase the vulnerability of other people and systems. This is maladaptation, defined as *“those responses that address immediate risks in a manner that increases future risks because they create conditions that ultimately raise vulnerability.”*⁶ Therefore it is not just the consequences of climate change that people have to deal with, but the consequences of actions others take to try to manage climate change impacts. This is very pronounced when we think about freshwater ecosystems generally, and the Ruaha Basin in particular, where there are many competing demands for water and many actions being taken by different actors to reduce their own risks but that increase risks for others through catchment connections. WWF Flow Forward framework states that *“in the majority of cases, damage to freshwater ecosystems will occur as a result of the synergistic impacts of climate change with other anthropogenic pressures.”* It is that interaction of factors - climatic and human actions - that this CVCA seeks to understand, and the findings are presented here through the following discussion of communities’ exposure, sensitivity, and capacities.

⁵ Pettengell, C. (2010) *Climate Change Adaptation: Enabling People Living in Poverty to Adapt*, Oxfam Research Report.

⁶ McGray, H., A. Hammill and R. Bradley (2007) *Weathering the Storm: Options for Framing Adaptation and Development*, Washington DC: WRI.

3 EXPOSURE

The CVCA communities reported exposure to a range of climate- and non-climate-related risks and changes. These were unreliable rainfall patterns, droughts, heavy rainfall events, temperature changes, floods, reduced river flows (and, in some cases, rivers becoming seasonal and water sources drying up), strong winds, cholera and other water-borne diseases, HIV/AIDs, pests and crop diseases, livestock diseases, landslides, wildfire, road traffic accidents, domestic violence, violence between different land and water users, and political conflicts.

3.1 Unreliable rains

The most pronounced climate related challenge that was consistently reported by women, men, and key informants in all the CVCA villages, was that the rains have become unreliable. The rainy season used to be expected from November through to April, however now the rains sometimes come early (and then stop before restarting), sometimes late (in 2016-17 they did not come until January), end early, pause mid-season, or come in very heavy rainfall events. In the villages of Mbarali sub-catchment it was also frequently reported that the rainy season had become shorter, and that there was less rain overall (though this may be an observation of shorter duration rather than actual rainfall amounts, especially with heavier rainfall events also reported). Men in Igoma reported a new trend of the rains pausing in February, which they hadn't in the past, and that the pause is becoming longer. They stated that *"it used to be one week, but now the whole month [there is] no rain."*

3.2 El Niño/La Niña and inter-annual variability

El Niño in 1998 was reported in all communities as a significant disaster event following heavy rain on a scale not seen before or since. They suffered flooding, landslides, prolonged and profound hunger, structural damage, and water borne diseases, including a severe outbreak of cholera in Nyakadete. In Igima they described the rainfall as *"extraordinary"*, raining continuous from November to May/June. In Mahango it was reported that the rain even came up from the spring, so *"it was raining from the top and from the bottom"* even in their homes. In Ifunda El Niño was so severe that all their farmland was submerged in water, leaving no place to farm. They reported that they had not experienced anything as bad since. The 1998 event was known by everyone as El Niño.

Whilst El Niño was talked about by communities as a standalone one-off event of historic proportions, two potential linkages are observable from the data and worth noting. Firstly, four out of seven villages reported hunger the following year in 1999, with Mahango, Nyakadete, and Igoma clearly attributing this to drought, and Mahango and Nyakadete requiring food aid. Whilst Wangama didn't specify drought, they did report hunger which they attributed to an outbreak of *vivavijeshi* (a type of caterpillar) on their crops, and a significant fire, which could indicate drier (drought) conditions. This fits with the scientific reports of the 1998 El Niño and 1999 La Niña being some of the strongest global episodes on record, and is important in terms of the potential cumulative impacts communities face from two hunger years back-to-back, caused by damaging heavy rains followed by drought.

The second linkage is that two villages reported a decadal trend for hunger events. In Nyakadete village the men reported that the elders say that years *"ending in a 8 or a 9"* brings hunger from heavy rainfall or drought, and between the men and women FGDs they reported hunger and disaster events in 1949, 1988, 1999, 2008, and 2016 supporting this perceived decadal disaster trend. In Mahango men also reported a perception that droughts occur every ten years, and the women substantiated that with reported hunger events in 1982, 1988, 1998, and 2009.

3.3 Flooding

Communities reported incidences of floods in some cases as opportunities (where it facilitated rice farming without the need for irrigation infrastructure) and in some cases as disasters. Flooding was reported to be caused by heavy rainfall events locally or upstream, combined with human activities upstream that cause vegetation, sediment, stones, and debris to wash down the river, which was said to contribute to localised flood risks. Both frequent smallscale flooding and infrequent devastating flood events were reported. Whilst

flooding has productivity benefits for paddy, mixed-maize farmers suffered most from these events, with crops and fertile soils washed away, and farmland waterlogged. Flooding also resulted in siltation and contamination of public water supply systems, leading to water shortages and outbreaks of water borne diseases.

Mahango suffered severe flood events in 1973, 1986, and 1998. The men reported that in 1986 it rained non-stop from 3pm until 6pm the following day, and was so intense that it destroyed roads, bridges, and even houses. The village was cut off, and they did not have enough food. Whilst rains were heavier in 1998, they reported that they suffered less severe impacts compared to 1986 because the irrigation infrastructure protected them, preventing water from coming up into the village.

In Igoma the Mapamile River floods about every two to five years, however in February 2017 they experienced an especially severe flood caused by heavy rainfall locally and upstream. They lost crops in their fields and their bridge collapsed, forcing farmers to reach their fields by swimming. Trees, stones, sediment, and other debris washed into the irrigation canals causing them to block and burst, and a canal bridge collapsed. As a result of the damage to the irrigation system, they were only able to produce three or four bags of rice from their plots in 2017, compared to their usual 10 bags. The impact of the damaged infrastructure has been conflict between irrigated farmers over water use and distribution.

Mwankagama is located on a floodplain, and so experiences minor annual flooding as well as major floods from time to time when there are heavy rains. Past floods were reported to have eroded riverbanks, destroyed crops, killed cattle, and forced the evacuation of households living near the river. Flooding can also sometimes cause conflict amongst neighbouring farms when farm boundaries are washed away. A flood in 1994/5 was recalled as the worst with many houses and farms destroyed, and the Mbarali Estate Canal was damaged.

3.4 Temperature changes

Some villages reported temperature changes; whilst others said there had been no changes to temperatures. In Igima village women, men and key informants all reported that the climate is getting hotter, with men saying that *"in the past we did not experience hot weather, but now we experience it often"* and women that *"sunshine has been getting stronger and stronger"* since the 1990s, which they said causes Irish potato seeds to dry in the field if they plant before the start of the rains. They also reported that temperature increases had led to malaria, opportunities to grow banana and mangoes which they couldn't grow before, and has delayed the arrival of snow (coming in July rather than June, before ending in September).

Elsewhere, reported increases in temperature were less pronounced, and in some cases it was reported to be colder. In Nyakadete, men reported a slight increase in heat, whilst women and village leaders made no mention of warming and instead said that the cold season was longer this year (2017) - normally ending in July or August - but during September they complained they still had to wear jackets and use covers on their beds at night. This current cold period was also reported in Mahango and Ifunda, but only for this year, so it is possible that this extended cold period was over-emphasised because it was occurring at the time of the CVCA, and may have been an isolated event rather than part of a trend.

Data from Iringa weather station provides evidence that temperatures in the area did indeed rise between 1980 and 2009, and the IPCC predicts temperatures in Tanzania to increase by 2-4°C by the end of the century, with the interior of the country likely to experience the greatest warming. Whilst there was not consistent reporting of temperature rises across all villages, this is to be expected as gradual changes to average temperatures are often difficult to observe because of seasonal and annual variability, and because their impacts are less obvious compared to such things as droughts and floods. Therefore it is not necessarily the case that temperatures have not risen, and are not continuing to rise, in villages that did not report this; it is most likely that they are not yet experiencing changes as pronounced as places where there are clearly new threats (such as from malaria) and new opportunities (such as new crops).

Observations and impacts of temperature changes:

- Rising temperatures has made malaria more common in Igima and Igoma since the 1980s.
- Increased temperatures were linked to increased pest outbreaks Wangama.
- Increased temperatures may present opportunities for agriculture. In Igima, bananas and mango are now grown, while in Igoma they now farm paddy, which was only possible in the Usangu plains in the past.

3.5 Pest, crop diseases, and fungus

Generally pests, crop diseases, and fungus outbreaks were reported to have increased in recent years; however the CVCA was not able to capture a very detailed and complete picture of the differences between each and their causes. For example in Igima increases in crop diseases, pests, and fungus were attributed to changing weather, but whether this is due to rainfall or temperature changes was not specified. New pests and diseases were also reported, such as *kanitangaze* which is known in Kenya but new to the area. Whilst the perception was broadly that changes to the weather is responsible for the increased frequency of outbreaks and the arrival of new pests and diseases, other factors may also play a part. For example men in Igima reported that *mbufuga* is the main crop disease that they now suffer, which they attributed to growing the same crops in the same field repeatedly, because in the past when they rotated the crops grown in each field they did not have this disease. Overall smallscale producers reported using more pesticides now than they had previously, or needing to use it when they hadn't previously. However despite the increased use of pesticides, they were still impacted by pests and diseases, which reduced yields and in some cases devastating whole fields, leaving many farmers unable to afford fertilisers and seeds to replant. Pests and diseases have the ability to wipe out farmers investments, an example given was from Igima: *"one man in the village saved the capital to expand his farmland to many acres but after an outbreak lost everything. He is now struggling to start a new farm."*

Igima reported major outbreaks of *maringiringi* (shaped like half a ring) in 1996, *ukungu* (a type of fungus that affects farms and particularly avocado) 2015-16, *kanitangaze* (attacks tomatoes) and *viwavijeshi* (caterpillars that attach maize and other crops) in 2016.

In Mwankagama women linked low rainfall with pest outbreaks, such as in 2016 when vermin ate germinating seeds and *maringiringi* ate immature crops. They also reported *dumuzi* and *viwavijeshi* affecting tomatoes, maize and paddy. The men stated that if a field is affected by pests, yields can drop from seven bags per acre, to just one or two bags.

In Wangama outbreaks of crop fungus (*ukungu/ukungu*) and pests (*viwavijeshi*) were reported to be a growing problem, with *ukungu* outbreaks occurring every year for the past three years, with significant negative impacts on Irish potato harvests, and even now occurring in the dry season when it is usually only experienced in the wet season.

3.6 Strong winds

Strong winds were reported in Mahango, Ifunda, Igima, Nyakadete, Igoma, and Mwankagama villages, causing structural damage, particularly taking roofs off of houses and schools, and flattening maize in the fields. In Mahango village strong winds were reported as the key climate-related hazard for women, with both women and men reporting an extreme incidence of strong winds and rain in 2013, which last for three hours and caused extensive flood and storm damage to 20-50 houses, the school, trees, and crops in the field. Strong winds are mostly reported in the rainy season and often occur alongside flood events. Men in Mahango reported these events occur when the northern and southern winds meet during the rainy season. Strong winds were repeatedly linked to cutting down trees and concerns that villages have more open space and are more exposed. Damaging strong wind events were reported in Mahango in 2013, Ifunda in 2014, and in Igoma and Igima in 2015.

A different type of damaging strong winds were reported in Nyakadete village, described as *"whirling wind that picks up dust but then can become huge and destructive for 30 minutes, taking roofs off houses"*, as well as less powerful mini 'cyclones' reported as common during the dry season. These were attributed to climate change, strong winds, and having fewer trees and bare earth. It is also said to be caused if a women goes outside with her *ungo* (a plate for shaking rice); indicating these cyclones may not be a new phenomenon. The reported impacts were removal of fertile top soil from farmland, and damage to services, infrastructure, houses, and trees.

4 SENSITIVITY

Sensitivity relates to the degree to which those issues identified in the previous chapter will have negative impacts on lives, livelihoods, and the resources and systems on which they depend. Climate change is often described as a threat multiplier. This is because it does not act in isolation to the challenges that communities already face, and in fact it often exacerbates them, as well as bringing new challenges. Therefore resources and livelihoods that are already under stress tend to be sensitive to shocks and changes of any kind, and may also be sensitive to actions taken by others to cope with climatic changes. An example of this would be if more water is taken from a river to cope with less rainfall, however the river cannot replenish this because of the reduced rain, therefore this action exacerbates the water shortage further. Some of the sensitivity that communities face can be characterised as a 'development deficit', and whilst they are not 'caused' by climate change, they must be addressed together with climate change impacts for successful adaptation to occur.

4.1 Rain-fed agriculture

Rain-fed mixed maize farming is a dominant livelihood in all the CVCA villages, as well as Irish potato farming in the Mbarali sub-catchment villages. Rain-fed farming by definition is entirely dependent on good rains and therefore is highly sensitive to the unreliable rains, shorter rainy season, heavy rainfall events, droughts, floods, and El Niño/La Niña episodes that were reported. It is also sensitive to temperature changes both directly (during crop growth and the temperatures that crops can tolerate), and indirectly by any changes to crop diseases, pests, and fungus, that result from temperature and rainfall changes, as well as other factors.

This sensitivity is demonstrated by the ways farmers are affected, and its consequences for their lives and livelihoods. When the rains come late farmers lose everything they have sown in the fields in their fields, for example in Wangama women reported that they plant Irish potato seeds in October, but when the rains are late the seeds dry out and die. Some farmers also said that when the rains come early they suffer losses, as the rains now start and then stop for a while, so their fields dry out and they lose those seeds. Those who can afford to, replant, but this doubles their expenditure on seeds, fertilisers, and labour for that season. Others borrow money or labour for income to rebuy inputs, or else go without a harvest for that season. Those who borrow to replant have to repay their debts at harvest when prices are lowest, leaving them with less income for the year and less to invest in their farms next year, thus carrying the negative effects of one year's late rains into the following year. Farmers are also sensitive to the rains ending early, as this can happen before crops have matured, leading to failed or reduced harvest.

When harvests fail, farmers have less food and less income. The price of maize also increases as a result of the scarcity, compounding the problem and resulting in hardship, and sometimes malnutrition. Mixed-maize and Irish potato farming have only one season per year; therefore it is a year before farmers can recover from these losses. The CARE-WWF market assessment suggests that Irish potato farming can have two seasons a year; planting in September and harvesting in March/April, and planting in July to harvest in December which would potentially address this issue. However it crucially states that the first crop is dependent on rainfall availability, and the second requires irrigation. This CVCA found that it was not possible to plant Irish potato in September as the rains rarely start that early and farmers reported that their seeds dried out in the field and failed if they planted before the rains had fully started. The CVCA also found that even where farmers had access to irrigation, this supported rainy season farming, and was not available for dry-season farming.

4.2 Seasonal income and consumption

Having only one agricultural season per year requires that harvests generate sufficient food and income to provide for families throughout the whole year, and requires good skills for planning and budgeting resources. An annual hardship period was found to be common; this was a time in the year when the previous harvest had been consumed and all available income invested in farming for the year ahead. In some places this resulted in a hungry period, but in other villages the hardship period was not reported to be as severe (see Chapter 5 for a discussion of factors influencing this).

