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SEI STOCKHOLM ENVIRONMENT INSTITUTE

FINAL REPORT: TANZANIA STUDY

ECOSYSTEMS, DEVELOPMENT, AND CLIMATE ADAPTATION: Improving the knowledge base for policies, planning and management

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I. BACKGROUND

The importance of ecosystems in Tanzania

Tanzania hosts a variety of ecosystems, including mountain, drylands, wetlands, coastal and marine ecosystems, many of which are trans-boundary (e.g. the Lake Tanganyika ecosystem, which is shared between four countries). These ecosystems directly support the livelihoods of many Tanzanians and much of the country's economy as a whole, providing goods and services including food, water, medicine, building materials, fuel and numerous natural attractions that support tourism.

The pressure placed on Tanzania's ecosystems has been steadily growing as the human population increases, the economy expands, and more ecosystem goods and services are appropriated, traded and consumed. Ecosystem fragmentation resulting from land use changes, overgrazing, artisanal mining, the destruction of watersheds through deforestation, extensive pollution, wildfires, and the inadequate levels of management capacity, institutional coordination and participation of key stakeholders are all contributing to the degradation and destruction of numerous ecosystems across Tanzania (NEMC, 2006). The result is declining soil fertility, reduced water flow and loss of biological diversity. Global anthropogenic climate change is placing additional strain on already degraded ecosystems, which in turn has consequences for human communities using, in various ways, the goods and services that these ecosystems offer.

Climate variability

Tanzania has a tropical climate with regional variations due to topography. The coastal regions of Tanzania are warm and humid, with temperatures ranging from 17-25°C throughout the year. The highland regions are more temperate, with temperatures around 20-23°C throughout the year.

The north and east of Tanzania experience two distinct wet periods – the short 'vuli' rains in October to December and the longer 'masika' rains in March to May; whilst the southern, western and central parts of the country experience one wet season from about October through to April / May. The amount of rainfall falling in these seasons varies greatly between regions, and can be as much as 300mm per month in the wettest regions and seasons (McSweeney et al, 2008).

The onset, duration and intensity of rainfall across Tanzania varies naturally between years, associated with variations in sea-surface temperatures. One of the most well documented ocean influences on rainfall in this region is the El Niño Southern Oscillation (ENSO). El Niño episodes usually cause greater than average rainfalls in the short rainfall season, whilst cold phases (La Niña) bring a drier than average season in Tanzania, often associated with floods and droughts respectively (McSweeney et al, 2008; Jack, 2010). Flooding is particularly severe when an El Niño year occurs in combination with the positive phase of the Indian Ocean Dipole, as was the case for the major floods in the north-central parts of the country in 1997, 2006 and 2010.

Observed climate trends

The mean annual temperature has increased by approximately 1.0°C since 1960 (McSweeney et al, 2008). Analysis of observational data from 6 stations in Tanzania carried out by New *et al* (2006), as part of a larger assessment for Africa, showed clear evidence of decreasing numbers of cold days and nights and a decrease in cold waves. Daily temperature observations show only small increasing trends in the frequency of hot days, but much larger increasing trends in the frequency of hot nights, especially in the months of December to February ('hot' defined according to the top 10% of temperatures measured for that place in that season) (McSweeney et al, 2008).

Observations of rainfall over Tanzania show statistically significant decreasing trends in annual rainfall, notably in the 'long' rains (March to May). Annual rainfall has decreased at an average rate of 2.8mm per month per decade (3.3%), while rainfall between March and May has decreased by 4.0 mm per month per decade (3.0%) (McSweeney et al, 2008). The greatest annual decreases have occurred in the southern most parts of Tanzania. Projections of possible future climate states across Tanzania suggest however that this trend might be reversed.

Future scenarios

The mean annual temperature over Tanzania is projected, using global climate models (GCMs), to increase a further 1.0 to 2.7°C by the 2060s, and 1.5 to 4.5°C by the 2090s, depending on the level of global emissions in the intervening years (McSweeney et al, 2008; Jack, 2010). All projections indicate increases in the frequency of days and nights that are considered 'hot' in current climate terms, increasing particularly rapidly in the December to February season (McSweeney et al, 2008).

GCM projections of mean rainfall show significant uncertainties, and therefore must be reviewed and interpreted with caution, but are broadly consistent in indicating expected increases in annual rainfall over much of Tanzania (McSweeney et al, 2008). Downscaled projections of precipitation changes show some agreement that precipitation will increase in the future during the late part of summer with some very slight signs of drying during the early summer, indicative of a seasonal shift with weaker early season rains and stronger later season rains, though for some locations the early summer is also wetter (Jack, 2010). The global climate models consistently project overall increases in the proportion of rainfall that falls in heavy events. We must therefore conclude that future changes in precipitation across the region are uncertain but with some indications of wetting for most locations.

Even though recent studies have not found evidence in observed data of increasing sea levels in this region (Cazenave and Nerem, 2004; Church et al, 2004), potential future changes in sea levels do need to be considered in the case of Tanzania.

Climate vulnerabilities and impacts

Changes in the temperature and rainfall patterns across Tanzania, whether associated with human-induced climate change and/or long-term natural variability, have numerous and extensive impacts on the varied agro-ecological systems across the country, as well as the built environment of towns and cities. Some of these impacts are very direct; others are mediated through complex feedback systems. As mentioned above, many of the ecosystems are already in a degraded state due to human activity and this makes them more susceptible to the impacts of climate change, as are many of the infrastructure networks that constitute the built environment.

These impacts are in turn experienced very differently by the various sectors, communities and households across Tanzania. Currently, large portions of the population are particularly vulnerable to climate change because of their limited livelihood base, poor access to markets and services (notably water supply, energy, transport, healthcare and social welfare), and weaknesses in the institutions that govern them (for a detailed analysis see Paavola, 2003).

Table 1 basic indicators suggesting high levels of vulnerability to climate-related risks in Tanzania, selected from the WRI Climate Analysis Indicators Tool - Vulnerability and Adaptation[1] (CAIT-V&A) and UN Millennium Development Goals Indicators[2]

Indicator	Value	Year	Original Data Source
Workforce in agriculture	78.7%	2004	Food and Agriculture Organization of the United Nations (FAO)
Number of people affected by drought	5,154,000	2000 - 2009	Emergency Events Database (EM-DAT)
% total population undernourished	35%	2003 - 2005	Food and Agriculture Organization of the United Nations (FAO), Statistics Division
Number of people affected by flood events	46,750	2000 - 2009	Emergency Events Database (EM-DAT)
% total population living within 100km of coast	19.8%	2000	Center for International Earth Science Information Network, Columbia University
% of urban population living in slums	66.4%	2005	UN-Development Indicators Unit Statistics Division
Notified cases of malaria per 100,000 population	24,088	2008	UN-Development Indicators Unit Statistics Division

Increases in temperature and changes in rainfall are affecting the length of the growing season, and this, together with changes in pest populations and plant disease outbreaks, affects crop yields. There are projections of large declines in maize production across many parts of Tanzania (Mwandosya et al, 1998). Maize is a staple crop grown by half of Tanzanian farmers for domestic consumption, and declining production could have serious food security implications. However, there is the potential of increases in coffee yields, an important cash crop, associated with these climatic changes, which could be beneficial for growers. These changes are likely to have differential impacts on commercial, emerging and small-scale farmers.

Malaria is being observed in areas previously unaffected by the disease, particularly higher altitude parts of Kilimanjaro, Arusha and the highlands around Lake Victoria. The increasing incidence of highland malaria is linked to a number of local environmental and socio-economic changes (e.g. forest clearance and swamp reclamation, deteriorating health care, increasing population density, etc.), but is further aggravated by regional climate variability and change (Yanda et al, 2006). There are a number of other health threats presented by changing temperature and rainfall patterns that pose a threat to large portions of the Tanzanian population, including water-borne diseases such as typhoid and cholera.

Climate change is affecting the severity and frequency of extreme events experienced across Tanzania. The threat of experiencing more intense rain events in certain areas increases the risks associated with flooding and resultant damage to housing, public infrastructure and hydro-electric plants (e.g. on the Rufiji, Kihansi and Pangani Rivers). Floods pose a particular risk to livestock farmers (potential for high levels of animal mortality) and communities residing on denuded slopes, prone to landslides.

Droughts particularly affect agricultural production (for subsistence farmers, emerging small-scale producers and large commercial growers) and thereby food security, as well as hydropower production and energy supply. This leads to difficult trade-offs in water allocations, notably between irrigation and hydropower production. A large proportion of Tanzania's population is reliant on agriculture-based livelihoods, and many have poor nutritional status, making them particularly vulnerable to drought and food insecurity. Increases in the duration and incidence of droughts are expected to periodically reduce the amount of grazing available to livestock-keeping communities in Tanzania. There is already

[1] http://cait.wri.org/cait-va.php
[2] http://mdgs.un.org/unsd/mdg/Data.aspx

considerable pressure on the land in many parts of the country and this may exacerbate conflicts between pastoralists, agriculturalists and national parks and wildlife authorities, notably in the Morogoro, Mara and Kilimanjaro regions. Hydropower constitutes a large portion of Tanzania's total electricity supply, important for manufacturing and commerce. The scarcity of rainfall comes on top of existing water management challenges, including over-allocations of water and the deforestation of river catchments, and will continue to affect rates of river discharge (notably in the Pangani, Ruaha and Rufiji Rivers) – for the most part resulting in a gradual decline in total annual instream flows (Lankford and Beale, 2006; Mtahiko et al, 2006). Changes in water temperatures in the large East African lakes, including Lake Tanganyika (O'Reilly et al, 2003), are affecting the nutrient loads and thereby the productivity, species composition and size of fish populations, in turn impacting on the livelihoods of those that rely on these resources.

