Water Futures:
Assessing pathways, synergies & tradeoffs in alleviating poverty
through sustainable ecosystem services in Sub-Saharan Africa

Situational Analysis 2
Tanzania & River Rufijji Basin with a special focus on Mbeya catchment

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Preamble

The *Water Futures* consortium[1] comprises leading social and physical scientists from East Africa (Ethiopia, Kenya, Tanzania, Uganda) and the United Kingdom and proposes to work with key stakeholders from small-scale farmers to national ministries in an effort to develop, test and institutionalise an integrated, interdisciplinary, and scientifically rigorous methodology to identify and assess pathways toward more sustainable and socially just water futures in Sub-Saharan Africa (SSA). This region is characterised by substantial intra- and inter-annual climate variability and influenced by multiple, dynamic drivers of biophysical and socio-economic change that collectively pose an immense challenge to the sustainable management of water for a range of ecosystem products and services to alleviate poverty.

The *Water Futures* consortium was developed under a Partnership and Project Development (PPD) grant (Ref. NE/IOO386X/1) from the Ecosystem Services and Poverty Alleviation (ESPA) programme of the UK's Natural Environment Research Council (NERC), Economic and Social Research Council (ESRC) and Department for International Development (DFID). Under this grant in 2010, the *Water Futures* consortium conducted national and basin-scale *Situational Analyses* in Ethiopia, Tanzania and Uganda (Fig. 1) to assess local conditions, capacities and priorities and engaged in in-depth consultations with a diverse set of stakeholders concerned with the future management and allocation of water in a context of multiple pressures and competing demands. The following *Situational Analyses* is consequently one in a series of three *Situational Analyses* that were used to design the Water Futures that seeks to:

(i) generate new data on biophysical and socio-economic drivers and their impact on water availability, allocation and use;

(ii) integrate this information into an innovative suite of models to downscale climate projections and simulate dynamic hydrological-ecological-crop interactions under different climate and development scenarios; and

(iii) link these models to a Decision Support System through a deliberative, multi-stakeholder engagement and multi-criteria mapping approach that will inform policy and practice in order to give priority to water allocation pathways that meet poverty alleviation and sustainability objectives, particularly the needs of poor people who rely on water-based ecosystem services for their well being.

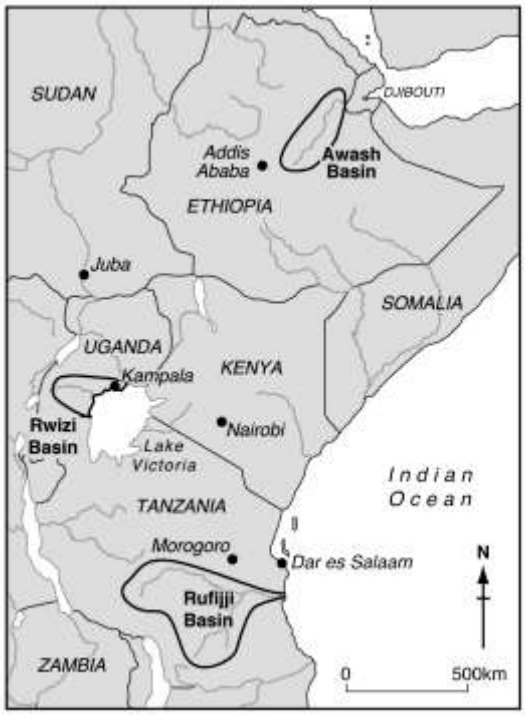

Figure 1. Water Futures study area including three focal basins

Cover photo: participants at the stakeholder engagement workshop held in Mbeya in October 2010