A difference between the perceptions of women and men in relation to this hardship period was found.⁷ Women reported this period occurred earlier than men did; with women stating this occurred September/November to February/March, compared to January/March to April for men. Women talked about this in relation to having no income and no harvest left, yet high expenditure on farming inputs and family costs such as school fees. Men talked about hardship in the last few months before the next harvest, with no income and all savings invested their farms, resulting in little to live on day-to-day. This could be characterised as women feeling the hardship when money must be found for household expenditures, whereas men experience it through how much they have left to eat and live on, and times when they are idle. This could be a reflection of women’s responsibilities to manage household budgets, provide food for the family, and send children to school, whilst also finding ways to invest in their own farming. It could also be linked to intra-household power relationships, with men potentially affected by the hardship later if their food and needs are prioritised within the household over women and children’s.⁸

This existing annual period of stress on seasonal food and incomes, indicates that communities are highly sensitive to the impacts discussed in Chapter Three, as subsistence is a struggle even in ‘normal’ years (i.e. the absence of a shock). This means that people have very little to fall back on when they are exposed to shocks or changes, making them more sensitive to their impacts. This is exacerbated further when a bad year is not an isolated event, but follows one after another, such as when a strong La Niña follows a strong El Niño, or a slow-onset change such as a declining productivity of soils or crop temperature tolerances reduces yields year on year).

4.3 Inward migration and village growth

Whilst there are many challenges related to agriculture in the area, the area is renowned for fertile land and new opportunities from rice farming, therefore it has attracted significant inward migration. All villages had grown significantly in recent years, largely due to inward migration, but also local rates of reproduction, and in Igima it was stated that the youth no longer leave for urban centres as there are fewer opportunities now.

Reported causes of inward migration:	Specific examples:
<ul style="list-style-type: none"> • Farming opportunities: Ifunda, Mahango, Nyakadete, Igoma, and Wangama. • Pastoralists moved on from other places: Mahango, Nyakadete, and Igoma. • Jobs on commercial farms: Igima and Mwankagama. • Reduced opportunities in urban centres: Igima. 	<ul style="list-style-type: none"> • Madibira rice scheme in Mahango and Nyakadete villages. • Mwankagama rice scheme. • Silverland Farm in Ifunda. • Vinyungu opportunities in Wangama. • Tea plantation in Igima.

The expanding village sizes have resulted in a significant strain on resources, notably on land available for farming and grazing (section 4.4), water for domestic and productive use (section 4.5), forests (particularly in relation to wood for building houses, section 4.6), schools,⁹ and health centres.¹⁰ Two villages¹⁰ have been split in two in response to their growing size, however while this may help with issues of administrative governance and service provision, it does not address issues of land and water scarcity. Indeed, some farmers reported losing land in these splits or land still under dispute many years later (section 4.4).

The failure of opportunities that attract large numbers of people also poses a significant challenge and has implications for local livelihoods. For example Wangama attracted inward migration due to opportunities presented by vinyungu farming, but now this is banned (see section 5.2) these people are left with no viable livelihood. Likewise the tea plantation at Igima mechanised in 2005 with the loss of 3,000 jobs. Nyakadete was the only village where a shortage of land was not reported, and as a result inward migration was viewed as a “blessing” by village leaders. They felt it brings development and new ideas, such as fertiliser use which was a

⁷ This issue was only discussed in detail in Igima, Mwankagama, and Wangama villages, therefore these observations relate to those villages only.

⁸ This is a suggestion on how the different perceptions from women and men in three villages could be interpreted, but the key point is that this difference was recorded in the CVCA, and more information and analysis would be required to really understand why. The information was collected by different facilitation teams, and therefore it is a possibility that the difference could be the result of a difference in how the team explained the task or how hardship was described.

⁹ For example in Igima class sizes were reported to be around 15 pupils in the 1980s-90s, and are now 70 pupils.

¹⁰ Mwankagama in 2013 and Mahango in 2015.

new practice people were now copying from new arrivals and getting the benefits. But whilst land was felt to be sufficient for new comers, water was not felt to be sufficient for the growing needs.

4.4 Land issues

Land shortage was a key issue reported by communities throughout the CVCA process. A number of factors were identified, including inward migration and increased population (discussed above); disputes and conflicts over land; policies that remove people from their land or prevent access to certain areas; and a perceived decline in the fertility of agricultural land (thereby requiring more land to produce the same). Of the different disputes and conflicts over land identified, conflict between farmers and pastoralists was the most pronounced and widespread. Many farmers reported that pastoralists did not keep their animals to the dedicated grazing lands, and instead allowed them to come onto their farms, destroying crops and costing them income. The reported conflicts ranged in severity from poor relations and some isolated incidences, through to violent incidences resulting in injuries and at times deaths. Villages had different ways of managing these conflicts, some fined pastoralists whose animals were caught where they should not be, others called the police, some tried to educate them about land use plans and policies, and elsewhere farmers took matters into their own hands. Farmers were very vocal that they were suffering as a result of the behaviour of pastoralists, and that they benefit little from current mechanisms of dispute resolution, for example fines collected by Village Councils rather than to compensate the farmer who had suffered losses, or dispute processes take time away from farming activities. However despite the claims by farmers that they suffer the most, the CVCA also discovered that pastoralists suffer from the behaviour of farmers and Village Councils too. In nearly all the villages, land designated for grazing had been taken for farming or tree plantations. Further farmers reported taking measures to restrict access for cattle even from places where they should be allowed access, and it was even reported that farmers have poisoned cattle. As this CVCA did not include pastoralist communities it is not possible to represent their grievances in these conflicts to balance the views of the farmers and village leaders that were collected, and therefore the information presented here is bias.

The second type of land conflict identified was between farmers over land boundaries; exacerbated by the perceived shortage of land. Acquiring additional land is considered to be harder or more expensive than it used to be, and encroachment is perceived to be on the rise. Farms are getting smaller as they are inherited and shared among siblings, driving up the demand for (and therefore cost of) land, and the increasing trend for timber production is increasing demand for land and taking land away from food production. Resolving these boundary conflicts were reported to take significant time away from income generating activities.

Disputes also occur between farmers and village leaders over land boundaries. This has happened when villages have been split, when farmers own land informally and villages decide to reallocate their land, or when new developments take priority over individual farmers. Farmers suffer as a result of the time and money needed to engage in processes to resolve disputes; not having formal land title/deeds; and not receiving compensation if their land is taken. The fourth conflict is between villages (and farmers) and the National Park authorities TANAPA, over the boundaries of the National Park. It is perceived that the national park frequently expands its boundaries without consultation or notification, and that this is increasing land shortages and exacerbating the other land conflicts.

A prevalence of government policies to remove people from their land was identified by the CVCA, and as a result people feared land being taken away from them. Examples discussed by CVCA participants were:

- Villagisation policy of 1974. Many reported losing land, assets, and livelihood, as well as disease outbreaks. Others felt more positively that it brought people together and gained access to services.
- Relocation of Igima village in 1947 from fertile land taken for a private tea plantation by the British. The eviction was considered to be a disaster event. They lost their farms so could not grow food, they had no shelter at the place they were moved to, and they lost their wealth and belongings.
- Eviction of pastoralists from the wetlands of Usangu by the government.
- Some residents of Mwankagama given only 28 days' notice and no compensation, forced to leave their homes and land to make way for a road.
- National Park redrawing park boundaries, taking land without consultation or notification.
- Village level reallocation of land in Wangama and Igima.

Insecurity of land tenure is therefore a key element in local vulnerability, and it is difficult to unpack how much the challenges farmers face are related to a shortage of land as such, or rather barriers to secure land ownership and effective management. In some villages many women and men reported owning farmland, whereas in others most relied on renting farmland when they could afford to. Pressures on land are also added to by the ban on cultivation on all land within 60m of any water source, and in some places new opportunities from timber production. Many villages also reported a decline in fertility of land, and often linked this to pressures on land availability. In Ifunda men reported that previously when your land became less fertile you just shifted to another place, but now there isn't enough land to do that. In Wangama and Igima they reported no longer practicing rotation farming, which they felt had led to the increased pests and crops diseases. Exhaustion of agro-ecosystems is costing farmers as they increasingly rely on expensive fertiliser, and suffer increased rates of crop diseases and pests, also requiring expensive inputs. Many villages reported that government subsidised inputs arrive too late or price caps are applied to late. Women in Mahango reported: *"instead of fertiliser reaching here in December it reaches in January to March. So if the government has been late the only way is to buy in normal shops at a very expensive price. If we go to those shops we are finished!"* This increased use of inputs also contaminates freshwater ecosystems, with implications for drinking water, fish health, and a wide range of other benefits to local communities.

The findings in the literature review (Annex 1) relating to conflict between water users and differing perceptions of the causes of water stress, is mirrored in the CVCA findings relating to land. A perceived shortage of land has led to conflicts between land users and a culture of blaming each other for the challenges they face.

4.5 Water issues

Water supply issues were found in all villages. The most common and severe challenges relate to public water systems for domestic use, but many of the villages also face issues related to productive water use. Whilst all villages have a public water supply system for domestic use (see Annex 4), most were reported to be unable to meet the needs of the village due to infrastructural issues, increased population size, and decreased water available from the source. Water supplies that are already under stress are highly sensitive to weather-related shocks and stresses, so these challenges are exacerbated by the unreliable rains, increased temperatures, and floods outlined in the previous chapter. Water sources are also prone to contamination during heavy rainfall events and floods due to a lack of toilets, poor hygiene practices, and untreated and unprotected water systems, which exposes communities to water-borne diseases. All villages reported water borne diseases during the rainy season, and also identified cholera as a key hazard, and whilst there have been a low numbers of outbreaks recently, it was still very much feared by women in particular, and there was even a cholera outbreak during the CVCA process. Cholera outbreaks are costly, particularly to women, as they incur medical costs, time away from income generating activities to take care of the sick and attend funerals, and closure of business activities, particularly brewing which was found to be an important income source for women. In one stark example it was reported in Nyakadete that during a cholera outbreak in 1998 as a result of El Niño, drips were removed from sick patients who did not have the money to pay.

Water shortages in the domestic water supply were also linked to domestic violence. One key informant in Mahango stated that *"everyone is affected by the water problems, but women are the ones who have to collect water at night [after queueing all day] so do not get to sleep and also suffer conflicts with their husbands because the men complain that the women are out too late. Meals are not prepared for the family at the right times if women are out queueing for water, and clothes are not washed as frequently."*

Significant changes to river flow were reported in a number of villages, especially since 1996. Where water shortages had not previously been experienced, these were now reported, and where rivers used to flow year-round, they had become seasonal. A high level of awareness was demonstrated by those participating in the CVCA about the interaction of a number of factors that might have contributed to this change, including climate change, droughts, siltation, over extraction of water upstream, increased irrigation use and commercial farming, vegetation clearance, upstream agricultural practices and land use changes, dams, and increased village sizes resulting in increased water demand.

As with land issues, the CVCA found that competing demands for water for productive use were leading to conflict among different user groups, notability between pastoralists and farmers, among farmers, and

between commercial farms and smallscale producers. Conflict was reported to be exacerbated in the dry season and particularly during droughts between pastoralists and farmers. Conflict was also reported at different irrigation schemes when water has to be rationed or is limited, and some farmers tamper with the system to get water. In the case of the Madibira scheme, women reported that water disputes had led to the death of one person, but that normally disputes are resolved by the leadership or by the courts.

In Ifunda and Igima conflict was reported between smallscale producers and the commercial farms that are perceived to be taking too much water from the river. At Ifunda, a 3,000 acre farm Silverland pays for a permit to take water from the river for irrigation for wheat, soya, Irish potatoes, and maize, and potentially also avocado and cashew nuts. The village has a long history of conflicts with the commercial farm, over access through the land and its treatment of local people. A new owner took charge approximately four years ago and relations currently seem to be much better than in the past. The women claim that Silverland used to block water but since meetings between local leaders, the water board, and the investor, the water is no longer blocked. Whilst they say there are no conflicts, the men complain that Silverland extracts too much water from the river which has depleted their water sources and impacts on their farming. Officials claim that Silverland takes less water than the permit allows and takes steps to use less water when the river is low, and that this was reviewed because of the community’s complaints. They feel that adequate water passes beyond Silverland, and the problem is further downstream where the water has disappeared (they think, underground) for the last seven years. Depleted groundwater could play a part since the practice of digging deep wells was introduced in the village 30-40 years ago, and nowadays because of the failure of two public systems for domestic water supply, the village primarily relies on deep wells in their homes for domestic water. Officials suggested a study will be undertaken, and it is vital that all factors, including Silverland’s extraction, potential depletion of groundwater, rising temperatures, and unreliable rainfall patterns are all incorporated into the analysis.

Overall the CVCA findings are consistent with the literature review (Annex 1) that since the early 1990s the area has suffered water stress and reduced river flow during the dry season, and that this has impacted on freshwater ecosystems and the services they provide to communities for drinking, sanitation, and agriculture, and that this water stress has led to conflict between water users. Community perceptions align with major studies with regard to over-abstraction and concerns about use of river water for irrigation during the dry season by commercial farms. The CVCA also provides evidence of the culture of blame identified in the literature review with different water users blaming each other for the water problems. Farmers blame pastoralists, pastoralists blame farmers, smallscale producers blame commercial enterprises, and downstream irrigation schemes blame upstream timber producers.

<p>Perceived causes of reduced river flow:</p> <ul style="list-style-type: none"> • Cutting down “water friendly” trees, particularly <i>Mivengi</i>. • Burning trees by water sources. • Vinyungu. • Brick making near to water sources. • Poor water infrastructure. • Climatic changes. • Increased extraction upstream by villages and commercial farms. • Cultivation on river banks. • Siltation. • Commercial farms not reducing water use during droughts. • Syphoning water for farming flowing continuously wasting water. • Increased village sizes and therefore increased water needs. 	<p>Village experiences of reduced river flow:</p> <ul style="list-style-type: none"> • Prior to 1996, Mahango suffered no water shortages, with adequate river flow even in the dry season. • Since 1996, rivers in Nyakadete have become seasonal, completely drying up in the dry season: <i>“In the 1970s during the dry season the rivers used to flow and you could only cross the rivers by swimming, but today even a child can cross the river, there is no water.”</i> • Since 2016 (to data collection in September 2017), the Lyandembera River in Ifunda has been so low you can walk across it.
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4.6 Deforestation

A reduction of trees was widely reported to be a hazard that communities faced. Cutting down of trees was reported for firewood, charcoal, timber, house construction, and clearing land for farming, and significant trees losses were also reported as a result of fires caused by burning farmland to prepare it for agriculture, bee keepers using fire in forests to disburse bees to collect honey from hives, and conflict leading to deliberate arson. All of which has resulted in villages having more open, bare spaces, and being less protected from strong winds, landslides, soil erosion and degradation, and strong sun.

Generally the CVCA found a high level of awareness in communities about the importance of trees. However fairly consistently, women complained that men still cut down trees, and were particularly concerned about the cutting down of trees they described as 'friendly to water' such as *Mivengi*, because they felt this was a factor in low river flow and water scarcity. Women talked much more about protecting trees, compared to men who focused more on planting trees, and this may explain some of the differences between their perceptions of the issue. In Ifunda the men stated that "*we plant a lot of trees now*" and that the people of Ifunda are "*aware and are mobilised to plant trees and take care of those trees.*" Ifunda grows many trees for timber business opportunities, and whilst the women have no problem with planted trees being cut (because they are then replanted); they were concerned that the natural forest is being cut too. They also rely on the *Mikusu* tree, natural fruit tree, for fruit to eat or sell, but the men often cut these too while they are cutting the other trees. They complain to their husbands, but are told that they are their trees to cut. Predominately trees being planted are for financial opportunities or those provided for replanting schemes, whereas we were told in Ifunda that seeds for 'water friendly' trees were harder to get and had to be collected from the bush. This shows that not all trees are equal, and addressing concerns of river flow and ecosystem services require different trees to those for timber production, and protecting mature trees remains vital unless sufficient and sustainable levels of tree planting re-establishes what has already been lost over many decades.

Strong winds were a key hazard reported in many communities, and the CVCA was not able to ascertain whether strong winds have increased in frequency or intensity, but certainly communities perceived that they are more affected by such things as strong winds, landslides, and floods because of widespread tree loss.