Increases in sea surface temperatures and ocean acidification are likely to have a significant impact on marine ecosystems. The effects of a large coral bleaching episode in 1998 (Lindahl et al, 2001; Garpe et al, 2006), linked to an ENSO event, is an indication of conditions that might get even worse under scenarios of increasing sea surface temperatures associated with climate change (Wilkinson et al, 1999). Coastal communities, reliant mainly on fisheries-based livelihoods and tourism, are vulnerable to increasing coastal erosion (driven by both climate and non-climatic factors) because of a lack of insurance against infrastructure damages and a lack of livelihood alternatives in the face of degraded fish and shrimp nurseries and declining fish stocks (URT, 2007).

Clearly there is a lot to consider when it comes to the influences of climate change and ecosystem health on socio-economic development, and vice versa, in a country such as Tanzania, hence the conceptualisation of this project.

II. INTRODUCTION

WWF-UK commissioned the Stockholm Environment Institute (SEI) to conduct a study exploring questions around integrating ecosystem-based approaches to climate adaptation into national policies and plans, focusing on the links between ecosystems, climate adaptation, and poverty alleviation, and the governance arrangements needed to support this.

Ecosystem-based approaches to climate adaptation involve governing and managing ecosystems in ways that enhance their resilience to climatic shocks and stresses – maintaining, and where possible enhancing, the quality and quantity of services they provide to society – and in so doing supporting human communities to adapt to current and future climate risks. This may contribute in various ways to achieving more sustainable forms of development, strengthening livelihoods in ways that reduce poverty and environmental degradation.

The key questions being addressed in the study are:

1. How do ecosystem goods and services support human well-being and the reduction of climate risks and social vulnerability?
2. To what extent have environmental considerations and ecosystem-based adaptation strategies been integrated into development policies and plans?
3. What are the opportunities for, and constraints to, further integration?

The project involved 3 country studies in Belize, Nepal and Tanzania. This report presents findings from the Tanzania country study. It is based on a review of existing literature and documentation, a series of interviews with key stakeholders, and a participatory workshop convened in Dar es Salaam in November 2010 (see further details in annexes 1 and 2).

Brief overview of the approach taken in this study:

1. review key literature and documentation on climate adaptation, the links between ecosystem goods and services and human well-being, and the mainstreaming of environmental considerations into development planning
2. conduct semi-structured interviews with key national stakeholders on the relevant ecosystems, the institutional structure governing them, and the drivers of change
3. facilitate a workshop to explore various future scenarios under different environment, development and governance conditions, identify what constitutes different levels of integrating climate adaptation into development and ecosystem management, and reflect on next steps
4. conduct semi-structured interviews with key national stakeholders on barriers and opportunities for further integrating climate change considerations into development planning and natural resources management (particularly taking an ecosystems perspective)
5. collect feedback from participants on the draft country study reports
6. compare findings from across the 3 country studies
7. produce project outputs specific to key audiences that can inform and feed into ongoing work

Due to the diverse and variable nature of livelihood activities, ecosystems and climatic conditions across Tanzania, focus was placed on ecosystems and communities in the Great Ruaha Catchment, a sub-basin of the Rufiji Basin, and the institutions that govern them, so as to build on and contribute to WWF's existing work there, as well as that of other stakeholders. The findings from Tanzania, presented below, will be compared with those from Belize and Nepal to draw broader learning and recommendations, presented in a separate briefing note.

This report is structured as follows:

Section I (above) gives a background to the study, providing a brief overview of the importance of ecosystems across Tanzania, the large scale climatic conditions and how these are changing, and the way these affect ecosystem functioning and human communities in general terms;

Section II (above) introduces the study, the approach taken and the focus of the Tanzania case;

Section III provides an overview of conditions within the Great Ruaha catchment in terms of the ecosystems, the economic and livelihood activities, and the local climate;

Section IV describes the main drivers of change affecting the health and functioning of the ecosystems and the livelihoods of residents in the Great Ruaha catchment, and present scenarios for how these drivers may play out into the future, as developed by workshop participants;

Section V presents information on the governance system, the set of authorities, processes and procedures guiding strategic and key operational decisions on how freshwater ecosystems are used and managed within the Great Ruaha, and discusses the extent to which climate adaptation is being integrated into water management and development policies and plans;

Section VI identifies the opportunities and barriers for further integrating ecosystems management and climate change adaptation into development and poverty reduction strategies;

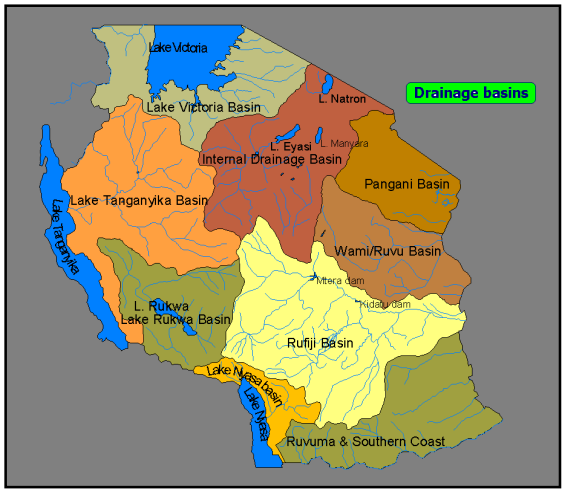
Section VII draws together the key findings, putting forward some concluding remarks; and,

Section VIII provides recommendations, suggesting possible next steps for building adaptive capacity and further integrating conservation, climate adaptation and development efforts.

III. THE GREAT RUAHA

In Tanzania, the case of the Great Ruaha Catchment within the Rufiji River basin is used to explore what it means in practice to try and integrate ecosystem-based approaches to climate adaptation into development. The Rufiji Basin is the largest of the nine hydrological basins in Tanzania (see maps

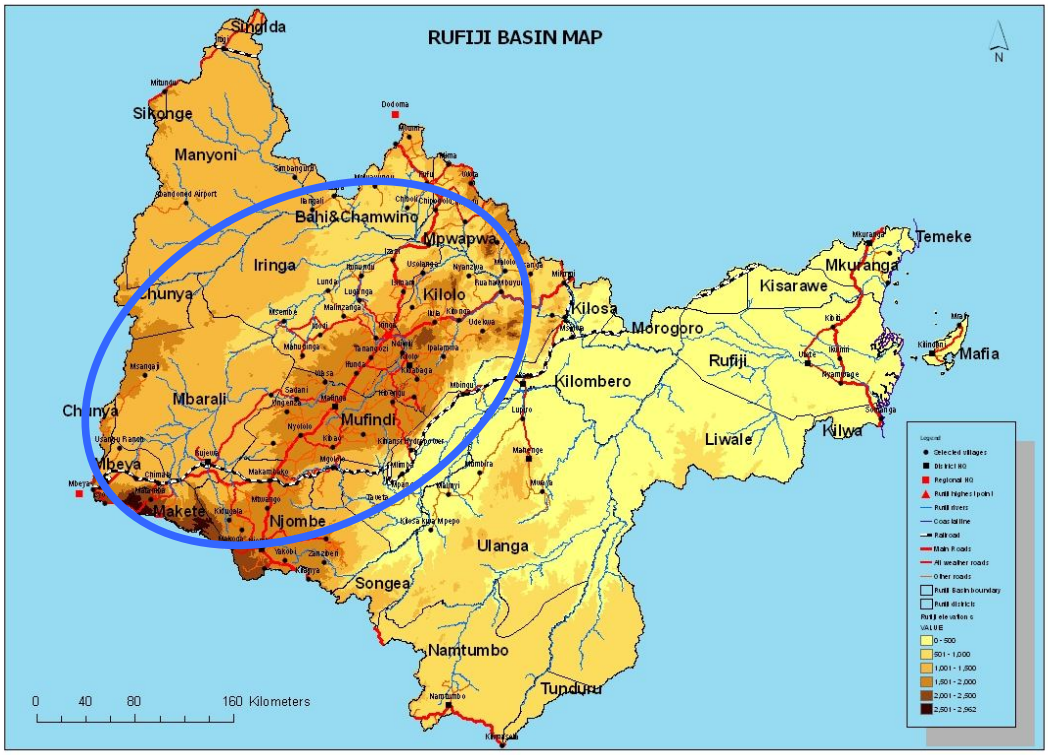
below), with a drainage area of about 180,000 km2, ±20% of Tanzania's area, and a population of approximately 6 million people (Rufiji Basin Water Board, 2010; Kangalawe, 2010). The basin includes a number of ecosystems, from afromontane forests in the upper catchment areas in the south west of the country, through wetlands and dryland / savannah ecosystems, to mangrove forests in the river delta, where the Rufiji River flows into the Indian Ocean, approximately 200km south of Dar es Salaam.



Map on left: shows Tanzania's 9 river basins, including the Rufiji in pale yellow

Map below: shows the river network and districts that fall within the Rufiji Basin and the shading shows variations in elevation. The blue ring has been added to roughly indicate the location of the Great Ruaha River sub-catchment

Source: Mwaruvanda, Rufiji Basin Water Office, 2010



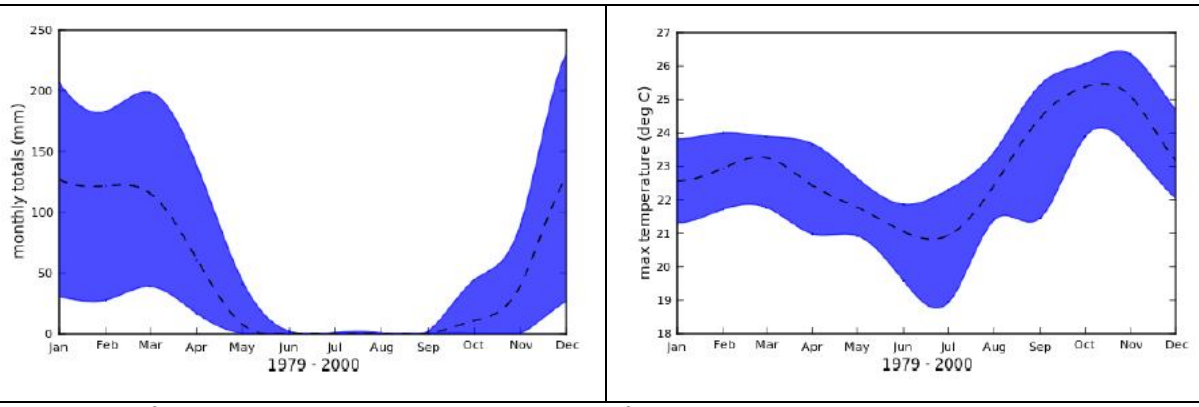
The Great Ruaha catchment is situated in the upper reaches of the Rufiji Basin. It has an area of approximately 84,000 km^2, which constitutes 47% of the total drainage area of the basin, and includes mountain forests, savannah, wetland and river ecosystems (NEMC, 2006). From a human-centred perspective, these various ecosystems provide a number of resources, or goods and services, many of which have multiple users and uses. In this project particular attention is given to the freshwater component of these ecosystems. Water from the Great Ruaha supports wildlife and fish stocks, both within the catchment and further downstream, and is used for hydropower generation, for agricultural

production (notably irrigated rice and vegetables, maize and livestock), forestry, aquaculture (fish farming), in mining activities, for transport, or domestic and industrial water needs, and supports extensive wetlands, which provide dry season water and grazing for livestock and wildlife.