[1] http://www.steps-centre.org/ourresearch/waterforfood.html

Overview

This report is a product of a situation analysis workshop that was held in Mbeya-Tanzania on 26-27th October 2010 which included stakeholders from the Ministry of Water and Irrigation, Ministry of Agriculture and Food Security, Uyole Agricultural Research Institute, University of Dar es Salaam, Sokoine University of Agriculture; Agricultural Extension Officers, NGO, Irrigation specialists based in the sub-catchment; and experts from the UK based Universities. Mkoji sub catchment has eleven main villages namely: Kongolo-Mswiswi, Nsonyanga, Kapyo, Mahango-Mswiswi, Azimio, Simike, Kwaheri, Madundasi, Kapunga, Utengule and Luhanga. The workshop centred its discussion on water resources, aquatic farming, irrigation, domestic water supply, marketing, conflicts and its resolution, and climate change. It was also discussed about effects of climate change on agriculture; coping strategies; health hazards and water resource management.

Water sources in Mkoji sub catchment derived from springs, streams and rivers which originates from Uporoto and Kipengere mountain ranges that form part of the eastern boundary of the Rift valley. The streams flowing into the sub catchment iclude Umtobo, Ipatagwa – (Umtobo and Ipatagwa form Mlowo river), Mkoji, Mswiswi, Mambi, Lwanyo, Lunwa, Meta, Chimala, Great-Ruaha, Kimani, Gwiri and Kimbi. However, water scarcity is experienced during dry season (June-December) for domestic, livestock and irrigation water supply. As a coping strategy, villages use dug wells to meet mainly domestic and livestock water supply.

Crops mainly grown during rain season are maize and rice, whereas they grow maize, beans and vegetables during dry seasons. The environment has changed due to land degradation especially in water sources. Land degradation was caused by population growth, increase in livestock within the catchment and lack of conservation education. Anecdotal evidence suggests that the length of rainy season has recently decreased and may be part of a broader trend due to climate change. The decrease of the rainy season has led to conflicts among water users and reduction of irrigated land. Farmers are using short duration seed varieties as a coping strategy. To cope with conflict resolutions, villagers have formed water users associations which are responsible for water allocation and distribution.

The economy of the area depends on agriculture with rice as a major cash crop. However lack of sustainable marketing system is a challenge. Other challenges are: lack of a marketing organization; poor marketing education (knowledge); poor quality of infrastructures including roads; and lack of a common seed variety.

Part A . Tanzania – the national context

1. Base statistics and characteristics

1.1 Population

Population growth affects national resources through increased demand for food, water, arable land, fuel wood, and other essential materials from the natural resource pool. The population of Tanzania increased from 23.1 million in 1988 to 34.4 million in 2002 (URT, 2003).

1.2 GDP/Capital and Gini co-efficient

GDP per capita is a common but gross indicator of national economic productivity (average real income of a person in the country). It is, however, an incomplete measure of economic well-being because it only covers market sector activities. According to the Minister of Finance and Economic Development (Tanzania), in 2009/2010 the GDP per capita was USD$517.6 and the 2000/2001 Gini co-efficient was 9.2 between 10% richest and 10% poorest; and 5.8 between 20% richest and 20% poorest.

1.3 Proportion of population living under 1 USD

Tanzania has a predominantly rural population and major economic activities revolve around non-irrigated subsistence agriculture. As such, economic productivity is closely linked to rainfall. Most farmers fail to meet the agronomic needs of their plants so that yields and income per hectare are low. The proportion of people living below the poverty marker of USD$1 per day was 16.6% in 2006/2007 period (UNDP Tanzania, 2010).

1.4 Proportion of population engaged in agriculture

In 2006, the proportion of the population engaged in agriculture was 80% with most living in rural areas. As a result, economic productivity and food security are strongly dependent upon favourable climatic conditions. Farmers employing irrigation also face considerable challenges associated increased competition for water, land degradation and episodically declining trends in water storage.