4.7 Market Access and price volatility

The CVCA found a number of different market access challenges that villages face; some have no markets, poor roads inhibit access to larger markets, many rely on just one buyer (limiting price and offering no alternative should that buyer stop coming), poor prices for producers, currently ban on food exports (September 2017, in anticipation of a national food shortage), and high levels of price fluctuation.

Smallscale producers felt they had few opportunities to get the income they deserved for their produce, and felt that others were benefiting more from their hard work than they were. Even where there were good production opportunities, such as the Madibira irrigated rice scheme, the productivity success had not been matched by profitability. Those irrigated producers were grateful for the volatility of food prices, as their prices increased in years of failed rains. However all other producers suffered with low selling prices in years of plenty and high prices for food in years of scarcity.

In Nyakadete, they reported that due to heavy rain last season was a poor harvest and food prices increased. The women reported buying a *debe* for 22,000 Tsh - "*which has never happened in our life history*" - the normal price is 7,000-10,000 Tsh. As a result they were struggling to feed their families and were selling chickens and 'bites' to cope. In Igoma, they reported that the price they received for maize declined this year from 60,000 Tsh to 40,000 Tsh per sack. The men blamed the 'free market', complaining that the market for maize is no longer reliable since the government stopped purchasing maize at a set price, and that input costs now exceed the price they get. They reported that they currently have produce stored in the *ghala* and at home, but there are no buyers to sell to. They used to sell to people in the Usangu basin, but since yields have increased there now they have lost that market and are forced to sell at a low price. Planned community development activities have stalled because people are unable to pay their contribution.

In Igima the women reported that options of where to sell their produce was constrained by middle-women, who loan expensive farm inputs upfront on condition that she will buy their produce once harvested to sell to Makambote market. They complained that all their money goes to the middle woman and they don't make a profit because prices are low, supply is high, and a limited number of buyers set the price. They also felt that the lack of a permanent market in the village constrained their options and limited competition, because buyers go direct to farmers who have little choice but to accept their price. They are also suffering this year from low prices for Irish potatoes, which they produce for the international market, but the government has banned international exports in response to expected domestic food shortages. They are forced to sell on the domestic market where the price is much lower and reportedly "*does not cover the cost of production, we lose money from the crops.*"

5 ADAPTIVE CAPACITY

Adaptive Capacity relates to the degree to which different women and men can effectively take steps to reduce their exposure and sensitivity, and to thrive in a changing climate. It is about the capacities that different women and men have to be actively involved in processes of change that enable them to minimise negative impacts, and maximise any benefits, from changes in the climate. The focus of this section is on what factors enable this, and what factors constrain this. These factors relate to different women and men's access to and control over natural, human, social, physical, and financial resources; and it is influenced by external factors such as policies, institutions, governance, and power structures. As a result, adaptive capacity is not the same for all members of a community, or all communities, and it can vary considerably between different women and men.

5.1 Opportunities from irrigated rice farming

There has been growth in rice farming in areas facilitated by natural flooding and irrigation schemes. These irrigation schemes are a lifeline for food production and income as they are less sensitive to poor rains and floods, and are reported to *"always"* produce something to eat, as well as allowing irrigated farms to benefit from the price increases that result from years with poor rainfall. The CVCA found irrigated rice farming to be an important livelihood opportunity, especially in the lower regions of the Ndembera sub-catchment. In Mahango women reported that *"we mostly depend on rice farms."*

The Madibira Smallholder Agriculture Development Project is a 3,000 hectare and 3,000 member irrigated rice scheme located near Madibira on the Ndembera River. The scheme opened in 1997, has a 99 year lease from the government, a water permit from the Rufiji Basin authority, and is run by the Madibira Agricultural Marketing Cooperative Society (MAMCOS). Annual production at the scheme is between 15,000 and 24,000 tons of paddy depending on the conditions. Women and men from 11 villages in the area 'own' land at the scheme, including the CVCA villages Mahango and Nyakadete. When the scheme was established everyone in Mahango aged over 18 years – both women and men - were entitled to join the scheme to own one hectare of land in their own name. At that time the entrance fee was 1,000 Tsh, plus a 5,000 Tsh annual share investment (up to 100,000 Tsh), and not everyone took up this opportunity. The scheme now is very popular and the fees have increased to 150,000 Tsh per year.

Everyone reported that you will always get a harvest at the scheme, and that support is also available such as extension officers and loans for agricultural inputs, school fees, food, or when family members are sick. Whilst both men and women reported the scheme to be productive and a lifeline for food for the village, profits were reportedly low, especially if paddy is sold rather than processing it and selling rice, or if loans need to be repaid immediately at harvest when the price is lowest. This year (2017) the price was very good as a result of the impact of poor rains on non-irrigated crops, so rice sold for 110,000-120,000 Tsh per 100kg. This income was vital as these farmers too suffered poor harvests from their other fields. There is no local market, so in normal years they only get a low price for their rice. Fertiliser is also needed at the scheme, which compares unfavourably with naturally flooding farmland available at Siriyamboga. Indeed when the weather is good, the non-irrigated farms were said to harvest better than the irrigated, however these suffer when the rains are poor which is happening more often recently, so the harvest is not as reliable as the scheme.

All rice farmers face potentially devastating losses from quelea birds eating their crops from April to June. Those not in the scheme hire someone for 70,000 Tsh per month to chase away the birds, but the scheme sprays poison to kill the birds. The men even reported they eat the dead birds, demonstrating few concerns about the use of poison, though this poison undoubtedly ends up washing into the Ndembera River. They also face threats from *mbenya*, a paddy disease. Before the rice scheme there were incidences of drought and hunger where the village had to rely on food aid and foraging. Now the scheme is seen as a big support in times of crisis, with the general consensus that with the scheme *"there will always been food around here,"* and there is no hunger anymore. Production at the scheme is however impacted by poor rains, and also by temperature variations, since the paddy is affected by too little sunshine and by the cold. *"In March it can be too hot, which makes the flowering problematic, and at the moment we are feeling the cold"* was considered unusual for September.

Whilst the farmers 'own' the hectare of land they farm, this is contingent on them keeping up the membership and maintenance payments, and not 'breaking the rules', and the scheme is on land leased from the government. Given the government's inconsistent decision-making on National Park boundaries, water permits, and its tendency towards policies of removing people from their land, a degree of fear that the scheme may be taken away from them is understandable, and the women voiced concern that "*if one day the government gave an order to leave that place we will die.*" There is considerable dependency on the scheme that should it fail, be closed down, or taken over, there are few other options for people. The scheme is also a contributing factor in the high levels of inward migration to the area, despite the scheme already being full.

Whilst irrigated rice farming was reported to be less sensitive to the key challenges the area is experiencing - notably unreliable rains - it is not completely immune, with incidences of water shortage and conflict over water reported at the scheme as well as lower harvests this year as a result of poor rains. Beyond the rainfall and river water levels issues, rice farming is also sensitive to hotter and colder conditions, and whilst neither have become very pronounced in the area yet, temperature changes are likely to increase over coming years.

Irrigated rice farming was found to be beneficial to communities, but a number of challenges were also found:

- Shortages of water.
- Increased temperatures affecting flowering in March.
- Increased cold impacting on harvests.
- Threat from quelea birds (and costs of labour or poison to manage) and *mbenya* disease.
- Need for fertiliser.
- Environmental impacts of fertiliser and poison on land and water supplies.
- High costs (land, maintenance, inputs, etc.) and low profitability.
- Dependency on access to infrastructure and land (ownership and tenure issues).
- Inward migration and viable scale.

5.2 Vinyungu and governance of natural resources

The CVCA found indications that the governance of natural resources has both improved and increased in importance in recent years. Water User Associations (WUAs) are active in educating communities and protecting water resources by planting 'water-friendly' trees, enforcing a ban on cultivating within 60m of water sources, and replanting degraded areas. Currently enforcement appears to be patchy, and it is too early to assess whether these measures have had the intended impacts, therefore transparent monitoring and reporting is required. However WUAs appear to be unfunded or poorly funded (some mentioned WWF funding which came to an end, and others that there is no money for travel costs) and seem to be mostly focused on village level user needs rather than linked to catchment level priorities, institutions, and initiatives.

Vinyungu, or bottom valley cultivation, is a traditional means of production that relies on natural moisture, or water from natural springs or river diversions, and has been a vital means of ensuring food and nutrition security and income generation for smallscale farmers, particularly women, across the region.¹¹ Relying on the fertile, moist soil, vinyungu mostly does not require the use of fertiliser. Nearly all villages reported vinyungu is an important means of producing food (particularly nutritious vegetables) for household consumption and surplus for selling, as well as being the key coping strategy when rains and harvests fail, and during periods of hardship. It was reported time and again to save lives during periods of hunger. However vinyungu is banned under the Environmental Management Act 2004 section 57, which prohibits human activities that adversely affect conservation to be conducted within 60 meters of riverbanks. The ban was well known, well reported, and well understood in all the CVCA villages. However the degree to which it is being implemented is unclear. The ban is intended to protect water sources from drying up and from contamination and siltation. Some villages did report some positive outcomes, though given the short timelines since implementation it was unclear if people were actually reporting observed benefits, or rather repeating what they had been told would be the benefits.

Given how strongly vinyungu was reported as a vital source of family food and nutrition, for income generation, and as the primary survival strategy during crises, it is hard to imagine how people will cope with the next period of hardship without this to fall back on if the ban was to be fully enforced. The women in

¹¹ Kyando, F. E. (2007) *Impact of valley bottom cultivation (vinyungu) on poverty alleviation in Mtitu river basin, Kilolo District, Iringa, Tanzania.*

Mahango reported they are worried about what will happen without vinyungu to fall back on, and one key informant insisted that without vinyungu prostitution would be the only remaining coping strategy. Except for Wangama where income from avocado production was discussed as a potential replacement for vinyungu, no other alternatives were reported, and observing the scale of vinyungu in Ifunda it is not clear how people could be stopped from this vital livelihood activity without an alternative being offered. This raises a question of what that alternative could be, and whether an infrastructure irrigation project of the scale that would be required to replace vinyungu, would actually be more or less climate compatible and conservation-friendly than traditional vinyungu.

Whilst the full implications of the ban will not be known for a while – and must be studied – it seems highly likely that this will increase the demand for infrastructure irrigation; exacerbate land and water shortages and conflicts; and increase levels of food and nutrition insecurity that result from poor rains, droughts, and floods. This issue demonstrates clearly why a holistic vulnerability reduction approach to climate change adaptation is vital, as all these trade-offs must be weighed up in the consideration of policies, and those implemented must be based on forward-looking assessments of both the impacts and the implications of the policies.

Summary of key information gathered on vinyungu:

- Vinyungu is used to grow a wide variety of vegetables mainly for family use, including green peas, tomatoes, Irish potatoes, maize, Chinese vegetables, beans, carrots, eggplant, and cabbage.
- Families tend to have small plots passed down for generations.
- Vinyungu is considered to be the primary way to cope with late or poor rains.
- Vinyungu is credited for saving lives during significant periods of hunger (including the 1998 El Nino), with testimony stating: *“people are just preventing us to go to vinyungu, but they don’t know how it saved us.”*
- Village leaders in Ifunda reported that people were not motivated to establish irrigation schemes, which they attributed to the success of vinyungu.
- Some women reported that since having environmental education they have stopped doing vinyungu as they have been told it causes water shortages and erosion.
- Vinyungu in Wangama was reported to have decreased (estimated 85-90 percent); however wealthier farmers still continue. Decreased vinyungu production was blamed for economic decline of the community.
- In Wangama some farmers are coping with the ban by producing avocado, which presents a new opportunity for year-round income. However expertise in avocado production remains low, and trees are affected by pests, so profitability is a challenge in the face of high costs of pesticides and fungicides. Without adequate training on alternatives, it is feared people will return to vinyungu.

5.3 Flexibility in farming and income generating activities

Women demonstrated a high degree of flexibility in their income generating activities as a way to cope with hardship. In farming some reported having learnt that if the rains come early they must still wait to plant as the rains tend to stop before restarting again so they would otherwise lose what they planted. They also reported switching to faster maturing crops (such as sweet potato and in one village they talked about a ‘modern’ variety of maize) if the rains are late or they face some other calamity. They are increasingly keeping animals at home, predominantly chickens and pigs, to sell when they had no other income; and women also brewed alcohol, cooked bites and meats, and traded to provide year-round income to help manage with the otherwise highly seasonal household incomes, as well as to manage difficult periods. Men by contrast seem more fixed in pursuing their dominant livelihood activity and having fewer strategies for managing difficult conditions, and reported more losses than women tended to. In times of crisis, men’s primary strategy was to migrate for casual labour, however this has negative consequences for the women and children left behind to fend for themselves and manage all the farming, household, and other income generating activities. Little evidence was provided as to whether this was or was not a successful strategy; indeed women reported that men would return with little by way of food and income, and sometimes with additional wives and children, increasing the burden on the household.

Annex 5 provides more details on the different income generating activities of women and men, and their opportunities and challenges.

Example of gender differences in flexibility from Nyakadete village:

In Nyakadete the farming is considered to be very productive, even without using fertiliser, and many people have

moved to the village for this reason. The women stated that *“it has never happened in our history not to harvest something. Even if there is late rain or early dry season, you cannot even miss 40kg,”* and, *“if you do farming, end of the day you get something, even with these calamities.”*

However the men reported more losses, such as in the 2015 and 2016 floods, some men said they didn't harvest anything at all. However others said that the floods are normally short-lived and you can go back to your field afterwards and cultivate something.

Women also reported that they no longer plant when rains come early, and instead wait and prepare their fields as normal in November to December. If the rains however do not come until January, then they replant with faster maturing varieties and grow more sweet potato, so that they will have something to harvest. The women said that *“10 years ago we didn't have an extension officer and didn't have much knowledge about agricultural practices, but now we have one extension officer for two villages, and we have some knowledge. So we were more impacted 10 years ago, but now we have learnt what to do if the rains are not clear. The agriculture officer has also taught us about the best seeds to plant at different times, and we have more experience now of what to do if the rains are late or early. We are very flexible, if there is no rains we plant sweet potato or make brew.”*

The degree to which Nyakadete could cope with unreliable rains and avoid hunger appeared to be higher than compared to the other CVCA communities, however the difference in approaches and reporting of impacts between men and women were common.

5.4 Land security and land title

Conflict over land and insecurity of land ownership, as a result of traditional ownership rather than title deed, presents a barrier to adaptation. From time and money lost to settling disputes; to little incentive to invest in longer-term health of soils and agro-ecosystems over short-term gains (such as abandonment of rotation farming, and increased use of chemical fertiliser); through to land being taken away from people, adaptive capacity is being constrained.

In Igima, some men sought land titles from the district government in an attempt to reduce the land disputes, but the cost of this has dissuaded others from doing the same. The village does not have a land use plan, and the village council manages land disputes through a Land Tribunal Committee. There are other examples throughout this report of land being taken by village councils, other farmers, the National Park, or to clear areas for new infrastructure or plantations, with owners receiving no compensation for their losses.

5.5 Inequitable resource access and the marginalisation of pastoralists

Whilst natural resource management and governance show some signs of becoming more important and improving, it does not appear to be inclusive and equitable. Instead it seems that particular interests are prioritised over others, such as commercial enterprises prioritised by national and district decision-making, and local farmers prioritised by village councils, and pastoralists do not seem to be adequately considered by any processes or structures. This is even evidenced by their absence from this CVCA process. It was the intention that this CVCA should include a highly representative sample of all land and water users in the area, however specific attention was not paid to how to enable the active participation of equal numbers of pastoralists and farmers in the logistical planning, and whilst requests went to each village to invite both pastoralists and farmers, it was not adequately considered how to meaningfully engage a mobile population who may not identify with administrative units (villages), or who may not have strong ties to them. Whilst governments are often criticised for their poor understanding of and engagement with non-settled populations, civil society organisations are rarely better equipped to meet this challenge, and in this case we let down this vital sub-community within the landscape we were seeking to understand, by not capturing their experiences and perspectives.