Water from the Great Ruaha provides ecosystem services that are not only used locally to support the livelihoods and coping strategies of communities resident in the river catchment area, but is also used (directly and indirectly) by others nationally and internationally, for example tourists visiting the wildlife in the protected areas and residents of Dar es Salaam using the hydro-electricity for domestic and commercial purposes. Within the Great Ruaha catchment the main livelihood activity is farming with rice, maize, beans, vegetables, groundnuts, etc. Other important livelihoods activities include: livestock-keeping; fishing; fish farming; brick-making; collecting timber and non-timber forest products; hunting and trading bushmeat; and tourism.

It is clear that there are very many stakeholders when it comes to considering the governance and management of the river basin as a whole, and/or of the various constituent parts. Moving up through the decision-making levels that influence activities in the catchment there are farmers, fishermen, hunters, National Park managers, through water basin officers, to TANESCO executives (the national power company), many of the sectoral Ministries (e.g. Water and Irrigation, Agriculture, Natural Resources and Tourism, etc.) and national inter-sectoral policy bodies (like the National Wetlands Steering Committee), to name but a few. All influence the functioning of the ecosystems reliant on the Great Ruaha in a number of ways, and use various goods and services they provide.

The climate also plays an important role in the state of the ecosystems and in the mix of livelihood activities practised. In turn the water flows, human activities and land cover in the catchment also influence the local micro-climate. The catchment receives a single rainy season from November to May, but the amount of rain received varies considerably between different parts of the catchment (i.e. spatial variability) and between years (i.e. temporal variability). The mean annual rainfall received in the mountains is approximately 1600mm, while the amount received on the plains is closer to 700mm (Kangalawe, 2010). In years of rainfall extremes – lows and highs – droughts and floods respectively are common. The tropical nature of the climate in the catchment area means that temperatures remain fairly mild throughout the year (on average low to mid 20s in degrees Celsius), varying spatially mainly according to altitude. As an illustration of the variability in conditions between years, data from a weather station in Mbeya (in the far west of the basin, at an altitude of 1750m) is displayed below.



Observed rainfall and maximum temperature climatologies for Mbeya station between 1979 and 2000. The blue envelope represents the range between the 10th and 90th percentile values for each month. The dashed line represents the median value for each month. Source: Climate System Analysis Group, UCT (Jack, 2010)

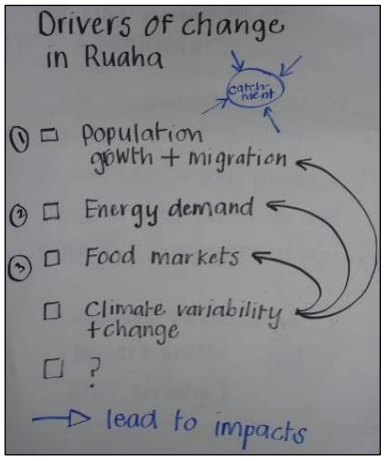
Evaporation levels are very high in many parts of the catchment, 1458 – 2391 mm/yr mean potential evaporation (Kangalawe, 2010), often resulting in a soil moisture deficit where the amount of water available is insufficient for normal crop growth. This creates a need for irrigation and a high demand on the water resources. It also represents a significant water loss from the Great Ruaha system.

IV. DRIVERS OF CHANGE

Many changes in the Great Ruaha system, both biophysical and socio-economic, have been observed and experienced over the last few decades. Some of the main drivers of change affecting the health and functioning of the ecosystems and the livelihoods of residents in the Great Ruaha sub-catchment include:

- Population growth, which is driving an increasing demand for agricultural land, clearance of natural vegetation and poor land management practices, leading to soil erosion and the degradation of water sources, and increased water abstraction. Also, migration into the area, especially of livestock herders from the north moving in search of pasture and water for their cattle, is associated with over-grazing, erosion and watershed degradation.

- Increasing economic activity, especially in irrigated agriculture (notably maize and rice) and in the production of energy, is placing huge pressure on the water resources of the catchment. Over-allocation and heavy abstraction of water has resulted in dramatically reduced in-stream flows. Since 1993 the Great Ruaha has been drying up completely in the dry season (a trend that has been developing since the 1970s). Damming in the upper parts of the Rujifi Basin (including the Great Ruaha) is having a detrimental effect on the river delta, changing the water courses and the volume of flows around the mouth, because there are no longer regular floods. Changes in flooding due to controls up-river (dams and irrigation canals) are also threatening the health of the wetland ecosystems, many of which are shrinking.



- Variable and changing climatic conditions, notably in the form of increasing temperatures, associated with increases in evaporation and transpiration, are affecting both the supply of, and demand for, water and energy (e.g. dams such as the Mtera Dam lose water more quickly to the atmosphere, farmers irrigate more to protect their crop yields, more air-conditioning in the cities increases energy demand, etc.) and leads to increased competition between the different water users. While trends of increasing temperatures are clearly visible in the temperature data from stations across the area, clear patterns in the rainfall data are more difficult to discern and vary between stations. Efforts by the Rufiji Basin Water Office (see details below) to detect and characterise changes in rainfall and river flows in the Basin are ongoing. Work already undertaken does not reveal any obvious trends in the annual hydrographs, however there do seem to be some trends in the rainfall patterns in the dry season (not discernable in the annual averages). More work is currently being undertaken to analyse additional climate data available for the area, as well as to generate future climate scenarios for the basin using climate models and downscaling techniques.

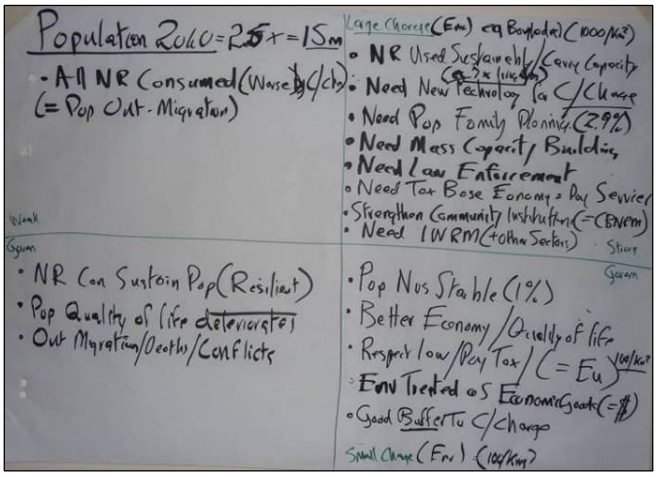
These drivers interact in a number of complex ways and are giving rise to numerous conflicts between water users, especially in the Great Ruaha catchment. The Rufiji Basin Water Office (RBWO) has recorded 9 major conflicts since July 2007. These include inter-sectoral conflicts, e.g. between hydropower and irrigation (Mtera Dam), pastoralists and irrigators (Usangu Plains), agriculture and environment (Ruaha National Park), hydropower and environment (Mtera and Kidatu Dams), etc. as well as intra-sectoral conflicts between groups of farmers irrigating upstream and downstream of one source, and even between users within one irrigation scheme (Mwaruvanda , 2010).

There are a number of related effects. People are becoming more dependent on groundwater sources, and increased abstractions are contributing to a drop in local water table levels (which is also linked to less percolation due to lower instream flows). Land use changes from natural vegetation to agricultural crops, or clear felling for timber and charcoal production, means there are less timber and non-timber forest goods available to those who collect them for fuel and food, whether for household use and/or to

sell on. Increasing water abstractions (both surface- and ground-water) together with increased rates of evaporation are associated with reduced in-stream flows, which threaten riverine vegetation and fish stocks, undermining the livelihoods of fishermen and those that dry, process and sell fish (often the women). This is further compounded by people (illegally) fishing with finer nets in an effort to secure their catch and protect a key income stream and livelihood activity. The Usangu and Ihefu wetlands, as well as the Ruaha National Park, depend on waters from the Great Ruaha River and so increased damming and abstractions upstream are undermining the functioning of those ecosystems and limiting the goods and services they provide, thereby threatening biodiversity downstream, as well as limiting further power generation and economic development from tourism, industry and alike. Many of these relationships need to be explored in further detail to understand the intricacies of the dynamics involved.