1.5 Major crops for export, internal markets, and imported

Agricultural GDP has grown at 3.3% per year since 1985 with growth in food and export crops at 3.5% and 5.4% per year respectively. Considering that the overall GDP growth target for halving abject poverty by 2010 is 6% to 7%, this performance falls short of needed growth for poverty alleviation. The government has given farmers the freedom to sell their crops to cooperatives or private traders. Due to competition, normal producer prices for food and export crops have increased as such farmers can now sell their produce much faster. Major crops for export include coffee, cotton, cashew nut, tobacco, sisal, tea, cloves, oil seeds, spices and flowers whereas major crops for internal market are coffee, cotton, cashew nut, tobacco, sisal, tea, cloves, sunflower, rice, maize, beans and spices. Imported crops include rice, maize and wheat to supplement food shortages.

1.6 Renewable freshwater resources

In 2001, estimated renewable water resources in Tanzania were 91 $km^3 \cdot year^{-1}$. This aggregate flux could, in theory, sustain irrigation to promote food security and economic growth but its distribution and delivery (transmission) remain severely limited. Tanzanian agriculture is dominated by smallholder farmers (peasants) cultivating an average farm sizes of between 0.9 ha and 3.0 ha.

1.7 Water availability

Per capita water availability in 2000/2001 was ~2,700 $m^3 \cdot year^{-1}$ (World Resources Institute, 2000/2001). This annual estimate reflects, however, neither the distribution of water resources in time and space nor its quality.

1.8 Arable land under irrigation

The total potential area for irrigation development in Tanzania is estimated to be 29.4 million ha. Of this total area, which includes 310,745 ha already under agricultural water management, 2.3 million ha are of high potential, 4.8 million ha are of medium potential and 22.3 ha are of low potential (URT 2002).

1.9 Major water users

Water in Tanzania is mostly used for agriculture, domestic purposes, hydro-electric power generation (HEP) and livestock. Rural water supplies remain limited require upgrading and expansion to alleviate poverty through improved access to adequate and safe water.

2. Post-1980 trends

2.1 Population

In the period between 1980 – 2010, Tanzania conducted two national population censi in 1988 and 2002. The population grew by 11.2 million from 23.2 million and 34.4 million people between 1980 and 2002.

2.2 GDP/capita

Post-1980 trends in GDP per capita at 1987 prices are shown in Figure 3. A moderate rise is evident from a low in the early 1980s following a steady decline.

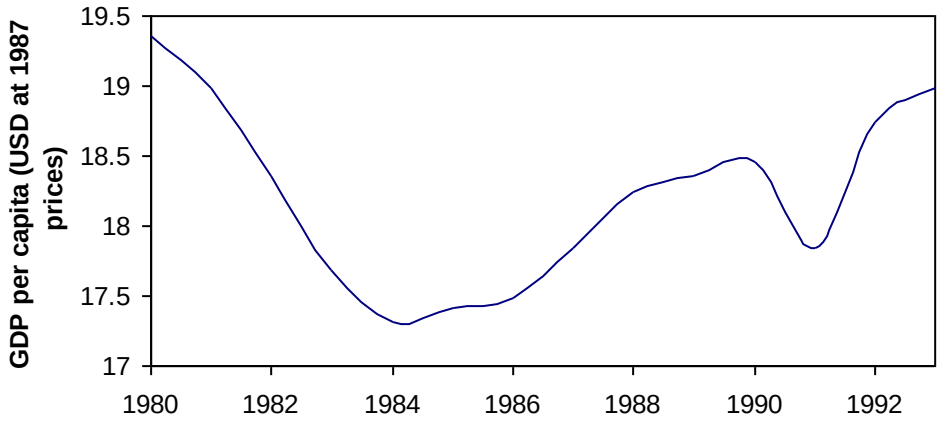

Figure 3. Changes in GDP per capita (USD 1987) from 1980 to 1993.

2.3 Inequality (Gini co-efficient) over time

Inequality, measured by the Gini coefficient, rose from 34% in 1991/92 to 35% in 2000/01. Further, consumption of the richest 20% increased from 43% in 1991/92 to 44% in 2000/01. These changes suggest a slight trend toward a widening gap between poor and rich in the country. Across Sub - Saharan Africa, the Gini co-efficient rose from 40 to 42% from the 1980s to 1990s (Deininger and Squire, 1998).