The CVCA found that pastoralists were marginalised, and do not have their basic needs for access to land and water met. Indeed out of the seven CVCA villages, five reported that there was insufficient provision of grazing land as a result of this not being prioritised or grazing land being reallocated for other uses. The other two villages did not mention provision of grazing land at all. This lack of grazing land for pastoralists to access has resulted in conflict as pastoralists try to access land and water in other ways. This conflict at best takes time away from other activities to resolve, and at worst generates a climate of intolerance and violence that has even lead to loss of lives. Therefore it is not only pastoralists' adaptive capacity that is undermined by this, but all communities.

Limitations on pastoralists access to resources is a particularly pressing challenge, but is not the only example of inequitable access and disadvantage identified in the CVCA. The issuance of water permits to commercial farms in areas where smallscale producers suffer water shortages and domestic water supplies are inadequate, and the issuance of permits to cut natural forests for charcoal where deforestation is already causing negative consequences, are examples of where wider issues of ecosystem health, local livelihoods, catchment management, and equitable access to resources are not adequately considered (the CARE-WWF Alliance Landscape Study which accompanies this study should offer more detailed insights into the decision-making processes governing these). To address the immense water and land challenges faced in the Great Ruaha Basin requires inclusion and valuing of all groups of people who live there and rely on its landscape. Collaboration across all land and water users, and a desire to manage trade-off in an inclusive and equitable way, is currently absent from formal structures and from the perceptions of settled communities, which limits opportunities for adaptation and to thrive in spite of a changing climate. Worst still, those most excluded (pastoralists) are often the most blamed, despite findings from credible studies to the contrary.

5.6 Access to credit and services

The CVCA found that credit (at modest levels) was broadly available, provided by a variety of sources including NGOs, financial institutions, membership organisations (such as the Madibira rice scheme), community savings and loans groups, as well as informally from neighbours or wealthy individuals which can be taken for repayment or in exchange for labour. Whilst there were incidences reported of credit being used for small business opportunities, the majority of discussions of loans and repayment focused on the purchase of annual agricultural inputs, and most required repayment immediately at harvest when prices are at their lowest. This requirement to sell produce at low prices in order to pay back loans simply continues the cycle of not having enough money to purchase the next season's inputs, and leads to borrowing once again. This also puts households under enormous stress after poor harvests, not having enough income to pay back loans and to get them through the year ahead.

Access to credit can contribute to adaptive capacity when it is used to manage infrequent incidences of hardship or when it is used to invest in opportunities that are less sensitive than current income generating activities. However if it is simply used as part of the annual cycle of input purchasing, and depends on good rains (which are becoming less reliable) to repay, it is questionable the degree to which it is contributing to adaptive capacity, and in fact it may instead be reducing it.

Examples of credit use from Wangama:

There are two credit and savings groups active in Wangama which provide an important resource to enable women to start new businesses. The motivation to start the groups was to address the hunger their families experience. Loans have been used to invest in new livestock rearing, small businesses, honey production, and a small timber plantation, but also to replant crops or try an alternative income generating activity if rains fail. However, they remain worried that they struggle to repay loans when crop yields are low.

Other services that were identified in the CVCA that can contribute to increasing adaptive capacity include receiving advice and support from Agricultural Extension Officers and Veterinary Officers, government subsidised inputs, information such as seasonal forecasts, and provision of food aid during crises. Between villages there were notable differences in access to and availability of these services; and therefore differences in adaptive capacity as a result. For example the women from Nyakadete cited tangible benefits to their farming as a result of support from the local Extension Officer (see box in section 5.3), whereas in Mahango it was reported there was little support available, except for members of the rice scheme.

One notable problem that women and men reported was that whilst there were policies for government subsidised inputs and price caps on inputs, they were not benefiting from these as inputs arrived too late or price caps were applied to late. As a result, women and men had to choose between paying full price for inputs or not use them at all. Therefore the benefits of these policies are being missed due to a failure to effectively implement and oversee these government policies. Other challenges identified related to the provision of food aid and seasonal forecasts. Villages reported that they did not have access to seasonal forecasts to help them manage the unreliable rains. Men in Igoma did report that this year the extension officer told them that late rains and low rainfall were predicted, and they should plant drought tolerant crops, but they said that generally they plant their crops at the same time every year as they don't usually get

information on whether the rains will come early or late. A village leader from Mwankagama said that he gets seasonal forecasts from time-to-time, but only if he happens to see an extension officer, and normally it's too late, arriving after the fields have been planted. These were the only reported cases of seasonal forecast use in all the villages. Access to food aid was also challenging, with women from Mwankagama saying that even when food aid is provided they have to fight for it and *"if you are weak, you can't get"*, and in Nyakadete that it isn't available to everyone, even those in need. Therefore action is needed to improve the timely and effective implementation of existing policies, provisions, and information that should reach communities and smallscale producers to support them in their livelihoods planning and in times of crisis.

Access to adequate reliable and safe drinking water was also found to be a key challenge constraining the ability of all villages to thrive. The CVCA found that public water systems are not fit for purpose, leaving communities suffering both water shortages and exposing them to water borne diseases. This dramatically increases these communities' vulnerability, and constrains their adaptive capacity through health and cost implications, and by increasing the work burden on women. The failure of these systems takes women's time, energy, and money away from income generating and other domestic responsibilities, and exposes them to increased risks including from domestic violence.

5.7 Domestic violence and the role of women

Domestic violence was reported as a significant hazard faced by women in all villages in Ndembera sub-catchment; however it was not reported at all in Mbarali sub-catchment. This could be a difference between villages in the two sub-catchments, however it could be a result of the data collection process, as the Mbarali team was led by a male international consultant, and the women on the team may not have felt as comfortable talking about this issue compared to the Ndembera facilitation team who worked with a female consultant. Domestic violence was reported to be a hazard both in times of hardship and in times of plenty. Whilst women identified it as a key hazard they faced, they also went on to describe it as being a *"normal part of love"* and that they didn't leave their husbands because they have children to take care of. Key incidences reported related to water shortages (when women are away from the home for long periods - and even late into the night - in order to collect water), and also after the harvest when both men and women had money to spend on alcohol, which would lead to arguments and men would beat their wives.

Women in a number of villages reported that they are primarily responsible for generating the income for household food, clothes, and school fees; and that the men do not contribute. However in Mwankagama the men spoke of leaving money each day for the family needs. Women in Igima were concerned that *"if we depend too much on our husband, our wealth will be spread to other women,"* and so many did their own farming activities. However women in Mwankagama and Wangama reported that in spite of doing their own income generating activities, their husbands controlled the money they made, controlling for example when they could sell animals and what they could spend the income they received for it on. In some places women owned land, notably at the Madibira rice scheme where they stressed that it was in their own name, however generally it was reported that women weren't able to legally own land, or that it was just starting to happen.

Girls were reported to be attending boarding schools without dormitories, and that they had to rely on getting money from lorry drivers for their living costs. HIV/AIDs was reported to be prevalent in all the villages, and girls at boarding schools were considered to be particularly vulnerable. Even where there were dormitories, child safety and welfare seemed not to be prioritised, with a reported fire at a school in Ifunda leaving children homeless and penniless far from home, left to fend for themselves which reportedly resulted in thievery and prostitution. Prostitution was also mentioned in relation to school girls generally, as well as associated with new developments (such as construction of roads and irrigation schemes), and as a way of coping during hardship and crisis.

Asset ownership for women in Igoma:

Women in Igoma reported that they did not use to be allowed to own land but that things are improving, and that women who had wanted plots on the irrigated land had been given them. They said houses are owned by men, but things like motorcycles are owned together as a family, as such they described that if their husband was not home and someone came to borrow it, she felt she could loan it, because she feels equal in ownership.

5.8 HIV/AIDS

HIV/AIDS was reported to be widespread across all villages, and many directly linked the arrival of HIV/AIDS to new services and infrastructure, such as the construction of roads, irrigation schemes, and plantations. In Igima it was linked to the establishment of the tea plantation and the influx of migrant labourers. There HIV/AIDS was expressed by some male participants as having the worst effect of all the hazards on the community because so many people are infected, it affects people's ability to work, and it has led to many orphans. They stated that *"there are lots of old people; the young have vanished."* In Wangama it was reported that most people in the community had been infected, however despite having a dispensary in the village, they had to travel to the health centre at Kidugala for medication, and the transport was costly. The lack of a dispensary at Nyakadete was also stressed as one of the main challenges the village faced. The National Park had built one in the next village for use by both villages, however the population of both villages had grown significantly since then, and whilst they used to only have to wait one hour to be seen; now they have to wait many hours. Women reported that it takes a whole day to go there and get medicines – often they are waiting until 8pm at night – which means they aren't able to look after their family and it can lead to arguments at home.

The South Highland zone, where this CVCA was conducted, is the most HIV/AIDS affected area of Tanzania. Whilst HIV prevalence was 5.1% for Tanzania as a whole in 2011-12, the prevalence in Iringa, Njombe, and Mbeya regions was found to be 9.1%, 14.8%, and 9.0% respectively; significantly higher than all other regions.¹² Women were also found to be more affected, with women aged 23-24 in Tanzania twice as likely to be living with HIV as men of the same age.¹³

5.9 Lack of opportunities for youth

The specific challenges faced by youth was not discussed in many villages, however in Igima it was reported that there are few opportunities for youth because there is limited land available and there are fewer opportunities in Dar es Salaam and Tanga than there used to be. The youth who suffered the most job losses at the tea plantation, and now fishing is said to be the only legal activity available to them to get income. They were most severely impacted by the swamp drying in 2002, and continue to be impacted as since that time some fish (including the *ningo*) have never returned to the swamp.

5.10 Innovation

Innovation and the ability to innovate, is considered to be a component of adaptive capacity. Innovation helps to minimise negative impacts of climate change through adapting existing activities to emerging conditions, and also through the pursuit of new activities to maximise any opportunities of climate change. However innovation inherently involves risk (the risk of trying something new and it failing), so even pursuing opportunities can be a risky business without the right knowledge, skills, experience, and inputs; or without knowing what conditions are needed and whether you can rely on having those conditions. NGOs often seek to provide new opportunities, but often do not adequately appreciate the (opportunity) risks, and in doing so may inadvertently increase vulnerability through maladaptation. The CVCA identified a number of initiatives that had been implemented or introduced, and a number of challenges and trade-offs inherent in each.

Agriculture is the mainstay of livelihoods at Ifunda, particularly rain-fed mixed-maize farming, but villagers are increasingly growing trees for timber on their farmland, a practice being promoted by the District Council. They grow cypress and pine for timber, and *Milingoti* for electricity poles and timber. Some people are also planting avocado trees and some guava for the fruit. Men reported that most people are engaged in some tree business now, however it is mainly just men. They now plant a lot of trees on their farms; in the region of 5,000 and 100,000 trees. Timber business is popular because they have seen how successful it has been in Mafinga, and they want Ifunda to benefit too. However it was reported that Mafinga may now be suffering with scarcity of food as a result of a widespread move from food production to trees. It was felt that this wasn't a problem in Ifunda because farms are big and most men are planting half maize and half trees, but it

¹² Data from 2011-12 survey reported in Mpondo, B. C. T., Gunda, D. W., and Kilonzo, S. B. (2017) 'HIV Epidemic in Tanzania: The Possible Role of the Key Populations', in *AIDS Research and Treatment*, Vol 2017 available to download at: <https://www.hindawi.com/journals/art/2017/7089150/>

¹³ <https://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/tanzania>

was feared than in coming years men may plant more trees, leading to food shortage. It was also noted that there is no longer grazing land for pastoralists as this has now been planted with trees, and that this could exacerbate conflict.

In Wangama avocado was introduced three years ago by a civil society organisation from Njombe who donated seedlings and trained households on how to grow and maintain avocado trees. The avocado trees are irrigated and fertilised with manure, and the avocados are sold to a white foreigner from Njombe where there is a market for them. Those who grow avocado benefit from year-round income, however it was reported that avocado farmers in the village are novices and do not know how to stop fungus and pests, as a result the cost of pesticides and fungicides reduces profits and capital for reinvesting in production, and reduced farm incomes means loans may fail to be repaid. In addition one key informant reported that snow destroyed the avocado flowers 2015, one out of the three years they have been producing so far. It is still early days for avocado production in Wangama and so the extent to which snow, fungus, and pests will impact and whether expensive inputs can be avoided or afforded remains to be seen. Further with just one buyer available to them, whether they are able to access a fair price and/or find other buyers remains to be seen.

Coffee was introduced in Ifunda in the past, but it was not successful because the environment was not right to get a good yield and also the market for coffee crashed. Between poor yields and poor prices it was impossible for them to continue with coffee farming. In Mwankagama production of cotton was introduced, but that also ended when they found it required expensive pesticides and fertilisers. These examples illustrate that whilst there are undoubtedly opportunities that NGOs can support smallscale producers to engage with, none of them are risk-free, and all risks must be considered when supporting innovation. In particular attention must be paid to viability in a changing climate, building knowledge and skills, and managing new unforeseeable risks and losses.

5.11 Knowledge of climate change

Climate change was cited by most villages as the cause of some of the changes they are experiencing. There was a high level of awareness about the concept generally, though as is often the case, some misunderstandings too. Generally trees were understood to be needed to ensure rainfall and water sources; that globally the climate is changing; and that actions elsewhere contribute to local changes in the climate.

Examples of community perceptions of climate change:

- In Wangama men said that cutting natural forests had made the climate warmer and drier. A metaphor used was: *“if you have a head full of hair and you shave it all, the sun rays will then hit you.”*
- In Mahango men reported that the causes of drought¹⁴ were human activities, water source encroachment, change in the global climate, and environmental pollution from industries. When asked about the effects of industries, a man replied *“when the flame goes up it doesn’t just affect one place it affects everywhere including Mahango village.”*
- Women in Mahango also reported that drought is caused by a shortage of rain, cutting down trees, not enough forest, and climate change.
- In Nyakadete women and men reported changes to the weather, with one woman commenting, *“maybe it is God’s will”* and the men’s group stating that *“the forests help in bringing rainfall and are the main source of water sources.”*
- In Mwankagama heavy rain was blamed on having too many trees. *“There is a hill on the other side of the river where there were many trees so that is why the rain came very heavy”.*
- A Mahango village leader reported that experts have told them that if they conserve the environment and plant trees, then the environment and weather will return to how it was.
- In Wangama they complained that they have planted more trees because they were told it would bring more rain, but it has not.
- Also in Wangama women reported that snowfall has decreased, which they attributed to a rise in temperatures as a result of trees being cut down, saying that *“the trees attract cold.”*

¹⁴ In this context the term ‘drought’ was used to refer to failed rains, reduced water in the river, and hunger.