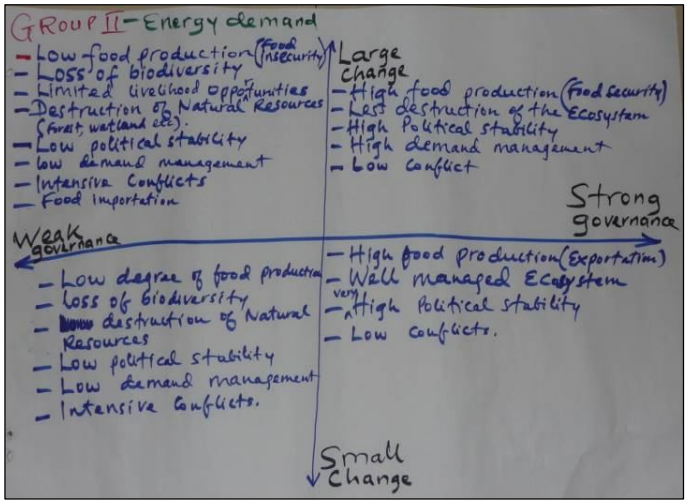
There are numerous changes underway in how water resources are managed in Tanzania, with moves towards taking a more integrated approach and setting up new multi-level and multi-stakeholder coordination units (e.g. the National Wetlands Steering Committee, River Basin Water Boards, Water Users Associations, etc.). These are still in the early stages of development but hopefully will be the basis for positive change. In order to explore some possible future pathways for how things may play out in the catchment under different circumstances, groups of participants in the workshop were asked to develop qualitative scenarios of how each of the above mentioned drivers might play out within the context of a changing climate. 4 scenarios were generated for each driver, comparing conditions under large change versus small change, and strong governance versus weak governance. The output from each group is presented below with a brief summary of the key points emerging.

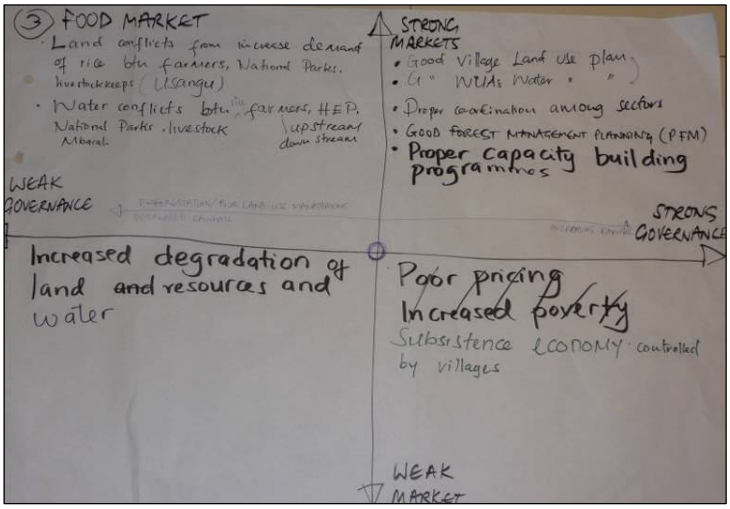
Qualitative scenarios of future change: a participatory exercise



The group considering **population growth and migration under climate change**, suggested that with weak governance, there would either be: increasing competition over natural resources, over-consumption, collapse or significant negative changes in ecosystems, and ultimately large-scale migration out of the catchment; or if population figures did not change very dramatically then there might be sufficient resources to sustain the communities living there, but with little coordination the quality of life is expected to decline. With strong governance and large scale population growth, natural resources would be under high demand as the catchment nears its carrying capacity, but there would be the institutional arrangements across all scales and sectors to manage them sustainably and ensure that new technologies (e.g. water and farming technologies) are adopted to effectively adapt to changing conditions. Under a scenario of strong governance but small population change, there might be a strengthening economy and increasing quality of life for those living in the Great Ruaha catchment. The environment is better managed through recognising the full economic value of the goods and services it provides and this means that both ecosystems and communities are in a strong position to deal with changing climatic conditions (high buffer capacity).

The group exploring changes in **energy demand** (especially hydropower and fuelwood in the context of the Great Ruaha) under climate change identified that the strength of the governance system would make the difference between levels of conflict over the available resources (associated with political stability, demand management practices, and the protection of ecosystem functioning and biodiversity) and levels of productivity (balancing between the use of water and land for energy production and food production). Large energy demand under weak governance and climate change could result in food insecurity and the need for extensive food imports, while under strong governance food production systems and safety nets would be in place to ensure food security (even in times of drought), and possibly provide the opportunity for exporting food if energy demand was kept manageably low.





The third group developed scenarios for changes associated with **economic activity**, specifically food production and markets, associated with increasing water demand for irrigation and land use change from natural vegetation to crop fields and grazing lands (especially in forested areas and wetlands). Expecting large changes in this regard by the 2040s, the group felt that under a weak governance system there would most likely be escalating conflict over land and water between farmers (especially rice farmers), National Parks and livestock keepers, resulting in deforestation, land degradation and reduced river flows. This would be made worse if rainfall received in the catchment area was further reduced due to global climate change. Whereas with a strong governance system in place this conflict and degradation could be largely avoided by having the mechanisms and organisations established and capacitated to undertake good land use planning, water use planning and forest management, with effective coordination between the different sectors and across the various scales (from the village level, through the district and basin levels, to the national level and ultimately the international level).

V. GOVERNANCE SYSTEM

Governing the ecosystems linked to the Great Ruaha River and the users of the goods and services provided (i.e. the stakeholders) is a complex challenge, particularly under a rapidly changing set of environmental and social conditions. The strength and effectiveness of the governance system influences the extent to which the drivers listed above play out, and shape the nature and distribution of the impacts or consequences for both human and non-human communities, as explored in the scenarios presented in the previous section.

In this study the term 'governance' is understood to mean the set of authorities, processes and procedures guiding strategic and key operational decisions to establish and monitor the long-term direction for how ecosystems are used and managed under climate change (determines the interactions between public sector, private sector and civil society actors).

National climate adaptation

The Division of Environment in the Vice President's Office (DoE–VPO) is the National Climate Change Focal Point for the United Nations Framework Convention on Climate Change (UNFCCC), and holds the mandate to coordinate climate change activities across Tanzania. In collaboration with the National Environmental Management Council (NEMC), the DoE-VPO provides policy guidance on all environmental issues (including climate change). Many early climate change studies, assessments and pilot activities are taking place (mainly with international funding), however there is still limited coordination between the institutions involved. As a signatory to the UNFCCC, Tanzania developed a National Adaptation Plan of Action (NAPA: URT, 2007), which identified 14 priority needs to be addressed (which includes a number of water-related priorities). This was further developed into the National Adaptation Strategy and Action Plan (URT, 2009a), which is intended to guide the activities undertaken by the relevant ministries, departments, district authorities, etc. On the whole however, there is still low or no awareness of the NAPA process and documents at the district level.

Since the NAPA was completed, additional government-commissioned studies have been conducted, funded largely by the Danish government, to assess the current and projected impacts of climate change in the health, water and agricultural sectors. Full project documentation for the NAPA priorities is still being developed in order to access funding from the Global Environment Facility (GEF), through the United Nations Environment Programme (UNEP), focusing on improving agriculture and rehabilitating coastal defences (re-enforcing the Pangani sea wall and conserving mangroves) in the Pangani, Rufiji and Bagamoyo Districts. There are, however, no guidelines yet for how NAPA implementation is to take place and no specific coordination amongst the institutions that will need to be involved with the implementation on how they will go about it.

As of yet, there have only been low level discussions about whether a stand alone climate change policy should be developed in Tanzania to ensure that climate change is a prominent issue on the national agenda, and to support and complement efforts to integrate climate change into other sectoral policies and plans (e.g. Water Policy (2002), Forestry Policy (1998), Energy Policy (1992), etc.). There is a National Climate Change Technical Committee (formed in 2009) comprising of members from relevant government ministries and institutions, non-governmental organizations, academic and research institutions. The main function of the committee is to guide research, review reports and advise the DoE-VPO on climate change-related issues and options in the country (on both mitigation, including REDD, and adaptation). However in effect, this committee is struggling to become fully operational.

Environmental Management

Addressing climate change explicitly appears in Section 75 of the Environment Management Act (URT, 2004). The National Environment Management Council (NEMC) is mandated to ensure implementation

of the Act and to take action against those who fail to comply. Climate change, and ecosystem-based approaches to climate adaptation specifically, fits into NEMC activities in a variety of ways. The Directorate of Environmental Planning and Research within the Council is tasked with carrying out ecosystem assessments; the Directorate of Environmental Information and Outreach is tasked with raising public awareness of environmental issues (including climate change) and rolling out education programmes; the Directorate of Environmental Impact Assessment (EIAs) reviews EIAs and consults with a range of other stakeholders; and the Directorate of Environmental Compliance and Enforcement follows up to ensure implementation. NEMC recognises that the way EIAs are currently undertaken does not adequately capture climate change issues. NEMC is in the early stages of trying to build up the organisational capacity needed in order to address this gap, by developing new partnerships with research organisations, learning from examples of how it is done in other countries, and sending staff on relevant training programmes. Including climate change considerations in the EIA process may be an important mechanism for mainstreaming adaptation into development priorities, because the proportion of enterprises undertaking an EIA is an indicator for sustainability in the National Strategy for Growth and Reduction of Poverty (URT, 2005), which feeds into the international human development reporting associated with the Millennium Development Goals.

As stipulated in the Environment Management Act (2004), Environment Units are being established in each of the sector ministries in order to mainstream environmental issues pertinent to that specific sector. These units are coordinated by the DoE–VPO, and are required to prepare environmental reports every 2 years. According to the Act there should also be Environmental Officers in place at the regional, district and ward levels, which are mandated to liaise with environmental sub-committees at the village level, forming a bridge between the grass-roots realities and the national planning and policy-making on environmental issues. These ultimately provide an important institutional structure for mainstreaming climate change issues and supporting the implementation of adaptation strategies, but there is still some way to go in creating these positions and getting suitable people into them, and putting processes in place for effective networking and coordination within and between the different units and levels[3].

National development strategy

The National Strategy for Growth and Reduction of Poverty (MKUKUTA), is a five year framework successor (2005/06-2009/10) to the Poverty Reduction Strategy (PRS of 2000) focusing on growth, well-being and governance, and sets the direction for government policy-making, planning and budgeting in Tanzania. It includes 'environment' as a cross-cutting issue, but there is still work to be done integrating and harmonising the development and environment goals and the means for achieving these goals to support implementation (e.g. of the Environmental Management Act) and reduce contradictory practices across sectors. The MKUKUTA implementation cycle came to an end in July 2010. There has been a lengthy review process and the new MKUKUTA II strategy is currently being finalised and endorsed. Tanzania's Development Partners lauded the government for "the clear importance given to… advancing adaptation efforts for climate change" in the new strategy (Dec, 2010[4]).