2.4 Proportion of people living under USD$1 per day

In Tanzania, more than 80% of the population depends upon subsistence agriculture with many people living below the economic poverty line of USD$1 per day. According to MDG Report Midway Evaluation 2000-2008, the proportion of people living under USD$1 per day declined from 22% to 16.6% between 1990 and 2006. The target for 2015 is 11%.

2.5 Food production (crops, livestock, fisheries)

Major food crops produced in Tanzania are cereals, legumes, tubers, spices and fruits. Cereal crops include maize, rice, millet, sorghum and wheat with maize being produced in the largest quantity. The average annual maize production in the periods of 1974 – 1984 and 1984 - 1997 were 1,648,000 and 2,487,000 tones and the corresponding production growth rate of 2.3% and 0.9%.

3. Policy/legal framework

3.1 Land tenure

In Tanzania, land is owned by the state. In practice, land is owned communally except in cases where large investments have been made. The government provides leases for land ownership for a specified period depending on the purpose of the land and existing laws. Besides of state land ownership, there are no comprehensive nationwide and multi disciplinary guidelines for land-use planning and management. There are partial guidelines which reflect a particular institution, ministry, or an authority such that, there are very few planners, policy and decision makers who are aware of the existence guidelines. The lack of guidelines has made it difficult for planning teams to function effectively. Consequently, not all regions or districts have established the proposed land use planning teams and advisory committees with the required appropriate members. Moreover there is no adequate harmonized land use or management efforts to resolve resource use conflicts.

This situation discouraged private companies to invest in agriculture. In some areas, non-agricultural investment is diverting arable land away from agriculture. If this situation continues, it will impair agricultural production and push it to less productive, marginal lands that may be ecologically incompatible with agricultural activities.

3.2 National poverty reduction strategies

Tanzania has taken initiatives for reducing poverty through National Strategy for Growth and Reduction of Poverty (NSGRP) - the second national organizing framework for putting the focus on poverty reduction on the country's development agenda. It is informed by the aspirations of Tanzania's Development Vision (2025) for high and shared growth, high quality livelihood, peace, stability and unity, good governance, high quality education and international competitiveness. It is committed to the Millennium Development Goals (MDGs), as internationally agreed targets for reducing poverty, hunger, diseases, illiteracy, environmental degradation and discrimination against women by 2015. The implementers of this strategy are Ministries, Departments, Agencies (MDAs) and Local Government Authorities (LGAs) through their respective strategic plans and programmes. Realisation of this strategy is proposed through three clusters:

Cluster I: Growth and Reduction of Income Poverty

Broad outcome:

- Broad based and equitable growth is achieved and sustained

Goals:

- Ensuring sound economic management.

- Promoting sustainable and broad -based growth.
- Improving food availability and accessibility.
- Reducing income poverty of both men and women in rural areas.
- Reducing income poverty of both men and women in urban areas.
- Provision of reliable and affordable energy to consumers.

Cluster II: Improvement of Quality of Life and Social Well-Being
Broad outcomes:

- Quality of life and social well -being, with particular focus on the poorest and most vulnerable groups improved
- Inequalities in outcomes (e.g. education, survival, health) across geographic, income, age, gender and other groups reduced

Goals:

- Ensuring equitable access to quality primary and secondary education for boys and girls, universal literacy among men and women and expansion of higher, technical and vocational education.
- Improved survival, health and well -being of all children and women and of specially vulnerable groups
- Access to clean, affordable and safe water, sanitation, decent shelter and a safe and sustainable environment and thereby, reduced vulnerability from environmental risk.
- Adequate social protection and provision of basic needs and services for the vulnerable and needy.
- Effective systems to ensure universal access to quality and affordable public services.