6 CONCLUSIONS

The CVCA highlights the importance of understanding not just what people are experiencing (exposure), but how they are experiencing it through their lives, livelihoods, and ecosystems (sensitivity), and what is enabling and inhibiting their ability to thrive in this context (adaptive capacity). It also demonstrates how and why vulnerability is different between different people in the same community, and between different communities; because their exposure, sensitivity, and adaptive capacities are all slightly different. Women's and men's experiences are different, farmers and pastoralists experiences are different, irrigated and rain-fed farmers experiences are different, rich and poor people's experiences are different, and commercial farmers and smallscale producers experiences are different. Yet they are tied together by their shared reliance on the Great Ruaha Basin, and the resources and ecosystems on which they all depend. Currently different water and land users blame each other for the challenges they face, which represents a major governance challenge for the Great Ruaha Basin. Relationships need to be built to work together to understand competing needs and to find equitable, resilient, and sustainable solutions in a changing climate. This CVCA and the work of the CARE-WWF Alliance is an important step towards this, and provides an analysis of the context that can be used to inform all sorts of different programming and investments, from all sorts of different actors. It can also be used to enable working on issues holistically and inclusively, rather than in programmatic and policy siloes that treat issues in a standalone way and risk inadvertently increasing the vulnerability of some people whilst seeking to reduce the vulnerability of others. A clear example of this is the current ban on cultivation within 60m of all water sources. This indeed seems like an excellent policy for the conservation of water sources and is clearly with merit, however the impacts on food and nutrition security of this policy is significant to say the least. This is an example of an issue that must be looked at holistically; not just at the impacts the policy is trying to address, but also at what will be the impacts of the policy. The trade-offs must be assessed and those negatively impacted must be provided with alternatives.

Unfortunately the absence of pastoralists from this CVCA process presents an enormous gap in the analysis, and everything presented in this report is biased towards settled and predominantly farming communities. Therefore it must be stressed that this is not a representative picture of all those who rely on the Great Ruaha River Basin and its ecosystems and resources for their lives and livelihoods, and who have a right to be part of the processes that govern how resources are managed and accessed. Any organisation seeking to programme in this context must address this gap in information and analysis, and it is recommended that further CVCA's be carried out specifically with pastoralist communities in the same areas. This additional work, combined with the findings of the CARE-WWF Alliance landscape and markets studies, will help to locate this CVCA and the local livelihoods it discusses, in the wider natural, social, and economic systems of which they are part.

The CVCA has provided a wealth of information to inform CARE-WWF Alliance in their future programme design. Based on the analysis presented in this report, the author offers the following set of key issues and recommendations to inform next steps.

6.1 Investment is needed in smallscale rain-fed agriculture to address unreliable rainfall patterns.

Smallscale producers reliant on rain-fed agriculture are suffering losses from the less reliable rainy seasons that they are now frequently experiencing. Rain-fed agricultural is inherently sensitive to changes in rainfall patterns, seasons, and temperatures, all of which are reported in the scientific literature and corroborated by the observations of the communities themselves as documented by this CVCA. Options for addressing this exposure are highly limited. Farmer managed natural regeneration can help with localised changes to rainfall patterns and temperature increases, and this would have multiple benefits for the communities studied in this CVCA; however this would not prevent the changes driven by global climate change. With few options for reducing exposure, interventions therefore need to focus on reducing sensitivity and increasing adaptive capacity.

Smallscale producers suffer losses because they plant in November no matter what, and if the rains come late they lose that first investment of seeds, labour, and fertiliser. Whilst some are able to replant with faster maturing crops when the rains come, there are many who cannot afford to do this, or can do this only by getting into debt; thereby increasing the risks they face if the harvest fails. Seasonal forecasts are one way that producers can seek to manage this. If credible information is available that the rains will be late or may

be late, farmers can be more flexible and forward-looking with their farming activities, and plant later or take other actions as appropriate (such as plant half their land and be ready with the inputs for faster maturing crops for the second half). Providing seasonal forecasts is not an easy task, and careful consideration is needed of: how to translate seasonal forecasts from technical language to farmer-friendly format; what institutions have the information, knowledge, and skills to develop and communicate farmer-friendly seasonal forecasts; how is quality controlled; what education and training is required with smallscale producers to understand how to use probabilistic forecasts for decision-making; how to produce and disseminate timely forecasts; how forecasts are communicated to reach all stakeholders especially the most marginalised; and what else is needed to enable farmers to act on the information received. CARE International has considerable experience and expertise in exactly these areas through the Adaptation Learning Programme for Africa (ALP) and use of their Participatory Scenario Planning (PSP) approach.¹⁵

As a result of increasingly unreliable rains and the ban on vinyungu, demand for irrigation is likely to increase as rain-fed farming becomes more precarious. Irrigation cannot simply grow exponentially, so rain-fed agriculture does require considerable investment and support to make it sustainable, profitable, equitable, and resilient, and therefore CARE's SuPER approach¹⁶ is useful in this context. A key governance challenge for the area will be how to manage the increasing demand for irrigation in balance with what the Great Ruaha River Basin can realistically and sustainably support.

6.2 Both productivity *and* profitability of smallscale agriculture needs to be addressed in the context of existing water and land shortages and stresses, and a changing climate.

The CVCA found that in addition to the productivity concerns discussed above, farmers are facing new profitability challenges, driven to some extent by climatic changes but also by other factors related to availability of land, water, and market access and instability. One key challenge is the increased prevalence of pests, crop diseases, and fungus, in part linked to changes in temperature and/or rainfall patterns, but also factors such as a decline in rotation farming perceived to be due to land shortage. Farmers reported needing fertiliser where previously it was not required, indicating an exhaustion of agricultural ecosystems. These increased costs from increased input use, are undermining profitability, whilst at the same time reportedly failing to adequately prevent losses, and government provision of subsidised inputs are not reaching the smallscale producers who need them. Against this backdrop cost of renting land is increasing and smallscale producers struggle to get a good or stable price for their outputs. Whilst irrigation schemes tend to (currently) have a higher degree of stability of production, membership fees and maintenance costs are increasing and fertility and water availability is reducing, so even here profitability is not guaranteed.

The challenges of increasing pests and diseases; declining fertility; increasing land rents and input costs; price volatility; and limited access to markets are all constraining the profitability of local smallscale farming, and need to be tackled holistically and in the context of a changing climate, changing demographic, and changing market conditions. Again, the SuPER approach could be useful to think through sustainable long-term solutions. Simply using increasing quantities of chemical pesticides and fertilisers is not a solution that works either for smallscale farmers, or for the ecosystem of the Great Ruaha Basin.

6.3 Reducing food and nutrition security risks associated with just one farming season per year is required to increase resilience.

The CVCA communities are vulnerable to any disruption to seasons as they rely on just one farming season per year. Whilst some communities reported that they are generally able to produce enough to manage throughout the year, most did not, instead reporting an annual period of hardship. In such a situation one failed harvest has devastating and long-lasting consequences. Many farmers have to borrow to rent land and purchase the inputs they need, so a poor harvest leaves them unable to repay their debts *and* unable to invest for next year. These communities would benefit from opportunities to smooth out these highly seasonal income and consumption patterns. Various options could be explored such as credit arrangements where repayment is not paid in cash directly after harvest when prices are lowest, but instead involve setting aside crops to be sold later when the price has risen. Such arrangements both provide the creditor with the

¹⁵ www.careclimatechange.org/our-work/alp

¹⁶ <http://careclimatechange.org/our-work/super/>

repayment plus interest, but also have the potential to generate additional income to go back to the farmer to invest in next year. Other options are activities that generate income at other times of the year, though as explored below, when introducing new income generating activities the trade-offs and risks must be fully considered. Livelihood diversification is one way to spread risks, however if multiple income generating activities are exposed and sensitive to the same risk (such as late rains) this does not spread risks. The goal of diversification is to have income to fall back on if late rains undermine your primary livelihood activity and/or to have something that provides for you at different times of the year to your primary activity. Therefore in order to ensure year-round food and nutrition security, livelihoods must either reliably provide enough in one season for families to thrive for a whole year; or they must be augmented by additional income generating activities at other times of year that are not affected by the same risks. Other options to support this include savings groups; household budget training for financial management; collective purchasing of lower priced inputs; and processing or marketing activities for increasing prices smallscale producers receive. The year-round food and nutritional security requirements of communities must be considered in future programming.

6.4 Farmers, NGOs, and governments must be more aware of, and better prepared for predictable inter-annual climate variability and its cumulative impacts.

The 1998 El Niño was described by all communities as a standalone event of historic proportions; however it was not a one-off event, but part of a wider system of inter-annual climate variability. Whilst not linking it to the 1998 El Niño as its corresponding 1999 La Niña, most communities did however report suffering significant hunger and drought in 1999, which coincides with the 1998 El Niño and 1999 La Niña being one of the strongest global episodes on record. We have found that local incomes and food and nutrition security is highly dependent on just one annual farming season, and therefore highly sensitive to just one poor harvest, suffering the consequences for the whole year and most likely significantly longer. Therefore when two failed harvests occur in a row, it has devastating repercussions for individual households and whole communities, and could bring livelihoods to the brink of collapse.

It is vital that governments, NGOs, and communities understand better this cyclical trend, and seek ways to ensure measures are taken in advance of strong El Niño and La Niña events, rather than afterwards when it is harder to reach people. FAO and OCHA are in the process of finalising Inter-Agency Early Warning Early Action (EWEA) Standard Operating Procedures (SOPs) for El Niño and La Niña events, and the Government of Tanzania could be encouraged to engage with that process and implement EWEA processes domestically. NGOs can also build into their programme designs 'crisis modifiers' to monitor deteriorating situations and pre-design EWEAs that can be implemented through their existing programming to support vulnerable communities and to protect nascent project gains.

6.5 Programmes designed now must be forward-looking, considering climatic, demographic, and other changes over the next five to 30 years.

The CVCA found that nearly all domestic water supply systems were not fit for purpose, for a variety of reasons, but one clear factor was that future population growth and inward migration was not factored into the design of these systems. As a result communities suffer water shortages as the demands of a significantly increased population outstrip the source and carrying capacity of systems. These lessons must be learned.

Looking forward to the design of the CARE-WWF programme, the role of temperature change will need to be considered. Whilst the CVCA did not find temperature changes to be causing widespread or substantial impacts on communities, it did find some isolated pockets of impacts such as later arrival of snow in Igima, and new exposure of malaria in Igoma. Whilst temperature could therefore be easily dismissed as a marginal issue – especially when compared to the other challenges outlined – it is worth noting that for observable impacts of changes to average temperatures this is quite pronounced. Although communities did not consistently report increased temperatures, the science does, and the arrival of malaria into a new area is actually a very strong indication of the trend, even in the absence of other villages reporting impacts (changes may currently be too subtle to detect in everyday life). The implication of this is that whilst the primary focus of the programme will not be on addressing temperature change, the design must be screened against the temperature increase that is happening and will become more pronounced – as well as manifest in different ways - over coming years and decades. For example an assessment of existing crops and their temperature tolerances would be useful for any agricultural programming, as for any crops already at or near their upper

limit of temperature tolerance, the programme will need to plan for their phase-out and replacement, rather than waiting until key crops fail. Likewise for any new income generating activities being supported, their viability not just in the current context but under increased temperatures or changed seasons is vital to consider above issues of profitability and marketability, as they will not be successful otherwise. The CVCA found some NGO projects had in the past promoted income generating activities not suited to the conditions. Not only must this be avoided considering currently conditions, this must be avoided for conditions in five years' time, and beyond.

6.6 Food and nutrition security risks as a result of the ban on vinyungu must be addressed.

The significant implication of the ban on vinyungu on livelihoods and access to nutritious food needs to be properly understood, and investments are needed to ensure that widespread food and nutrition insecurity does not become an unintended consequence of the ban. Whilst the aims of the ban are the right ones, the trade-offs do not seem to have been adequately appreciated, nor does it seem that investments have been put in place to replace this vital source of food and income both in daily life and crucially in times of crisis.

Critical assessments are needed to understand whether the blanket application of a 60m is the best solution, or whether there are other options, or a more nuanced application, that can deliver the same or similar results for water source conservation without such severe consequences. The poorest are likely to be hit hardest as it is clear they rely on this low-cost, low-input activity, and because when restrictions are to be applied to resources they tend to lose out most, illustrated by one woman from Wangama reporting that they had stopped vinyungu, but that richer farmers had not. Further investigation is needed as to whether vinyungu in all places and under all circumstances is damaging to the degree that it outweighs the benefits, and consultations on how to manage the trade-offs and investment in alternatives, are urgently needed.

6.7 Women's adaptive capacity should be harnessed and barriers to transformation removed.

The CVCA found that women are highly adaptive in their approaches to managing periods of hardship, farming activities, and household budgets. There were many incidences of women discussing all the different ways they try to manage the different challenges faced, demonstrating that rather than simply suffering impacts they were constantly finding different ways to eke out what they needed. Indeed in Nyakadete even though men reported suffering various losses, the women insisted that you *"can always harvest something"* and *"if you do farming, end of the day you get something, even with these calamities."* Women consistently talked about using faster maturing crops such as sweet potato to manage late rains, floods, or other disasters. They also demonstrated the value of social capital in coping and adapting, frequently reporting that they borrowed from each other informally when someone was in need, they laboured for each other, and many also had joint businesses such as through women's savings groups. Women also demonstrated various ways they manage hardship, generating income through a variety of activities (such as brewing, cooking bites, and selling poultry and livestock), as well as foraging and food preservation (such as knowledge of fruits and vegetables that can be found in the forests and how to prepare them, and preserving pumpkin leaves for the dry season). These capacities are vital for households and communities to survive, and to pursue opportunities for adaptation.

However women's adaptive capacity is also significantly constrained by domestic violence, men's control over their assets, unequal burden of family economic and domestic responsibilities, and inadequate domestic water systems. In some communities women reported domestic violence as a key hazard that they face, both in times of plenty (when there was money for alcohol) and in times of scarcity (when women were out for many hours, often late into the night, to collect water during shortages). Gender-based asset ownership varied from place to place, in some cases women owned land and other assets, though in many cases women reported that they weren't in control of how they managed these assets (such as needing to get permission from their husband before they could sell an animal) or how they spent the money they generated. Some women reported they were solely responsible for food, clothes, and school fees, and that the men don't contribute to these costs, and in one village women reported losing money for the family to their husband's mistresses. Where women discussed annual periods of hardship, they tended to report it occurred early than men did, indicating that women may suffer resource scarcity within households before men do (with men's needs being prioritised over theirs). Finally - and significantly - the burden of inadequate village domestic water supply systems falls entirely on women, taking large amounts of time and energy away from income

generating activities, family caretaking, and household management to collect water, and to treat it and take care of sick family members when the water is contaminated. The skills, knowledge, flexibility, and solidarity demonstrated by women have enormous potential for transforming lives and livelihoods, but it sadly remains unfulfilled while women are limited in these ways.

6.8 Smallscale producers face an uncertain future without secure land tenure and political prioritisation.

Adaptation to climate change requires long-term planning and investments, and ensuring fertility of agricultural land relies on a decadal perspective rather than year-by-year management. Healthy soils are vital to be able to thrive in a changing climate. However given the precarious situation of land ownership for smallscale producers in the Great Ruaha Basin, this could inhibit those sorts of long term investments. The CVCA found numerous examples of farmers losing land through land disputes and removal policies, and that very few smallscale producers have formal land title. Smallscale producers reported feeling that government put other priorities above theirs, and examples were found of land for commercial plantations and National Parks being prioritised over land rights for smallscale producers and pastoralists. Secure land ownership is important for adaptive capacity and enabling smallscale producers to plan for their future.

6.9 The marginalisation of pastoralists, and the culture of blame, undermines adaptation for all.

The marginalisation of pastoralists has resulted in conflict as pastoralists are not assured access to the resources they are entitled to. The CVCA found that time and again even the small areas of land that villages should allocate for grazing had been taken for other purposes. Their marginalisation prevents sustainable management of the Great Ruaha Basin, as this requires the engagement of all stakeholders and a willingness to work together to achieve shared outcomes. The absence of pastoralist representation in formal processes of land and water allocation and management - and in this CVCA - results in an incomplete picture for decision-makers, preventing effective analysis and planning. Further it means that pastoralists have no stake in initiatives and rules coming out of these processes, so are unlikely to follow them. Processes must become more inclusive and evidenced-based in order to counter some of the damaging narratives around causes of water scarcity that scapegoats others, particularly pastoralists, often without justification.