Water management

With regards to water management specifically, the National Water Policy (URT, 2002) lays out the institutional set-up to manage water at the national, basin, catchment, sub-catchment, and water user levels. The Rufiji Basin Water Board (RBWB), established under Section 22 of the Water Resources

[3] For a report (with listings) and a map of climate change actors in Tanzania prepared by the Citizens' Global Platform in 2009, visit the CGP website: www.globalplatform.fi

[4] For full commentary see:
http://www.tzdpg.or.tz/uploads/media/DPG_commentary_on_MKUKUTA_II_FINAL.pdf

Management Act (WRMA) of 2009, is a fully autonomous government agency under the Ministry of Water Resources and Irrigation that is mandated to bring together all the different actors using, or influencing the use of, water in the 4 sub-catchments of the Rufiji and coordinate activities between them. The Board consists of 10 members each representing key sectoral stakeholders (e.g. a representative for irrigated agriculture, another from the power company (TANESCO), always one from either DoE-VPO or NEMC, etc.), and meets periodically to agree on water allocations, to work at resolving any conflicts between competing users, and to coordinate catchment management activities such as water source protection, water pollution control, etc. The Board recruits and appoints staff in the Rufiji Basin Water Office (RBWO), based in Iringa. The RBWO is tasked with monitoring river- and ground-water in terms of quantity and quality, managing various hydrometric and weather stations to collect data, and have an obligation to enforce the national water law as well as the environment law (thereby supporting the work of NEMC).

The Water Resources Management Act (URT, 2009) also establishes institutions in additional to the Basin Water Boards, namely: Catchment committees; Sub Catchment committees; Water User Associations; and Water User Groups. In the case of the Rufiji, the work of the Basin authority is supported by 5 catchment offices, with technical staff overseen by catchment committees (with a maximum of 5 members), one of which is the Great Ruaha Catchment Committee. Each catchment also has a number of Sub Catchment Councils, in which more stakeholders are represented. The RBWO, in collaboration with the District Authorities, is assisting water users to form Water User Groups or Associations (more than 187 single use associations currently exist).

The Water Resources Management Act does address issues of climate change, but the problem is in the implementation. Technical staff within the Ministry of Water Resources and Irrigation feels that there isn't sufficient baseline data available yet to know how to adapt appropriately. Various initiates are underway to improve water management nationally, for example, to protect and conserve water sources, drill more boreholes, rehabilitate existing dams and build new ones, in order to increase water supply (especially to Dar es Salaam) as well as environmental flows in the rivers, but there is not yet an explicit link made to climate change when assessing, (re)designing, and prioritising these measures. A national assessment is currently underway to assess the impacts of climate change in the water sector, and this will ultimately inform adaptation planning at the national level.

Despite the current lack of scientific data and analysis on climate changes and associated impacts in the Great Ruaha and Tanzania more broadly, changes in climatic conditions are being perceived by actors working in water management, notably: more flash flooding associated with heavier rain events; later onset of rains; more prolonged droughts; and more regular occurrences of droughts. Some of the related impacts being identified include: springs drying up; reduced flows in rivers; satellite lakes shrinking; and wildlife moving to find water. There is also evidence of people migrating more between different parts of the country, particularly those with livestock seeking water and pastures, and people moving to the lakes to engage in fishing. In an effort to maintain agricultural outputs, here is increased farming taking place in wetlands, particularly in the dry season (mainly vegetables but increasingly maize as well), contributing to high nutrient and sediment loads downstream and algal blooms[5]. However, it remains difficult to distinguish the extent to which these impacts are attributable to global climatic factors from a more localized suite of factors, including changes in micro-climatic conditions, water usage and land management practices (such as over-abstractions, deforestation in catchment areas, increased damming, etc.).

Enacting the law at the local level is difficult because it challenges certain existing practices. For example, the Water Resources Management Act stipulates no human activity of a permanent nature

[5] For a more in-depth analysis of how climate change impacts on the freshwater resources, livelihoods and ecosystem services in the Great Ruaha River Catchment Area, see the 2010 WWF report entitled "Mainstreaming Climate Change Adaptation in the Management of Freshwater Resources in the Rufiji Basin", prepared by Dr Richard Kangalawe at the Institute of Resource Assessment.

within 60 meters from a water source, but substantial amounts of activity already occur within these zones, and constitute many households' livelihoods. There have been efforts in the past to try and forcibly move people out of water source areas, and this has led to considerable tension and even outbreaks of violence (e.g. the expansion of the Ruaha National Park). Similarly, it's against the law to discharge waste into a water source, but many households and industries are already doing so, and penalising them threatens their livelihood security or economic viability in many cases, so it takes time to educate people about the problems of water pollution, to develop wastewater treatment plans and gradually change common practises. Processes are currently underway to make by-laws, a set of rules that are context specific to the local conditions, that have to be agreed with communities and the District Council, endorsed by central government, and can then be enforced. This issue of law enforcement for long term sustainability and development in the face of widespread poverty is a deeply challenging one. Awareness and education campaigns and enforcement activities all provide useful opportunities for mainstreaming systems thinking and climate change considerations, but highlight the complexity of the challenge at hand.

An Irrigation Master Plan is in place as a mechanism to reduce conflict between water users and to support agricultural production and food security even in times of poor rains and drought. A Strategic Environmental Assessment has been done on the Irrigation Master Plan, but climate change has not been fully factored in, partly due to a lack of suitable data. Also, the Plan focuses more on large industrial scale irrigation, while water policy notes that 80% of irrigation is that of small scale traditional irrigation practices. The periodic review and revision of this plan is one opportunity for taking a more integrated perspective on ecosystem functioning and climate change in the context of water management and poverty reduction through agricultural expansion.

The RBWO is currently in a 2 year process of developing an Integrated Water Resources Management and Development (IWRMD) Plan for the Rufiji Basin. This involves broad consultation with a wide range of stakeholders, and the plan aims to ultimately integrate relevant aspects of the district and sectoral plans, as well as those of the Action Plan for Mainstreaming Climate Change Adaptation in the Management of Freshwater Resources in the Rufiji Basin (developed with support from WWF Tanzania). The plan will be reviewed after 3 years and fully revised after 5 years, so these will provide opportunities to refine and strengthen the plan based on an expanded knowledge base and set of implementation experiences. In the context of climate change this will be an opportunity to include the findings from a 5 year study (CLIVET) currently being undertaken by the University of Dar es Salaam, the University of Copenhagen, the Geological Survey of Denmark and Greenland, the Tanzania Meteorological Agency, and the Ministry of Water Resources and Irrigation, funded by Danida, exploring climate change in the Rufiji Basin, developing downscaled climate models for the Basin and studying different adaptation strategies (see annex 3 for other international initiatives on climate change taking place in Tanzania more generally). The Rufiji Basin Water Office is the first in developing an IWRMD plan, so there are many lessons being learned that can be used to inform the process in the other river basins. The challenges foreseen with implementing the IWRMD plan include: harmonising it with other existing policies and plans; clarifying various roles; getting all relevant institutions to feel ownership of the plan; and assimilating the IWRM activities into the different planning cycles and philosophies of each institution.

Climate data and information

While the RWBO maintains a network of monitoring stations within the Basin, including 15 weather stations and over 200 rain gauges, the Tanzania Meteorological Agency (TMA) collects, processes, archives and distributes weather and climate data and information nationally. The TMA manages a core network of weather stations, quality controls the data, archives it and makes summary information available. Users of weather and climate data and processed information include agricultural extension workers, water managers, staff working in conservation reserves and protected areas, university staff and students, NGOs, etc. In TMA's experience, users often initially do not know what data they need or

want, and so part of the service TMA has to provide is to assist users identify what variables, timeframes, locations, etc. are relevant to and suitable for their specific needs.

The length of observational data records vary across the stations, with longer records for many of the coastal stations (dating back to the early 1900s). The network of stations across Tanzania has been deteriorating over the last few decades. In 1977, when the East African Community (EAC) broke apart, there were over 2000 weather stations in operation across Tanzania, whereas currently there are less than 800 functioning. This is due to the costs associated with maintaining, replacing and installing additional equipment (to comply with World Meteorological Office standards), as well as training the necessary technicians to set up and manage the equipment, analysts to work with the data, and archivists to manage the data and results[6].

Currently TMA has little capacity to run climate models and apply downscaling techniques for generating scenarios of future climates across Tanzania. TMA staff also have limited expertise and experience in the interpretation of scenario data required for informing non-specialists working on 'downstream' climate change issues, either in the public policy arena or with businesses and communities. On the request of the DoE-VPO, and funded by DANIDA, the TMA have contracted the Centre for Energy, Environment, Science and Technology (CEEST) to generate and analyse downscaled climate projections for Tanzania.

Non-state actors

There are a number of national and international NGOs working on water management, conservation and community development issues in Tanzania and specifically in the Rufiji Basin; many of which are now increasingly integrating work on addressing existing climate risks and future climate change into their activities. For example, alongside the work of WWF in the Great Ruaha, IUCN is working in the Lower Rufiji assessing the climate vulnerability of local communities and piloting various water management measures that may contribute to climate adaptation. There are also a number of private sector companies operating in the catchment, notably tourist operators running safaris and river trips.

Progress in integrating climate adaptation into water management

In a second exercise undertaken during the workshop (drawing on the thinking that had gone into developing the scenarios presented above), participants worked in groups to develop a 'governance-action matrix'. Considering 3 aspects of the system governing how water resources and other ecosystem goods and services are used in the Great Ruaha catchment - namely (1) institutions and networks, (2) policies, strategies and incentives, and (3) capacity and resources - groups were asked to describe 3 levels for integrating climate adaptation into water management in the Great Ruaha Catchment in order to populate a 3x3 matrix, as shown below. Level 1 describes what the governance system looks like if there is little or no integration of climate change issues into water management practices, level 2 describes early integration efforts with a focus on capacity strengthening within the governance system to mainstream climate change issues, and level 3 is a situation where systems thinking is central to management practices and climate change strategies are fully integrated and operational.

The colour shading in the matrix gives an indication of what participants and interviewees perceive the situation to be currently, either predominantly at one of the levels (bright yellow), or somewhere between two of the levels (pale yellow). This is of course a subjective assessment, and should be read as such. People were then asked to reflect on what some of the barriers and opportunities are for moving from the current state to the next level of integrating ecosystem-based approaches to climate adaptation into the ways in which water resources in the Ruaha are managed, as discussed in the following section.

[6] This is emphasised in Tanzania's First National Communication (URT, 2003) to the UNFCCC

Table 2: Governance - Action Matrix for integrating climate adaptation into water management in the Great Ruaha Catchment

Components of governance system	Level 1 = ad hoc, little or no integration	Level 2 = capacity building & early integration	Level 3 = well integrated & operational
Institutions & networks	Little or no collaborative research underway on climate change issues (only very niche and specialised); limited coordination between various government ministries; few people in-house with expertise and experience in dealing with climate change issues; not many multi-stakeholder forums effectively functioning	RBWO undertaking IWRM planning that integrates climate related issues; Local government authorities undertaking land use planning; Participatory Forest Management with communities under Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism; building up extension services to provide suitable climate information at the local level; small-scale farmers union (MVIWATA) undertaking capacity building at community level on climate change issues; Universities (e.g. SUA & UDSM) integrating CC issues in natural & social sciences curriculum and offering consultancy services	DoE-VPO and NEMC well capacitated and working closely with sectoral ministries, district councils, river basin offices and non-state actors to implement the National Adaptation Strategy and Action Plan in alignment with IWRM plan in the Ruaha; corporate social responsibility programmes (e.g. from energy and agricultural companies) funding local climate adaptation measures
Policies, strategies, incentives	Separate sectoral policies with little or no consideration of CC (e.g. Wildlife, Forest, Tourism, Fisheries policies); no CC specific funding in the Medium Term Expenditure Framework; adaptation not explicitly addressed in Village Land Use Plans; Kilimo Kwanza Strategy (URT, 2009b) pushing for agricultural development but Ruaha water already over-allocated	National Adaptation Strategy and Action Plan exists; some consideration of CC factors in the national strategy for growth and poverty reduction (MKUKUTA II); early mainstreaming into laws and policies of key sectors (e.g. Environmental Mgt Act, National Water Policy; National Science Policy); active NGOs strategically pushing the CC agenda (e.g. WWF & IUCN); entry level coverage in integrated management strategies and sectoral development programmes; economic assessments of adaptation options being commissioned (e.g. DfID study)	Integrated management strategies and plans (e.g. water resources, coastal environment, etc.) fully developed and under widespread implementation; technological needs assessment for addressing climate change undertaken and informing investments; good alignment between national and international climate change policies; money raised from national REDD programme funding district level adaptation programmes; long-term research projects on climate change ongoing with international partners (e.g. CLIVET and CCIAM projects)
Capacity & resources	Inadequate finances to support collaborative adaptation initiatives; limited knowledge on climate change (CC) related issues and little/no climate modelling capabilities in-country; limited public education campaigns	Political leadership to tackle current environmental degradation exists; equipment to rehabilitate and replace stations received under Water Sector Development Programme; technical training provided on how to use instruments; available data with gaps (climate, water flows, groundwater levels, etc.) widely accessible	Adaptation funds operational; sectoral budgets reflect additional resources to adopt new technologies and revise practices in view of climate change; scientific expertise on CC related issues well developed; high CC awareness at all levels; continuous monitoring at stations; specialised people working on data archiving and analysis; models developed suitable to local context

VI. BARRIERS AND OPPORTUNITIES FOR INTEGRATION

Reflecting on the governance-action matrix and the current situation in Tanzania in terms of integrating ecosystem-based approaches to climate adaptation into water management practices and development planning, participants and interviewees suggested a number of barriers and opportunities for further integration and strengthening the governance system.

Policies and planning

The lack of a national policy that deals specifically with climate change is seen as a barrier to ensuring that climate change is taken on as a key priority, and fails to provide a clear strategic direction for investments and activities. The development of such a policy would need to be led by the DoE-VPO, building on work that has gone into the NAPA. The National Climate Change Technical Committee, if fully operationalised with a clear mandate, could play an important part in this process, as a forum for multi-sectoral and multi-stakeholder contributions and deliberations. The prominence given to climate change adaptation in the new MKUKUTA II Strategy for Growth and Reduction of Poverty provides a good indication of will and intent on paper for further integrating climate change considerations into development planning – the challenge is of course turning that into action.

The existence of the NAPA and National Adaptation Strategy and Action Plan to guide the activities undertaken by the relevant ministries, departments, district authorities, etc. provides an opportunity to develop this stream of work further. Even though the NAPA projects have not yet been financed and implemented, the NAPA document is reviewed by consultants when developing sectoral or integrated plans and so adaptation activities are slowly being picked up and incorporated into work undertaken outside of the DoE-VPO. However, there is still fairly limited awareness of the NAPA and National Adaptation Strategy and Action Plan at the District level. One of the challenges foreseen in implementing the NAPA and other large-scale adaptation initiatives is getting financial resources from international funders down to the District and local levels, where implementation needs to take place. Equally, getting views from communities up to central government about local adaptation priorities and feedback on where there is a lack of integration in government activities on the ground, remains a key challenge. Participants highlighted that while there are lots of discussions going on at the international level on securing and distributing adaptation funds for Least Developed Countries, there is very little discussion underway at the national level on mechanisms for accessing these global funds and a structure for effectively channelling the money, with the necessary technical expertise and coordination capacity, to meet local needs related to climate change.

Within the water sector, the Ministry of Water Resources and Irrigation recognises that in the context of Tanzania, water is at the forefront of the climate change challenge and is under pressure from other sectors that rely on water (e.g. energy, agriculture, natural resource and tourism) to manage the available resources effectively. The Water Resources Management Act provides a good basis for this, but the enactment and enforcement of the law in the face of widespread poverty and limited institutional capacity, remains a barrier to achieving long term sustainable development and climate change adaptation. The process of developing the Integrated Water Resources Management and Development (IWRMD) Plan for the Rufiji Basin includes a review of related policies and plans and consultation across a wide range of stakeholders. This provides an important opportunity for championing a more holistic approach to managing water resource uses that integrates climate change, ecosystem functioning and poverty reduction considerations.

The fact that climate change is not yet considered within the Environmental Impact Assessment process is seen as a limitation to ensuring that decisions around new developments factor in both direct and indirect climate-related risks, and incorporate suitable mitigation and adaptation recommendations.

Institutional arrangements and capacities

The elevation of environmental issues, including climate change, to the level of the Vice President's Office is a positive indication of the importance placed on integrating environmental considerations across various sectoral development efforts. However, the challenge remains ensuring that the Division of Environment is an effective coordinating unit, not just at the national level, but also bridging with other levels of government. Environment Units, coordinated by the DoE–VPO, are being established in each of the sector ministries in order to mainstream environmental issues pertinent to that specific sector, as stipulated in the Environment Management Act (2004). The legislation also calls for Environmental Officers to be appointed at the regional, district and ward levels, but various institutional, financial and human capacity constraints are hindering implementation. Ultimately however, this will hopefully develop into an important network for championing a holistic view on climate change as a key environmental and developmental challenge, and facilitate the integration of climate adaptation (and mitigation) measures into sectoral policies and plans. The establishment of the National Climate Change Technical Committee, with representation from state and non-state actors across a range of sectors, provides a potentially powerful forum for guiding climate change initiatives, but is an opportunity that is not yet fully realised due to various operational shortcomings to-date.

Currently the Tanzania Meteorological Agency has patchy and low quality meteorological data, with little capacity to run climate models and apply downscaling techniques. This makes it difficult to develop a robust characterisation of current climate variability, identify long-term trends, and to generate localised scenarios of plausible future climates across Tanzania. They also have limited expertise and experience in the interpretation of scenario data required to inform adaptation planning. This is a barrier to the widespread integration of climate information into decision-making (e.g. by DoE–VPO, NEMC, Ministry of Water, RWBO, etc.).

Within the water sector, the Water Resources Management Act (WRMA) of 2009 establishes a multi-level set of institutional actors to facilitate participatory water management practices spanning the local to national levels. The formation of Water User Associations (WUAs) creates an opportunity to convey different local priorities to higher level decision-makers, as well as convey information about national and basin level decisions and investments down to individual users of the water resources and the related ecosystem goods and services. This is critical in making the connections between the global phenomenon of climate change (and related international actions to intervene) and the locally perceived realities that determine the requirements for suitable adaptation, within a development context. For example, the WUAs provide a forum through which people can become more aware of the science of climate dynamics and the value of data collected from observational stations in research and planning. The WUAs can also provide regular opportunities to share information about changes water users have observed and activities they have undertaken to cope with or adapt to changing weather patterns, including the adoption of new technologies or the modification of existing ones (e.g. water capture and storage technologies, new building techniques and materials, modified grazing regimes, different seed varieties, etc.).

There are a number of private sector companies operating in the Rufiji Basin and the Great Ruaha Catchment specifically, which could potentially be incentivised to engage in conservation, climate adaptation and mitigation activities, for example through eco-tourism accreditation schemes. This in turn could be linked to job creation initiatives and contribute to poverty reduction. There are however various barriers to achieving buy-in and establishing effective coordination mechanisms, which need to be explored further.

Data, research and training

One of the key challenges faced by the Ministry of Water Resources and Irrigation and the RWBO is the current lack of robust baseline data and scenario data to support technical planning and further

research into understanding various system dynamics, in order to inform policy decisions. For example, a Strategic Environmental Assessment was done of the Irrigation Master Plan but climate change was not fully factored in due, in part, to a lack of suitable data. One barrier to addressing this problem is periodic vandalism of infrastructure and equipment that constitute monitoring stations. The long-term degradation of the network of meteorological monitoring stations across Tanzania, and the resulting patchiness of the data sets, is a barrier to effective climate analysis by both the TMA and academic research institutions.

There are a number of long-term research projects currently underway dealing specifically with climate, water and livelihood issues (see listing in annex 3), many of which involve international collaborations. These will hopefully yield useful information to inform adaptation planning and begin to fill some of the current data and knowledge gaps.