The CARE-WWF Alliance must engage with pastoralist communities to inform the process of programme design, and an adapted CVCA approach for mobile pastoralist communities developed by CARE International in Ethiopia could provide a useful resource to facilitate that engagement. Access to land and water, and inclusion in governance processes, must be improved for pastoralists to enable them to adapt and thrive, and to enable effective catchment level management, conflict resolution, and climate change adaptation.

6.10 NGOs must learn the lessons from the failures of new 'opportunities'.

The CVCA found examples of new activities that had been introduced with varying degrees of success. New opportunities for smallscale producers are important, but they do come with risks, and if NGOs or other actors intend to promote a particular activity then they must understand the risks and trade-offs involved, and support smallscale producers to understand them too so that they can make an informed choice about what to invest in. In short, maladaptation must be avoided.

In the first instance strengthening and adapting what people are already doing is a lower risk option than introducing something new, as people have knowledge and skills in these activities which can be built on. Next, building out from existing activities to those with synergistic benefits, such as manure in systems where there is both crop farming and livestock production, or processing crops to add value to what is already produced. New activities that seem to present an opportunity for smallscale producers can then be considered, but only if the activity is viable in the local conditions and the changing climatic conditions. For example, since the introduction of avocado in Wangama, one out of three years it has been affected by snow. Therefore understanding the level of risk snow poses to reliable, sustainable, and profitable production is required. The resources needed must also be considered; are the water, land, and inputs needed both available and affordable? Inputs were too expensive to make a success of cotton production in Mwanakagama. An activity may not be sustainable if the investment relies entirely on the NGO remaining involved or on just one buyer, if it takes land away from much needed food production, or if it relies on knowledge and skills that local producers do not have.

ANNEX 1: Literature Review of the Water and Climate Change Challenges in the Great Ruaha River Basin

Written by Matt Fortnum

Summary

The catchments of the Great Ruaha River (GRR), in southwest Tanzania, provide a critical source of water for a diversity of users, including large- and small-scale irrigated agriculture, livestock keeping, hydropower generation, and biologically and economically significant ecosystems, such as the Usangu wetlands and Ruaha National Park.

Since the early 1990s, the GRR ceased flowing during the dry season, which has reduced hydropower generation and degraded freshwater ecosystems and the critical services they provide to the 6 million inhabitants of the basin, such as water for drinking, sanitation, and agriculture. Water stress has led to conflict between water users.

Two major studies have attributed reduced river flows to the over-abstraction and inefficient use of river water for irrigated agriculture in the dry season, and dispute the common view that overgrazing of the wetlands and climate change are the primary causes. Climate change is, however being, observed with slight, long-term declines in rainfall and increases in temperature. Significant inter-annual climate variability challenges the livelihoods of the basin's population, but they have developed a range of coping strategies to deal with its effects. The causes of water stress are politically contentious both locally and nationally.

Significant effort has been made to address the water issues of the GRR basin. Decentralised water governance has been rolled out by national government and donors; in the GRR basin, a sub-office of the Rufiji Basin Water Office and Water User Associations have been established at the sub-basin and local level. Several large-scale projects have also been implemented. These include the WWF Great Ruaha River Project, which made significant progress in diversifying livelihoods, piloting water efficient rice production techniques, and restoring river flows and wetlands. However, the freshwater system of the GRR remains under severe stress, with water shortages for livelihoods likely to continue or be exacerbated in the face of climate change.

1. Introduction

The CARE-WWF Alliance is embarking on an ambitious initiative in the Great Ruaha River (GRR) Basin in southwest Tanzania to have impact at scale on food and nutrition security and climate resilience. Undertaking a vulnerabilities and capacities analysis of the communities in the watershed is critical to project design and effective implementation. In preparation for data collection, we review existing literature to explore current knowledge of the vulnerability context in which the project will be implemented.

Climate change, water and poverty are interlinked in the developing world where climate change is likely to be experienced primarily as increased variability in rainfall and availability of water (Paavola, 2008). Therefore, it is crucial to understand hydrological conditions and change in the GRR basin, and existing institutional arrangements governing water management and use, to inform the design of a climate resilient agriculture project.

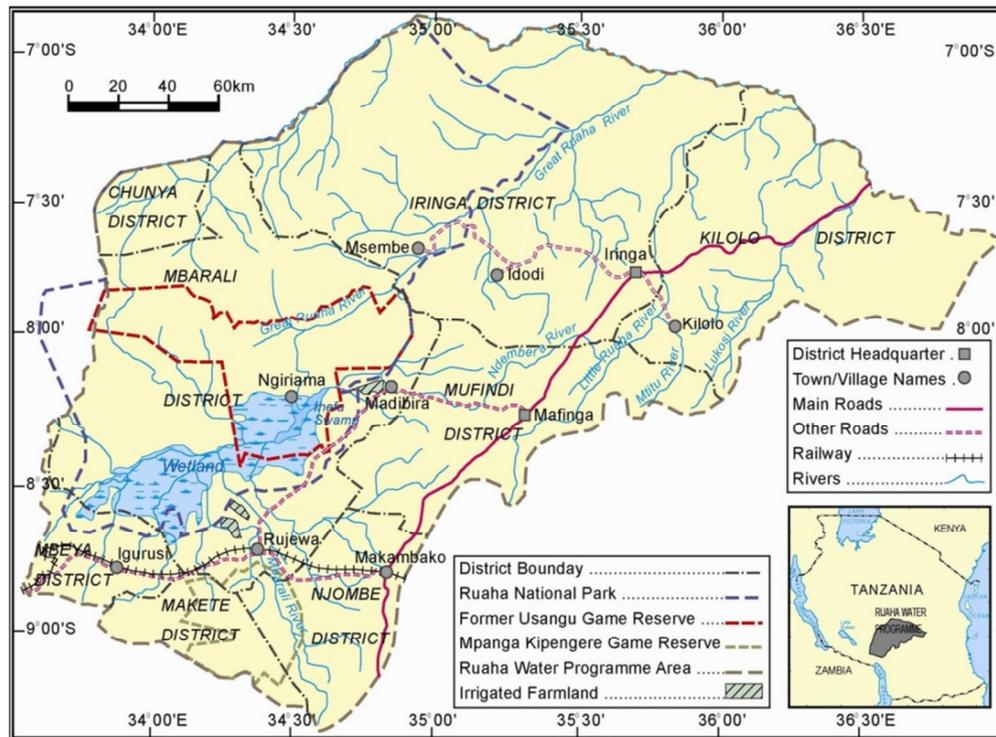
In this review, we first introduce the GRR basin and, specifically, the Usangu Plains and Southern Highlands sub-basin, the proposed project area. When possible, we refer to the Mbarali and Ndembera sub-catchments, where a Climate Vulnerability and Capacity Analysis will be undertaken. Second, we examine the water issues in the region, referring, in particular, to the cessation of river flows during the dry season since the early 1990s. We consider the potential role of climate variability and change, as well as land use change and water management failures, as causes of the region's water problems. Lastly, we review the water and climate institutional context, and existing knowledge on the sensitivity and capacities of households and communities to climate change.

2. The Greater Ruaha River basin

The Great Ruaha River (GRR, Figure 1) is the main tributary of the Rufiji River, which has the largest hydrological basin in Tanzania. It is fed by several smaller rivers that flow from the Kipengere Mountains and merge at the Usangu plains into a complex of wetlands, channels and lagoons. When water levels in the

wetlands are sufficiently high, water spills over into the GRR, which traverses the southern periphery of the Ruaha National Park before meeting the Little Ruaha River and entering the Mtera Reservoir.

Figure 1: Map of the Great Ruaha River Basin



The GRR basin covers an area of 83,970 km² and has a population of approximately 6 million people (Kashaigili et al., 2009). It hosts a diversity of land uses, including irrigated agriculture, livestock husbandry and hydropower generation. The Mtera reservoir stores water for hydropower plants at Mtera and Kidatu, which contribute almost 50 percent (280MW) of installed electricity generation to the national grid. The Ruaha also maintains nationally and internationally significant and protected ecosystems, such as the Usangu wetlands, Selous Game Reserve and Ruaha National Park, which support an economically important wildlife tourism industry. In the dry season, the river is the main source of water for wildlife in the Ruaha National Park.

The Usangu plains are 1,100 m above sea level, and contain the Usangu wetlands (1,800 km²), which comprise of the Western and Eastern (Ihefu) wetlands and support diverse fauna and flora, including 400 bird species (Kashaigili, 2008, Kadigi et al., 2007). Kadigi et al. (2007) identify three major farming systems in the Usangu basin: year-round maize-mixed farming in the Upper Usangu; paddy farming in the Middle Usangu; and agro-pastoralist farming in the lower Usangu. The systems have evolved in response to the variable climate conditions and water availability across the Usangu basin.

Irrigated agriculture is generally found in the upper parts of the Usangu plains, with a mixture of state owned, large-scale, and smallscale farmers. The area of irrigated farmland ranges from 20-40,000 ha depending on rainfall (Van Koppen et al., 2004). Irrigated paddy fields in Usangu produce 105,000 tons of paddy, which can produce about 66,000 tons of rice, accounting for approximately 14% of Tanzania's total annual rice production. This generates USD 15.9 million, and supports 30,000 farming households in Usangu (Kadigi et al. 2004). Livestock is another key source of income, a store of wealth and important part of cultural identity (Coppolillo and Dickman, 2007, Masozera et al., 2010). Almost half of the 1.5 million people living in the Usangu basin are in poverty, with an average income of USD0.80/day (Kashaigili et al., 2009).

Most rainfall is received during the rainy season from November until April, and annual total rainfall varies according to altitude from 1600 mm in the highest areas to 500-700 mm in the lowest areas (Kashaigili, 2008). Surface flows are the primary source of water for domestic and agricultural use. There is less groundwater availability and its location is less predictable (Igbadun et al., 2006). The major water users in the GRR basin are: (i) rainfed agriculture and domestic water users in the upper catchment; ii) irrigated agriculture on the

plains at the base of the escarpment; (iii) domestic users and rain-fed maize cultivators on the plains; (iv) pastoralists and fisherman in the wetlands; (v) wildlife and tourists in/to the Ruaha National Park; and (vi) the hydropower stations at Mtera and Kidatu. Below these stations there are no significant water users (Lankford et al., 2004).

3. Water challenges

River flow declines and water scarcity

In 1993, downstream of the eastern wetland and upstream of the Mtera dam, the GRR ceased flowing for the first time on record. Now, the once perennial river dries every dry season and early wet season, between September and January. These changes had national implications since it reduced hydropower output, causing electricity shortages and rationing in Da es Salaam, the capital of Tanzania. Dry season water shortages are also degrading the Usangu wetlands and Ruaha National Park where the river dries for increasing periods (Langford et al. 2004). The minimum dry season area of the Ihefu wetland has decreased by about 40 percent (McCartney et al., 2007).

The supply of freshwater ecosystem services, such as water for drinking, sanitation, and agriculture, has also been affected (Voigt et al., 2012), and declines in hygiene have increased disease incidence in humans, livestock and wildlife, indirectly because of drought (Mazet et al., 2009). According to Kassian et al. (2017), about 70 and 90 percent of households surveyed in the villages of Lumuli and Ifunda said that reduced river flows had negatively affected their crop yields. In some areas, especially, the Usangu Plains, water for irrigation has been rationed (Kangalawe et al., 2011).

Intensifying competition for dwindling water resources is causing water conflict (Kangalawe, et al. 2011). Rain-fed and irrigated agriculture, pastoralist households, subsistence fisheries, wildlife tourism operators and hydropower operators compete for the water resources of the catchment. Those located downstream are at disadvantage, compared to upstream users such as irrigated agriculture. An increase in competition in Usangu has resulted in conflict and even violence (Lankford et al. 2004), especially amongst crop cultivators and livestock keepers (Kangalawe et al., 2011).

Land use change, water diversion, and agricultural development

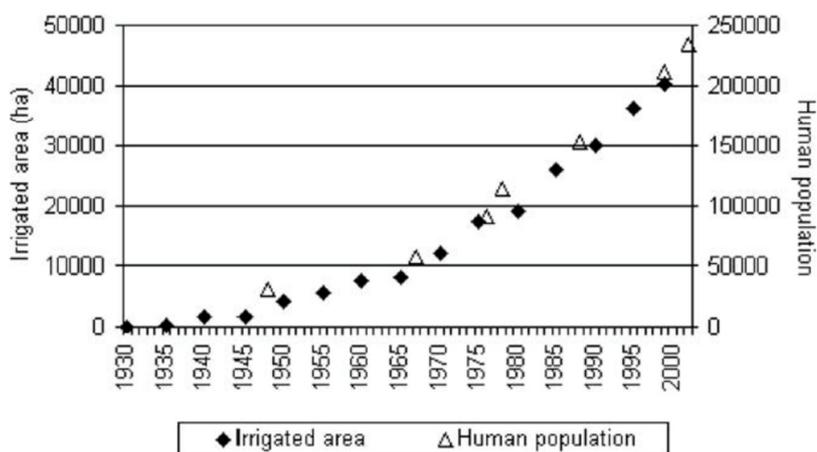


Figure 2: Population and irrigated area dynamics in the Usangu Plains, 1930 to 2000.

(Source: Kashaigili et al., 2006)

Land conversion for agriculture has expanded in recent decades in the upland areas of the basin (Kashaigili et al. 2006). A study by Kashaigili et al. (2006) found that the cultivated area using irrigation has also increased from just over 10,000 ha to 40,000 ha between 1970 and 2000. The expansion of irrigated agriculture in Usangu was promoted through development agencies in the 1970s and many immigrants arrived to grow rice on or around small irrigation schemes and farms run by a state-owned company, NAFCO. Many residents still depend on rain-fed agriculture, but uncontrolled water diversions provide supplementary irrigation to reduce the risk of crop failures (Kashaigili et al. 2009). It is large-scale agricultural production in the Usangu basin, which is one of the largest consumers of water, that is having the most significant influence on water stress, especially during the dry season, according to two studies commissioned by DFID.

First, a hydrological modelling study by Sustainable Management of the Usangu Wetland and its Catchment (SMUWC) project found that maintaining water flow into the wetlands was the most important factor in determining outflow into the river rather than overgrazing on the wetland, which was commonly blamed for the water problems. It also countered claims that climate change and deforestation were responsible, showing that abstraction of 40-50 cumbers from 100-130 abstraction points was the most significant driver of hydrological changes in both the wet and dry season. It estimated the irrigated agriculture in Usangu extracts 25-30% of the GRR's water. The study concluded that the first drying of the river was mainly the result of abstraction of water for irrigated agriculture and the wetting of paddy fields into the dry season.