The increasing number of international training courses and capacity building programmes (see a few examples in the box below) also provide an important opportunity for expanding expertise within relevant agencies and organisations, both locally and nationally, as a forum for learning new skills, sharing experiences with counterparts from other regions and countries, and for building more extensive networks across sectors and disciplines.

Examples of climate change adaptation training courses:

Climate Systems Analysis Group (CSAG), Stockholm Environment Institute (SEI), United Nations Institute for Training and Research (UNITAR): Winter School on using climate information for adaptation and policy development

Global Climate Adaptation Partnership (GCAP): Adaptation Academy

Food and Agriculture Organisation (FAO): 'Planning for Community Based Adaptation (CBA) to Climate Change' e-learning tool

German Gesellschaft für Internationale Zusammenarbeit (GIZ, was previously GTZ): 'Integrating climate change adaptation into development cooperation' training course

International Centre for Climate Change and Development (ICCCAD): short courses on climate adaptation

Centre for Sustainable Development (CSDi): community-based adaptation online course

Wetlands International (WI) and the African Institute for Capacity Development (AICAD): Community and Ecosystem Based Climate Change Adaptation course

... to name only a few. However, not many include an explicit focus on ecosystem-based approaches to climate change adaptation.

VII. CONCLUSION

It is clear that there are many challenges associated with really taking a holistic and fully integrated systems perspective – recognising and understanding the linkages and feedbacks between human systems, ecosystems, and the climate system – let alone putting this into practice in a planning and management context. Equally however, there is a growing sense of the need for and value in doing so, to deal with many of the protracted challenges already being faced in places such as the Great Ruaha catchment, and many others. There are various ongoing efforts in Tanzania to strengthen the governance system in order to support shared decision-making and implementation across scales, in the case of water from the local level of establishing water user groups, through various geographical scales (sub-catchment, catchment, district, basin), up to national government. However, in order to take a fully integrated ecosystems-based approach, it is essential to deal with water in the context of forests,

wetlands, fisheries, etc. and the institutional challenge is that there is no one agency, at any of the decision-making levels, that deals with ecosystems management in a holistic manner. At the basin, district and village levels this points to the need for developing effective mechanisms to coordinate and build collaboration between the many of the various resource management committees, users groups and associations that already exist. These collaborative efforts will be critical both in scaling up local pilot actions that prove to be effective means of adapting to changing climate conditions, and in harmonizing and implementing large-scale policies and programmes (relating to water management, climate adaptation, economic development, wildlife protection, etc.) in a way that leverages international funds and expertise while meeting local needs and aspirations, balancing between short-term gains and longer-term sustainability.

Central to developing a more collaborative governance system is the need for improved outreach and communication capacity as a basis for establishing and fostering partnerships and building functional networks for coordination and collaboration, especially across different sectors and disciplines (i.e. between academia and community-based organisations, between government agencies and companies supplying alternative technologies, etc.). This involves being sensitive to, and working with, very different and sometimes opposing perceptions of the situation and priorities for investment.

VIII. RECOMMENDATIONS

Some recommended next steps based on the findings from this study include lobbying and supporting sectoral ministries, particularly through the Environmental Units, to implement aspects of the National Adaptation Strategy and Action Plan that fall under their mandate, with coordination and support provided by the DoE-VPO. People from within the Environment Units should be actively sought as participants in key climate change meetings and workshops, ensuring there is potentially a clear benefit to them to participate in terms of fulfilling their function more efficiently and effectively. Holding the DoE-VPO accountable in their role as a coordinating unit could involve proactively enquiring about the agenda and outputs of the National Climate Change Technical Committee and seeking opportunities to present to the Committee on recent activities and research findings.

In the case of water management, lobbying and support for the inclusion of ecosystem-based climate adaptation measures (with explicit links to livelihood strengthening) should be aimed at the River Basin Water Offices, particularly through active engagement in the consultative process of developing the IWRM plans, for example the Integrated Water Resources Management and Development (IWRMD) Plan for the Rufiji Basin currently being developed. This will help in building a strong basis for leveraging and channelling international adaptation funds as they become available. This IWRM planning process could also be used as a platform for offering short training events on topics such as ecosystem services, climate change, and tools for adaptive planning, and for facilitating deliberative dialogues between various different stakeholders, making the links between different sectoral interests. This could be a forum for raising widespread awareness of the new "*Action Plan for Mainstreaming Climate Change Adaptation in the Management of Freshwater Resources in the Rufiji Basin*", prepared with support from WWF, and for eliciting action pledges and laying the groundwork for implementation.

Enactment of the water and environmental laws and implementation of the development strategies and IWRMD plan requires establishing new partnerships between a wide range of stakeholders, as well as strengthening existing partnerships to increase knowledge and skills exchange, and enable shared decision-making. The extension services network needs to be strengthened, as do the technology development and transfer mechanisms, to ensure that context specific information about climate change and adaptation measures flow in both directions between farmers and government (i.e. research must be oriented to develop practical solutions to real life problems and provide technological answers appropriate to the socio-cultural and economic characteristics of the recipients). This may involve

engaging more strongly with the private sector to explore what contributions they could make to facilitating and financing ecosystem-based adaptation and mitigation measures. It could also involved partnering with government agencies such as NEMC on research projects, leveraging international funds and expertise available within the NGO and commercial spheres to strengthen capacity within government and build valuable partnerships.

In terms of robust adaptation planning, it would be worthwhile conducting holistic vulnerability assessments at the catchment level that consider the complex interactions and feedbacks between the ecosystem(s), the social system and the climate system. This should build on existing research being undertaken (e.g. within the CLIVET project) and invest in sharing the findings of these assessments widely, through multiple mediums that suit different stakeholders. As part of this process there would be great value in establishing, or building on existing, data gathering and sharing mechanisms, harnessing new ICTs including mobile phone platforms. The next step would then be to identify locally suitable indicators for measuring progress in adaptation (linked to ecosystem services and livelihood resilience) and institutionalise measures for evaluating the effectiveness of interventions together with the communities and other stakeholders involved.

A local training programme on the links between climate adaptation, livelihoods and ecosystems is needed for Village Extension Officers, Ward Extension Officers, Division Officers, Councillors and Head of Departments within the local government authority. This programme needs to be sustainable in terms of financing, training capacity and ongoing support, and ideally should in part be budgeted into the yearly district development plans by the local government authorities. Developing a simple training kit in Swahili on climate change and adaptation planning would provide a useful resource in this context. District Commissioners hold a key position when it comes to leveraging and channelling government funds to meet local development and climate adaptation needs, so they need exposure to the spectrum of problems and access to the facts that can be used to motivate for, and substantiate, budget allocation decisions.

Useful resources:

Tearfund, 2010: How to integrate climate change adaptation into national level policy and planning in the water sector, http://tilz.tearfund.org/webdocs/Tilz/Topics/watsan/Water%20Adaptation%20Guide_Web.pdf

Mysiak et al, 2010: The Adaptive Water Resource Management Handbook, http://www.newater.info/index.php?pid=1052

UNEP-UNDP Poverty – Environment Initiative, 2009: Mainstreaming Poverty-Environment Linkages into Development Planning: A Handbook for Practitioners Handbook, http://www.unpei.org/Knowledge-Resources/PEI-Handbook.asp

Caribbean Community Secretariat (CARICOM) and the South Pacific Regional Environmental Programme (SPREP), 2004: Guide to the integration of climate change adaptation into the environmental impact assessment (EIA) process, http://www.iaia.org/IAIA-Climate-Symposium-DC/documents/Caricom_Climate%20Change%20and%20EIA.pdf

UNDP, Environment and Energy Group, UNDP Bureau of Development Policy, 2010: Designing Climate Change Adaptation Initiatives: A UNDP Toolkit for Practitioners, http://www.adaptationlearning.net/sites/default/files/17750_CC_un_toolbox_0.pdf

DfID Nepal, Livelihoods and Forestry Programme, 2010: Participatory Tools and Techniques for Assessing Climate Change Impacts and Exploring Adaptation Options: A Community Based Tool Kit for Practitioners, http://www.forestrynepal.org/publications/reports/4667

CARE, undated: Community-Based Adaptation Toolkit, http://www.careclimatechange.org/tk/cba/en/Open_Toolkit.html

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ANNEXES

1. Lists of interviewees and workshop participants

Name	*Organisation*	*Contact*	*Interview (I) / Workshop (W)*
Dr Richard Kangalawe	Institute of Resource Assessment (IRA), University of Dar es Salaam	kangalawe@ira.udsm.ac.tz rkangalawe@hotmail.com	I
Mr Fred Manyika	Division of Environment, Vice President's Office	Freddy_Manyika@yahoo.com Freddy_Manyika@hotmail.com	I
Mr Faustine Tilya	Tanzania Meteorological Agency	ftilya@meteo.go.tz	I & W
Mr Willie Mwaruvanda	Rufiji River Basin Water Office	rufijibasin@hotmail.com williejbn@yahoo.co.uk	I & W
Mrs Elizabeth Nkini	Environment Unit in the Ministry of Water and Irrigation	None provided	I
Mr Joseph Kubena	Min. Water & Irrigation, Sector Environment Coordinator	kubena_tz@yahoo.com	I & W
Dr Amos Majule	Institute for Resource Assessment (IRA), University of Dar es Salaam	amajule@ira.udsm.ac.tz amajule2000@yahoo.co.uk	I & W
Ms Rose Sallema Mtui	National Environment Management Council (NEMC)	nrsallema@yahoo.com	I & W
Mr James Ngeleja	National Environment Management Council (NEMC)	jlngeleja@gmail.com nemc@nemctz.org	I
Mr Alfei Daniel	International Union for Conservation of Nature (IUCN)	alfei.daniel@iucn.org	I
Dr Japhet Kashaigili	Sokoine University of Agriculture (SUA)	jkashaigili@yaho.co.uk jkashaigili@suanet.ac.tz	W
Euster Kibona	Environmental Protection and Management Services (EPMS)	eusterkibona@yahoo.com epms@bol.co.tz	W
Ms Grace Chitanda	RBWO, Hydrologist	chitanda@gmail.com	W
Mr John Balarin	Wildlife Division, DSM, Wetlands Adviser	swmtanzania@gmail.com	W
Mr Norbert Ngowi	Regional Secretariat, Iringa	norbertjuk@yahoo.co.uk	W
Prof. Henry Mahoo	University of Sokoine	mahoohenry@yahoo.com	W