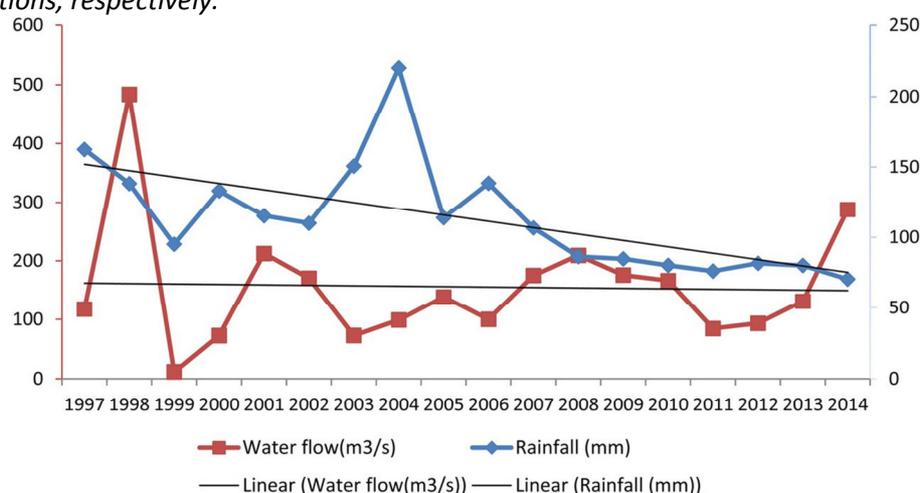
Second, the Raising Irrigation Productivity and Releasing Water for Intersectoral Needs (RIPARWIN) project provided further evidence on the causes of water stress in the GRR basin. It concluded that (McCartney et al., 2007):

- Smallscale farmers use water more efficiently than large state-owned NAFCO farms, and overall productivity of rice per unit of water was higher or at least the same on smallscale farms.
- Water is used inefficiently because of non-beneficial losses from irrigation, such as evaporation from bare plots; about 12% of water used for irrigation is wasted in this way.
- With a lack of monitoring of water rights, enforcement is not possible, resulting in withdrawals of water up to double the permitted amount. Existing water pricing is not high enough to incentivize efficient water use and tends to instead encourage expansion of irrigated areas so that farmers make use of the water they have purchased.
- Modern irrigation technologies are used inappropriately making them more water inefficient than traditional technologies, despite the opposite being intended

Climate variability and change

Kangalawe et al. (2011) characterize the climate as having 'seasonal shifts and variable seasonal distribution with unpredictable onset and ending of rains and shortened growing seasons'. Data on annual rainfall from 1997 to 2014 (Figure 3), recorded at Kalenga station, shows that there is marked inter-annual variability in mean annual rainfall and water flow (Kassian et al., 2017). The highest water flows were recorded in 1998 and the lowest in 1999, which coincides with some of the strongest global El Niño and La Niña episodes on record, respectively. In 1997/1998, large areas of the GRR basin flooded, especially along the Chimala River, and rice yields were exceptionally low; conversely, the wet year produced abundant yields for maize farmers in upland areas.

Figure 3: Annual mean flow of Lyandembera River (m3/s) and rainfall from 1997 to 2014, recorded at Ilongo and Kalenga stations, respectively.



Several authors suggest a declining trend in annual rainfall and increasing temperatures in the GRR catchment and suggest climate change could exacerbate this trend (Kangalawe et al., 2011, Kashaigili et al., 2009) and result in lower minimum flows of the GRR (UHT, 2012). Rainfall and river flow data recorded at Kalenga and Ilongo stations shows an insignificant (expressed as R2 values below 0.5) decreasing trend between 1997 and 2014, but a statistically significant decline in rain fall when using a Mann-Kendall test and over two thirds of

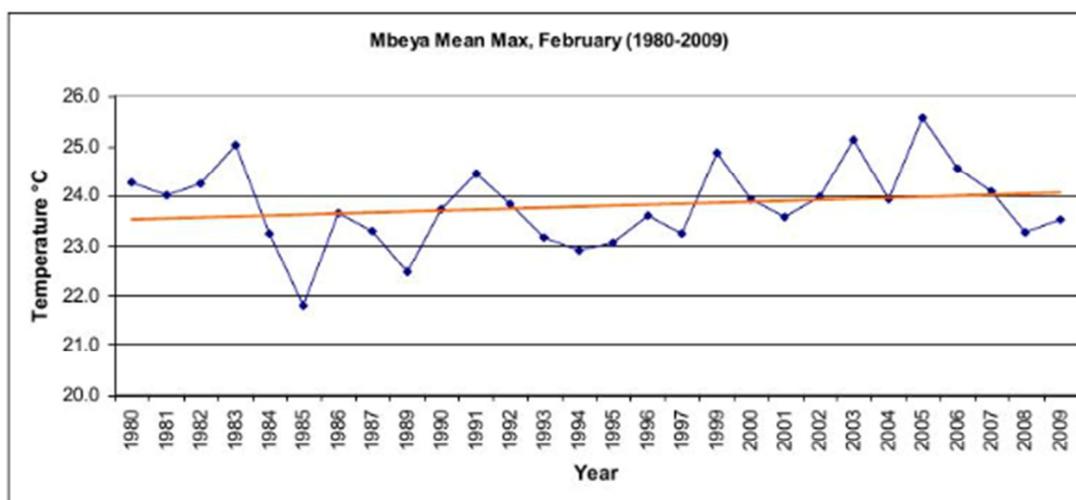
households interviewed perceived a decreasing trend in water flow (Kassian et al., 2017). Another study, however, showed increase rainfall trends between 1980 and 2009 at Iringa station and declining rainfall in Mbeya in the upper catchment (Kangalawe et al., 2011).

The Intergovernmental Panel on Climate Change (IPCC) predicts temperatures in Tanzania to increase by 2-4°C with the interior of the country likely to experience the greatest warming and reductions in rainfall, resulting in prolonged dry seasons and an increase in the severity of periodic droughts. Temperature data from Iringa weather station shows that temperatures have indeed risen between 1980 and 2009 (Figure 4), and droughts occur about every five years, according to households surveyed by Kangalawe et al. (2011). While it seems that climate change is not the dominant driver of declines in river flow, it is likely to be a severe challenge for the GRR basin and its water management in the future, with lower minimum flows likely to impact hydropower generation and thus national electricity supply.

Nevertheless, climate variability and change is affecting local livelihoods. For example, the delayed onset of rains has made it problematic to follow traditional cropping calendars: ‘some 20-30 years ago potatoes were used to be planted before 15th of November of each year, and harvested in February, and beans planted in those fields thereafter. Today the situation is completely different; the staggered planting that used to be practiced in the past is almost disappearing as all crops have to be planted at the beginning of the rainy season, lest they may not come to maturity before the rainy season ends.’ (Kangalawe et al., 2011)

In the same study, members of various water associations in Njombe district reported that crop failures have become common because of climate change, resulting in reduced food and income for households, and a failure to pay school fees.

Figure 4: Mean maximum, February temperatures at Mbeya municipality (1980-2009). (Source: Kangalawe et al. 2011.)



Water politics and management failures

Stakeholders have contrasting views on the reasons for the wetlands and rivers drying, and the water scarcity. These have led to actions that have failed to address the causes of the water issues.

In 2006, the government evicted cattle herders and livestock from the wetlands of Usangu, which were later integrated into the Ruaha National Park. Agro-pastoralists were forced to leave Mbarali district because overgrazing was identified as the primary cause of the degradation by Ruaha park officials (Walsh, 2012). TANESCO, the company operating the hydropower plants, also promoted the view that irrigation and land degradation by overgrazing were the causes of the electricity shortages in the 1990s and later. However, the SMUWC and RIPARWIN research found there was no significant connection between changes in the flow of the GRR and the level of the Mtera reservoir: *“The drying of the river is a dry season phenomenon, and the difference between the low flows of the past and the no flow of the present is so small that it has little effect on water levels at Mtera. The reservoir is filled by the water that flows into it during and immediately after the wet season, when the Usangu Basin overflows and spills into the Great Ruaha. Analysis showed that the total*

volume of water flowing down the river and into the reservoir has not changed significantly over time” (Walsh, 2012).

As discussed above, the seasonal drying of the river was said to be caused mainly by the increasing diversion of water for dry season rice production and wastage of water by large state owned farms, rather than irrigated cultivation in the wet season and livestock keeping on the wetland (SMUWC Project, 2001 in Walsh, 2012). This conclusion has been resisted by the promotion of narratives of environmental degradation.

The SMUWC study found that power shortages from the Mtera/Kidatu stations were likely to have been caused, instead, by the mismanagement of reservoir storage, e.g. water released for electricity generation exceeded the rate of recharge during a series of dry years. Because of the political sensitivities of this revelation, no action was taken to address the management problem or modify the narratives about environmental degradation being the cause, according to Walsh (2012).

4. Water and catchment management

Actors, institutions and interventions

Tanzania has several policies and institutions related to water resources management, including the National Water Policy (2002), National Environment Policy (1997), Land Policy (1997), National Forest Policy (1998) and Water Resources Management Act (2009). They provide a framework for stakeholder participation, conflict resolution and sustainable water management. Tanzania has adopted the Dublin principles of Integrated Water Resources Management (IWRM), and is being implemented by the Ministry of Water. It involves a nested and decentralised system of water governance, with nine watersheds managed by Basin Water Boards.

The Rufiji Basin Water Office is a government agency tasked with water resource conservation, planning and conflict resolution, the granting of water rights, and freshwater ecosystem management. It opened a sub-office for the Usangu plains in Rujewa, Mbarali district, in 2001. Its allocation of water rights has been criticized for allowing rights that exceed available water in the dry season, thereby legitimizing over-abstraction, but not increasing rights sufficiently during the wet season (Lankford et al., 2004). Lankford et al. (2004) point out that water scarcity in the dry season does not disqualify more water from being abstracted in the wet season for irrigation, and that there is potential to develop groundwater sources or construct more water storage to address dry season shortages.

Water User Associations (WUAs) are the primary institution for water management at a local level in Tanzania, with IWRM principles rolled out through participatory processes. In the Ruaha catchment, WUAs have been funded by external donors, such as the WWF. Their roles are to conserve and manage water catchments sustainably; increase the usage of water for economic and social improvements and develop sustainable and responsive institutions; resolve conflicts on water use; and lastly monitor water availability and use (IWRA, 2017). They are the local actors implementing the mandate of the Rufiji Basin Water Office.

Table 1 summarises past programmes and interventions that sought to address water issues in the GRR basin. Efforts have made to improve water productivity and develop mechanisms for more efficient allocation of water resources amongst users. Interventions to increase irrigation productivity have been key to these attempts (McCartney et al., 2007). This has included training rice farmers in water management.

The WWF Great Ruaha River project was found to provide adaptation benefits by strengthening WUAs and regional institutions. The project diversified and increased the profitability of rural livelihoods, conserved riparian vegetation and reduced tree felling for charcoal. Livelihoods diversified into activities that require less water than agriculture, such as retailing, manufacturing clothing and beekeeping. Farmer field schools improved rice production techniques, which increased yields and enabled farmers to better manage the irrigation of their fields, reportedly doubling water efficiency. Farmers have also agreed a growing calendar to improve irrigation application to stop diverting water during low flows and reduce water losses during transmission (Kashaigili et al., 2009).

The conservation of riparian ecosystems and restoration of springs and river flows has enabled flows into the Ihefu wetlands to resume and the period when there is no flow into the Ruaha National Park has reduced from 3 months to one month per year. The SWMUWC and RIPARWIN research projects have played a key role

in raising awareness and increasing understanding of the causes of the GRR basin's problems (Kashaigili et al., 2009).

Lankford et al. 2004 identify weaknesses in catchment management as key contributors to the water problems of the GRR basin. First, the current institutional arrangements are not responsive to seasonal and inter-annual climate variability. Second, water availability constraints require difficult trade-offs to be made amongst different groups and interests, but existing measures are inadequate for ensuring decisions are equitable.

Table 1: Selection of past policies and projects in the GRR basin

Year	Initiator	Description
1996	World Bank loan	River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP).
1998-2002	DFID	Sustainable Management of the Usangu Wetland and its Catchment (SMUWC) investigated the nature and causes of hydrological changes and the development of strategy.
2001	Ministry of Water	Rufiji Basin Water Office (RBWO). Its main responsibility is issuing water rights, which aim to control the amount of water used for irrigation on the plains; rights are halved for dry season period.
2003	WWF Tanzania	WWF Great Ruaha River project promoted integrated and sustainable water use and management of natural resources to improve ecosystem functioning for livelihoods. The project resulted in an integrated river basin management plan, increased awareness of sustainable management and use of water, and SMUWC and RIPARWIN research projects, supported by DFID.
2006-2007	National government	Eviction of hundreds of cattle herders from the wetlands of Usangu in Mbarali district by the national government.
2007	National government	Policy of expanding irrigation.

Household and community vulnerability, coping and adaptation

The RIPAWIN study (2002-2005) showed an increase in household vulnerability from upstream to downstream in the upper GRR catchment, mainly in relation to access to natural and physical livelihood assets. Further, female headed households were more likely to be vulnerable than male headed households.

Households engage in several coping strategies during the dry season. Irrigation is often used to maintain crop yields, including the use of dip wells, shallow canals, water pumps and buckets to extract river water. Farmers also excavate shallow wells in their fields, which they deepen during periods of water stress to secure sufficient water for irrigation (Kyando, 2007, Kassian et al. 2017).

Seasonal and permanent migrations are also important coping strategies. In the dry season, cattle herders in the middle and lower Usangu used to move their herds to the permanent Ihefu swamp in the Usangu eastern wetland while their pastures are unable to sustain their herd (Kadigi et al., 2007). However, this seasonal migration is no longer permitted since the area was designated as the Usangu Game Reserve and later incorporated into the Ruaha National Park.

Collective institutions and social networks are critical for reducing vulnerability and promoting livelihoods, according to the RIPAWIN study. The development of water association was therefore recommended as important for building social capital.

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ANNEX 2: Summary Descriptions of CVCA Villages

Ndembera sub-catchment	Mbarali sub-catchment
<p>Ifunda Village Located in upper section of Ndembera sub-catchment on the Lyandembera River and the main road linking Dar es Salaam to Zambia. Key livelihoods are mixed-maize rain-fed farming, trees for timber, vinyungu, and pastoralism, and there is a 3,000 acre commercial farmer Silverland at the village. Domestic violence and HIV/AIDs are prevalent.</p>	<p>Wangama Village Located near the headwaters of Mbarali river surrounded by forested (natural and plantation) hills, and near to the Kipangu Nature Reserve. Irish potato, mixed-maize farming, vinyungu, domestic livestock keeping, pastoralism (limited), and newly introduced avocado are the key livelihoods, as well as women’s businesses supported by savings groups. The village has a very high incidence of HIV/AIDs.</p>
<p>Nyakadete Village Located in the mid to lower section of the Ndembera sub-catchment, near Madibira, and borders the Ruaha National Park. The Mfyamba River flows on the west side, and the village is surrounded by natural forests. Rain-fed mixed-maize and rice farming dominates in the village, but many women and men also own land in the nearby Madibira Smallholder Agricultural Development Project which is an irrigated rice scheme. There is no dry season farming and women engage in brewing and other income generating activities to manage seasonal incomes. Pastoralism is common in the area. The area suffers from HIV/AIDs.</p>	<p>Igima Village Located in the mid-section of the Mbarali sub-catchment, surrounded by the Kibena Tea Company tea plantation, and the TANWAT wattle plantation, and near to Lihogosa swamp / reservoir which was dammed to provide water for the plantations. Only rain-fed agriculture is practiced by the villagers, but the tea plantation is irrigated. Irish potato and avocado (newly introduced) are grown for the export market. Fishing is important for youth. Many people don’t own land and 3,000 people lost their jobs when tea plantation mechanised. HIV/AIDs was stated by some men as having the greatest impact of any hazard because of the impact on ability to work and the loss of a generation by the disease.</p>
<p>Mahango Village Located on a lower section of the Ndembera River near Madibira town. Mahango village is highly dependent on irrigated rice farming at the Madibira rice scheme, but there is also rain-fed rice and mixed-maize farming and pastoralism. Women also rely on brewing and other income generating activities. Domestic violence and HIV/AIDs are common.</p>	<p>Mwankagama Village Located on the lower section of Mbarali river, with mixed-maize farming, Irish potato, vinyungu, an irrigated rice scheme, a commercial irrigated rice farm, domestic livestock keeping, and pastoralism. Not everyone owns land and rent costs are high. Women have multiple income generating activities including brewing, food vendor, milk, manure, small businesses. The community is also affected by HIV/AIDs.</p>
<p>Igoma Village Located in the lower section of the Ndembera sub-catchment, the community has both rain-fed and irrigated mixed-maize and rice farming, having an irrigation canal constructed in the village that supplies water to 60 acres of land, divided into small plots. Most households also own animals, and some pastoralists are in the surrounding areas. The village benefits from income from a telecoms company for siting a mobile phone mast on village land. The community is also affected by HIV/AIDs.</p>	

ANNEX 3: Examples of Conflicts Over Land Collected by the CVCA

Farmers and Pastoralists

In Mahango, violent conflict was reported by women, stating that “the livestock keepers are most stubborn and always armed. Four people have lost their lives and some people were left disabled due to this conflict.” Women reported that if a livestock keeper enters your farm you call the police, that you should not go alone to face them as they are very strong and have machetes. They said that when this happened they used to be taken to the police station to be fined, but now the Village Council working together with the Ministry of Natural Resources tries to educate pastoralists on the importance of preserving the water and land. When asked if they also receive education they replied that “we have no big problems, they are the ones with the problems”. Using the fines that had been collected they have repaired a motorbike donated by the Rufiji River Basin Office, and undertake patrols along the river. The men reported that a letter has been sent to Mbarali District Office asking for assistance to resolve the conflict, but there has been no feedback yet.

In Nyakadete the conflict between farmers and pastoralists is not new, with villagers saying it has always been there, and blame pastoralists for not adhering to the village land use plan and being poorly educated. Farmers felt that more pastoralists and cattle have moved to the area than the land can support, and that they suffer from crops and newly planted trees being destroyed, and from soil erosion. However CVCA found that farmers take actions to restrict livestock passing near their fields, even where they are supposed to have access, and also that some farms have encroached onto grazing land, thus reducing the land available for grazing. The conflict was reported to be violent at times, resulting in many injuries and in some cases lives have been lost, there have also been incidences of arson destroying property and land, and overall poor relations between these different parts of the community were reported. Farmers complained that resolving disputes takes their time away from farming activities, and whilst the Village Council collects fines from pastoralists whose animals are caught on farmland - reported by women to be 5,000 Tsh for each cow - the money goes to the village office and not to compensate the farmer. The women reported that they are meant to sit with the pastoralist and agree compensation after they have paid the village fine, but they felt unable to collect money from them, and instead ‘forgive’ the loss in order to “keep the peace.” However the women felt that the conflict has reduced since 2013 thanks to increased clarity of land demarcations and construction of the lambo, stating that “earlier the village did not have a good land use plan for the different livelihoods, so the conflicts were severe. Now they have a good land use plan and understanding is better.” However this observation was not made by the men.

These conflicts were less severe in Ifunda where herd sizes were reported to be smaller (between 10 and 50 animals) and the disputes had not lead to violence. Farmers complained that pastoralists allow their cattle to feed on the farms, however the area that had been set aside for grazing (Mlafu area, five miles from the village centre) has been planted with trees because of the economic opportunities of timber, which is likely to exacerbate conflict in the future as more and more land in the village is taken for timber opportunities.

Conflict was also reported in Mahango over land and water, with a significant lack of land for grazing land reported because both pastoralists and farmers have apparently cultivated on that land. They reported that there is a village land use plan, but that “the people don’t follow it, especially the pastoralists.” The conflict is ongoing; however the men noted 2009 as a particular year of conflict and fighting between farmers and pastoralists, which coincides with a reported incidence of drought and hunger.

In Mwankagama men reported coming into conflict with pastoralists because they failed to adhere to village bylaws and trespass, however the women reported that there is insufficient land set aside for grazing and that the boundaries of farmland are unclear, making it difficult for pastoralists to know that they have trespassed. However they also reported that sometimes farmers use poison on the farm to kill the livestock.

Farmers and Farmers

Men reported in Ifunda this was an issue if they sell part of their land, as the person who buys it just takes more than they purchased. Taking action on land disputes takes up a lot of their time, and while the courts decide neither farmer is allowed to farm the land, costing them production too. They complained there are delays in deciding cases, and sometimes corruption.

Farmers and Village Councils

In Mwankagama there is an ongoing land conflict with the neighbouring village of Mabanda about access to the Mwendamititu irrigation scheme, and their boundary, since the village was divided into two. This was apparently resolved by the District government reviewing the boundary with a GPS device, which solved the boundary problems for those who formally owned land in the other village, but most did not have formal tenure, and so they are still in conflict about their land in Mabanda. Households have also been evicted with only 28 days' notice recently to make way for a new road, and received no compensation for their lost land. It was reported by the men that the road is being built because heavy equipment used by the Mbarali Estate damaged the old road, which also triggered a conflict because the villagers were not allowed to transport their crops with heavy vehicles. One man in Igima reported being in conflict with the Village Council as it had taken his land and redistributed it to others, so he has taken the dispute to the Ward, District, and Regional officials, and now the case is with the Ministry of Land. In Igoma the village collects revenue of 2.4 million Tsh per year from a telecoms company who has erected a mobile telephone mast on the village's land, however there is a second mast that is in dispute with a neighbouring village; both claiming it is within their village boundary and demanding income for it. That conflict has also led to violence.

Farmers/Villages and the national park

In Mahango, men reported disputes ongoing since 2001, caused by the national park expanding its boundaries and removing people from parts of 21 villages (including Mahango). The land lost was reported to be fertile farm land, and the village felt strongly that "the government expanded the National Park area because it likes animals more than the people." They said that area taken had previously been earmarked by the government for expansion of the rice scheme – which they all supported – but they don't understand why the government changed its mind and expanded the National Park instead. They complained that each time TANAPA comes they say the boundary is somewhere else, and whilst there have been numerous meetings on this issue, including with the Regional Commissioner, the situation remained unresolved. The men and village leaders reported that they have requested land back from TANAPA to allocate for grazing to try to resolve some of the conflict between farmers and pastoralists over lack of grazing land.

ANNEX 4: Summary of Village Domestic Water Supply Issues

Ifunda Village

A tap water system for domestic water supply was constructed in 2014. Households pay 1,000 Tsh per month per household, however the system was widely reported to not function properly, with women complaining that sometimes there is no water in the taps for one or two months. The village also has deep wells with hand pumps, constructed approximately 30 to 40 years ago by DANIDA which were reported to work well to start with, but are no-longer functioning well. The water from these pumps are free, however the women reported that when they breakdown a fee of 1,000 Tsh is charged to every household for maintenance. Nowadays they mostly rely on digging wells in their homes. Young men in the village have become experts at doing this, and for a fee will dig a well, and install a rope and bucket. However many families do not have wells, and many women have travel long distances to a neighbour's well or to the river, with well water being preferred (even if the walk is longer) as it is considered cleaner than the river water. However the home wells are dry during the dry season (particularly August to October), so they have to dig deeper or go to the river then. The price of water was reported to be the same year round; 100 Tsh per bucket.

The NGO Waridi has indicated it would support the village to install a gravity tap water system to get water from the mountains, and the village is organising itself to collect contributions from all households to get the system funded.

Nyakadete Village

The village has three or four public water taps installed in 1998-9, and some people have taps in their homes. The annual fee for households is reported to be 2,000 Tsh per year for the water, however the men reported they now only pay when repairs or maintenance is required. Private taps cost 20,000 Tsh to be connected, used to incur an annual fee of 10,000 Tsh, but this charging has ceased as private taps are used as public taps, which people letting their neighbours use it.

Whilst the water for livelihoods come from the rivers and springs in the village, it was reported that the water for this domestic system comes from Mto Mfyamba river in the mountains, which fills a reservoir tank and then is piped to Nyamakuya and Nyakadete villages. This may account for the different perceptions between women and men as to whether the village suffer water shortages as the domestic supply appears to be more reliable than the rivers which have now dramatically reduced in flow.

However all water sources were reported to be vulnerable to contamination that causes human diseases, such as cholera, when there is heavy rain and flooding, due to a lack of latrines and human waste contaminating water sources, including the tap water infrastructure.

Mahango Village

The village is reported to have over 10 public taps, and 27 taps in total (some privately owned), however these do not provide adequate water supply for the village. Indeed the women stated of the water system; "they are just taps, they are not providing water." The current situation of payments is unclear considering that they are not fully functional, but previously women reported each household paid 1,000 Tsh per month for the village taps, and those with taps in their homes pay a connection fee (possibly 90,000 Tsh) followed by 2,000 Tsh per month, and women then pay 2,000 Tsh to draw 10 drums from private tap owners.

The supply system was built in the 1970s but was recently upgraded by TASAF and the District Council. However this upgrade has never worked properly, with a newer smaller tank located uphill collecting very little water, which is all gone within just one hour if it is used. TASAF have come back to see what the problem is and discovered that the pressure from the water intake is too low, and that the pipes need to be replaced, but they do not have the money to do this. The system is now either reconnected to the old tank or directly to the river (differing reports were provided), but there was agreement that there are water shortages, particularly during the dry season, and that women can often queue until midnight to collect water. The men reported district and regional officials have been made aware of the problems, but no action has been taken.

Igoma Village

Domestic water is piped from water sources to 22 domestic water points in the village, which are managed by the Village Council under the water management committee (COWSO). Each household contributes 1,000 Tsh a month for its maintenance. Domestic water supply is sufficient during the dry season but during the wet season intakes get blocked with sediment and some pipes collapse because of the high water pressures. Because of this design fault, they were without water for one month in the past.

Wangama Village

Domestic water is piped directly from a highland spring (called Mujuhilu), and is managed by the water user association under the Village Council. No water supply issues were reported.

Igima Village

The village has eight domestic water points supplied by second water projects; Mlevela in 1986 and TOVE in 2011. Water from these projects supply 16 villages including Igima, but the intake is insufficient to supply all the villages. In addition, water points are not always within 400m of all homes as nationally legislated, and it was estimated that about two-thirds of community pay their water fees late.

Mwankagama Village

The village does not have reliable domestic water supply, instead water is collected from private wells and the irrigation canals. Drinking water supply is a significant problem for the community. In 1988 DANIDA built a piped domestic water supply, with water stored in a water tower on the outskirts of Mwankagama, however tower has been empty since 2001 This was attributed to the expansion of Rujewa town as a result of the District government headquarters relocating there, and population growth in villages that the pipes serve before reaching Mwankagama's tower. The district engineer told the community that the intake's capacity is not sufficient to serve all the villages in the pipe network, and in addition, the women feel that the pipes get silted from cultivation near to the intake. As a result households purchase water from those with private wells, such as the petrol station at a cost of 25-50 Tsh per 20 litre jerry can, or collect for free from deep wells at the Catholic mission schools (those these are only open to the public 1-2 hours each day, and often closes when many people visit), or use jerry cans or pumps to collect water from the Mbarali Estate irrigation canals, even though they know this is contaminated and not safe for drinking. As a result a large proportion of household budgets are spent on purchasing safe water or treating unsafe water, or else contaminated water is consumed. Women report regular cases of diarrhoea and typhoid as a result, and blame this situation on the 2017 outbreak of cholera.

ANNEX 5: Summary of Gendered Income Generating Activities

Summary of different income generating activities of women and men identified in the CVCA, and the opportunities and challenges.

Women	Men
<p>Brewing was popular and profitable, and many women reported this being relied upon for generating the cash needed for expenses like school fees. Brewing was one of the few dry season opportunities reported in many places, and presents a year round income opportunity. Brewing is impacted by poor domestic drinking water supply, with women sometimes having to pay for water or to collect from the river to get the water for brewing, and also impacted by poor harvests (women tended to use their own maize to brew, but also purchased additional ingredients needed).</p> <p>Currently (September 2017) the women were suffering as brewing had been banned across the region to a cholera outbreak. They reported that without brewing they had nothing to do, though some did admit to continuing to brew and sell in secret. Women in Nyakadete reported that if it wasn't for the ban they would have electricity by now because they would have been able to afford the connection charge, but instead they are currently sat at home with nothing to do since the ban was introduced in July.</p> <p>Risks related to brewing was that maize was used for brewing even during food shortages, with Village Councils wanting maize to be prioritised for food use, and also many women reported suffering domestic violence, which was often linked to alcohol consumption.</p>	<p>Timber production was an income generating activity that was reported to be growing in importance. It presents an opportunity as the market appears to be well established, especially for communities near to Iringa. It could also potentially be harnessed to reverse some of the impacts communities are suffering due to deforestation of the natural forests, as planted trees could provide protection against strong winds and landslides, if managed for those purposes. However the trees grown for timber production are different to the ones stated to be helpful for ecosystem rehabilitation, and women reported that men do not just cut down the trees they plant; they also cut down trees in the natural forests and vital fruit trees that they rely on as well.</p> <p>Another reported benefit was that the growth in tree business had dramatically reduced fire risks and losses from fires, as men take concerted action to protect their now valuable trees, and have changed agricultural and bee keeping practices as a result.</p> <p>Potential risks from this trend for timber plantations however is the potential for land for food production to be taken over for trees, leading to food shortages; grazing land taken for tree production, exacerbating conflict and undermining pastoralists ability to pursue their livelihoods; and prioritising trees for business over local needs for healthy natural forests and ecosystem services.</p>
<p>Vinyungu was a key activity for women. See section 5.2 of the main report for information on vinyungu.</p>	<p>Charcoal does not tend to be used locally, but it was reported that men make charcoal locally to sell elsewhere. Women frequently blamed men cutting down trees for charcoal production for deforestation, even though it was reported men were fined if they were caught doing it without permission. One example from Igoma was that a man was sent to prison for this, but carried on when he returned.</p>
<p>An increasing trend for keeping animals at the home for income generation was reported. Mostly this was chickens and pigs, but also cows, goats, ducks, and sheep. Largely these were smallscale activities, though some women reported larger scale investments, including one woman from Wangama who had 300 chickens. Female-headed households owned animals, and married women reported such assets were owned together with their husbands, and their husbands tended to control when they could sell them and what they could spend the money on,</p>	<p>Beekeeping was reported in nearly all CVCA villages, with between 50 to 200 hives reported in village forests. A key challenge was from forest fires, though beekeeping methods were in one case blamed for causing fires in the past (using fire to clear bees from hives for honey collecting) however it was reported that they no longer do this. No further details were collected relating to ownership of the hives or marketing/profitability.</p>

<p>however it was largely reported as women's work. Animals were reported to be something they could sell anytime they experienced a hardship. Some animal diseases were reported.</p>	
<p>Milk production was only reported in Igima, as part of a CARITAS project with women. The milk they produce is sold to a company called ASAS who collects it twice a week. This provides a year round source of income. One woman reported; <i>"I get 16 litres a day and sell for 650 Tsh per litre; 600 for me and 50 to ASAS for transportation."</i> She reported using the income to buy pesticides, pay for labour on her land, food, and other expenses.</p>	<p>Fishing was as an important income generating activity for youth in Igima, who have few other options, and who were most affected when the swamp dried up in 2002 and there was no fish. Some fish were reported to have never returned since that time. In other places fishing was mentioned a few times in passing, but never as a primary livelihood strategy. One woman reported cooking and selling fish that her husband caught when they needed additional income.</p>
<p>Cooking and selling bites was a common income generating activities for women. Opportunities presented were selling at bars, village markets and monthly markets, and to lorry drivers, though they reported that this wasn't as profitable as brewing.</p>	<p>Mining was reported in Ifunda for lime in and Igoma for gold. In Ifunda women reported that they did not benefit at all from the lime quarry, but felt it was an important resource.</p>
<p>Trading was also common to turn to during times of hardship in order to generate some income to support family needs</p>	<p>Brick making was mentioned in nearly all villages but no detailed information was collected. Women reported that men made bricks in or near water sources, and the activities destroyed vital water sources and uses too much water.</p>