Mrs Jophia Nzobonaliba	Mbarali District Council, Agriculture Officer	bigarts@yahoo.com	W
Mr Mhina S Majid	Iringa Rural District, DNRO	mtandens@yahoo.com	W
Ms Bevarine Mgoda	Mbeya Rural District, Community Development	No email provided (phone: 0784359755)	W
Mr Augustine Shirima	Mufindi District Council, Forestry Officer	No email provided (phone: 0755038296)	W
Mr Michael Haule	Njombe District Council, Community Development	bonahaule59@yahoo.com	W
Ms Paskalia Bazil	Ministry of Water and Irrigation	paskalia44@yahoo.co.uk	W
Mr Jason Rubens	WWF-TCO	JRubens@wwftz.org	W
Ms Mwamini Masanja	WWF-Ruaha Water Prog.	MMasanja@wwftz.org	W
Ms Rita Kamenya	WWF-Ruaha Water Prog.	RKamenya@wwftz.org	W
Ms Anna Taylor	Stockholm Environment Institute (SEI Oxford)	annactaylor@gmail.com	I & W

2. Workshop Invitation and Agenda

Workshop

Ecosystems, Development and Climate Adaptation in the Ruaha Catchment
Blue Pearl Hotel, Dar es Salaam, 19th November 2010

The World Wide Fund for Nature (WWF) and the Stockholm Environment Institute (SEI) welcome you to participate in this 1-day workshop on the role of healthy ecosystems in supporting human communities adapt to climate variability and change in the Ruaha Catchment.

Workshop objectives:

- to compare future scenarios for the Ruaha Catchment based on perceptions of key drivers of change and the relative strength of the governance system;
- to explore the extent to which ecosystem-based approaches to climate adaptation are currently reflected in the national and landscape-scale policies and plans of Tanzania (on paper and in practice);
- to identify next steps for further integration between ecosystem management, social development and climate adaptation.

Workshop agenda:

Time	Activity
9:00 - 10:00	Welcome: Mr Petro Masolwa, Conservation manager WWF TCO Round of self-introductions Elect meeting chairperson Overview of the project and the workshop agenda: Ms Anna Taylor, Research Fellow SEI Oxford
10:00 - 10:30	Tea Break
10:30 - 11:15	Overview of water management in the Rufiji Basin: Mr Willie Mwaruvanda, Rufiji Water Basin Officer
11:15 - 12:15	**Scenario Building Exercise** Work in teams to generate four qualitative scenarios for the Ruaha Catchment in 2040s, based key drivers of change and the extent of the country's capacity, policies and plans to address these changes (i.e. a weak versus strong governance system)
12:15 - 13:00	Climate changes in the Rufiji Basin: Mr Tilya, Tanzania Meteorological Agency
13:00 - 14:00	Lunch
14:00 - 14:30	Teams briefly present back on their scenarios and plenary discussion on the processes that would need to take place to achieve the positive scenarios, focusing specifically on institutional arrangements, policy processes and knowledge requirements to enable this transition
14:30 - 15:15	**Governance-Action Matrix Exercise** Work in teams to develop a matrix for each component of the governance system, characterising 3 levels of integration of climate adaptation into water management, and establish the current baseline for the Ruaha Catchment
15:15 - 15:45	Break
15:45 - 16:15	**Taking action: Challenges and Opportunities** Round of comments from all participants on: ▪ one challenge I face in reaching the next level of integration ▪ the next step I will take in my work to further integrate climate adaptation
16:15 - 17:00	Next steps for project: Ms Anna Taylor, Research Fellow SEI Oxford Next steps for Ruaha Water Programme on mainstreaming climate adaptation: Ms Mwamini Masanja, WWF Ruaha Programme Links with Ministry of Water Resources and Irrigation: Ministry Representative Next steps for WWF TCO on addressing climate change: Mr Jason Rubens, Marine and Climate Change Advisor, WWF TCO Thanks and farewell: Mr Petro Masolwa, Conservation manager WWF TCO

3. International climate change projects and programmes in Tanzania

Impacts of Climate Change on Water Resources and Agriculture - and Adaptation Strategies in Tanzania (*CLIVET*):

CLIVET is a 5 year capacity building project, initiated in November 2009, that aims to increase the capacity in Tanzania to project climate changes and impacts on water resources relevant for the agricultural sector. For more info visit the project website here.

Climate Change and Development – Adapting by Reducing Vulnerability (CC DARE):

CC DARE is a joint UNEP – UNDP programme, funded by Danish Foreign Ministry, providing financial and technical support to 15 Sub-Saharan countries aimed at removing barriers and create opportunities for integrating climate change adaptation into national development planning and decision-making frameworks. Tanzania participated in the pilot phase of the project. A scoping mission was undertaken in October 2008, where a stakeholder consultation was held with a broad representation of national climate adaptation actors. Tanzania submitted 8 proposals for funding through the CC DARE programme, of which two were approved and began implementation in March 2009:

1. "Identification, documentation and dissemination of indigenous forecasting to adapt to climate change within selected communities".
2. "Improving smallholder livelihoods through woodlots management: An adaptation to climate variability & Change in Makete District, Tanzania".

Africa Adaptation Programme (AAP):

AAP is a UNDP programme, funded by the Government of Japan, to assist 21 African countries in implementing integrated and comprehensive adaptation actions and resilience plans, ensuring that national development processes incorporate climate change risks and opportunities to secure development gains under a changing climate. Tanzania has a 2 year project (2010 – 2011) to be executed by the Division of Environment in the Vice President's Office that aims to: introduce long term mechanisms that can cope with climate change uncertainties; strengthen leadership and institutional frameworks that can manage climate change risks and opportunities; enhance climate change resilient polices and measures in priority sectors; establish national adaptation financing options; and disseminate climate change knowledge generated, stored and shared nationally, regionally and internationally (see full project document here).

United Nations Poverty-Environment Initiative (PEI):

The UNDP-UNEP Poverty-Environment Initiative (PEI) is a global programme that supports country-led efforts to mainstream poverty-environment linkages into national development planning. The PEI provides financial and technical assistance to government partners to set up institutional and capacity strengthening programmes and carry out activities to address the particular poverty-environment context. The second and current phase of the PEI in Tanzania (July 2007-December 2010) focuses on "Integrating Environment into National Strategy for Growth and the Reduction of Poverty (NSGRP/MKUKUTA) Implementation". Follow the web link above to see achievements, lessons learned and outputs.

Understanding the Findings of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, Climate Change 2007- Integrating Climate Change Adaptation and Mitigation in Development Planning:

National-level dialogues aimed at addressing the need for better communication at the science-policy interface on issues related to climate change are a key aspect of this project. Over the course of this project, nine national-level science policy dialogues will be convened, the second of which was held in Tanzania in January 2010, entitled: *Integrating Climate Change Adaptation and Mitigation in Development Planning for Tanzania* (organized by the Pan African START Secretariat (PASS),

Institute of Resource Assessment (IRA) and the University of Dar es Salaam). The science-policy dialogue sought to engage the science and policy communities in identifying climate change risks and means for better communicating these risks to the public, as well as to identify options for adaptation and mitigation of climate change and policy processes that would be needed for implementing these various options (see the full report, including the list of participants, here).

Netherlands Climate Assistance Programme (NCAP):
The Tanzanian NCAP (2004-2008) focused on the production of technical adaptation policy options based on the vulnerabilities and adaptive capacities of local communities. Field assessments focussed on communities in the Rufiji valley and Kilimanjaro. See output document on the NCAP website linked above, as well as notes on lessons learned here.

Resilient Agro-landscapes to Climate Change in Tanzania (*ReACCT*):
ReACCT (2008-2011), led by the World Agroforestry Centre (ICRAF), aims at assessing the regional impacts of climate change on agriculture and environment in Tanzania (Morogoro) and at designing adaptation strategies and practices for small-scale agriculture and land use (agriculture, forest, hydrology, biodiversity, fishing, transport etc.). The widespread application of these adaptation strategies and practices is expected to result in resilient "agro-landscapes" and livelihood systems with improved adaptive capacity to climate change. In order to reach these goals, the project is built on 3 major analytical thrusts:

- Improving the description and understanding of inter annual climate variability, likely long term climate change in the region and their impacts on current land use systems and respective environmental, social and economic pressures;
- Assessing smallholder constraints and opportunities with regard to potential climate change impacts on agriculture and ecosystem services; and
- Developing, testing and monitoring a range of technologies and good practices for improving the overall adaptive capacity of rural households, communities and agro-landscapes.

For more info visit the project website here.

Dynamic Interactions among People, Livestock, and Savanna Ecosystems under Climate Change (EACLIPSE):
This research project, led by Michigan State University with the University of Dar es Salaam as a partner, is examining the dynamics between coupled human-biophysical systems in savanna areas of Kenya and Tanzania under climate change. Climate change is affecting savanna ecosystems which directly impact livestock and crop production, and peoples' livelihoods. Find more information on the project website here.

Climate Change Impacts, Adaptation and Mitigation programme (CCIAM):
The CCIAM programme, funded by the Norwegian government, is a 5-year programme that includes research, capacity building and student exchange, focusing on promoting natural forest conservation, afforestation, reforestation and better agricultural practices for improved livelihoods. The main coordinator in Tanzania is Sokoine University of Agriculture, and the Norwegian University of Life Sciences through its Department of International Environment and Development Studies (Noragric) is the main Norwegian partner.

Climate Change Adaptation in Africa (CCAA):
There are 7 climate adaptation projects funded under the CCAA programme (financed by CIDA and DFID) that include work in Tanzania. Click on link above to see the list and access relevant project documents.