Cluster III: Governance and Accountability
Broad outcomes:

- Good governance and the rule of law
- Accountability of leaders and public servants
- Democracy and political and social tolerance
- Peace, political stability, national unity and social cohesion deepened

Goals:

- Structure the systems of governance as well as the rule of law is democratic, participatory, representative, accountable and inclusive.
- Equitable allocation of public resources with corruption effectively addressed
- Effective public service framework in place to provide foundation for service delivery improvements and poverty reduction
- Rights of the poor and vulnerable groups are protected and promoted in the justice system
- Reduction of political and social exclusion and intolerance
- Improved personal and material security, reduced crime, eliminate sexual abuse and domestic violence
- National cultural identities enhanced and promoted

3.3 Water legislation (permit, priority of use)

Water use permits are issued only for a determined beneficial water use. Procedures, criteria and guidelines for issuing of the permits are in the process (National Water Policy, 2002). The first priority in planning water uses is water for basic human needs in adequate quantity and acceptable quality (National Water Policy, 2002) whereas the second priority is for the environment to protect the

ecosystems that underpin water resources, now and in the future (National Water Policy, 2002). Other uses are social and economic criteria, which will be reviewed from time to time. Utilization of trans-boundary water resources will be based on the principle of equity, right and rationality in accordance with agreements among the riparian state, and by respecting the principle of international obligations on trans- boundary water resource (National Water Policy, 2002).

4. Literature review

4.1 Parallel initiatives and research projects

The government has taken some parallel initiatives in establishing academic and research institutions in the country in order to implement the National Water Policy (2002). These include: Sokoine University of Agriculture (SUA), University of Dar es Salaam (UDSM), Ardhi University, Dar es salaam Institute of Technology, Ministry of Agriculture Training Institutes (MATIs), Ministry of Agriculture Research Institutes (MARIs), Water Development and Management Institute (WDMI), Tanzania Official Seed Certification Agency (TOSCA), the Tropical Pesticides Research Institutes (TPRI), Tanzania Bureau of Standards (TBS), Commission for Science and Technology (COSTECH), Vocational Education Training Authority (VETA). Their roles in relation to irrigation interventions are in the areas of training, research, crop marketing and certification of inputs and equipment (National Water Policy, 2002).

The government of Tanzania established the Ministry of Water and Irrigation (MWI) to improve the standard of existing irrigated agriculture and to exploit more land for increasing food security and to facilitate decision making among different stakeholders. In 2002, the Government prepared the National Irrigation Master Plan (NIMP), taking into account the relevance of the new policies to the irrigation sub sector. The NIMP is now in use and is available for all stakeholders interested in investing in irrigated agriculture. The major strengths of the irrigation section to date include well-trained manpower with professional engineers and plant and equipment obtained through government and donor funding (Chiza, 2005).

Under the Ministry of Agriculture and Food Security, the government has established the River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP) in the Pangani and Rufiji River Basins for the production of rice, maize, tomatoes and onions among other crops. The project was jointly implemented by the Ministries of Agriculture and Food Security as well as Water and Livestock Development from 1996 to 2003 (Chiza, 2005). Other parastatals for there is potential investments to increase economic growth and food security include:

- Mbozi coffee farms with a total land area of 409.32 hectares: Ishera, Ndungu, Tukumbi, Ng'amba, Ihanda and Hanseketewe.
- Cashew nut Company and Factories in Mtwara, Kibaha, Likombe, Masasi, Newala, Tanita in Dar es Salaam, Lindi, Nachingwea and Tunduru.
- National Milling Company; Rice Mills in Isaka, Tabora, Shinyanga, Mtwara, Iringa, NMC residential properties, Mwanza maize Mill, Mtwara Hammer Mill, Wheat and Maize Mill in Ausha.
- Bagamoyo Farms Limited.
- Tanzania Seed Company (Kwamtili Estate).
- Rice Farm - Dakawa, Mbarali Rice Farm, Kapunga Projects, Madibira Project and Ruvu Maize Farms, Mbozi, Namtumbo Project.
- Wheat Farms/Workshop-Basuto plantation, Gawal, Gidagamwd, Mulbadaw, Murandja, seteet wheat Co. ltd, warret and Central Maintenance Services Centre - CMSC.

- Sugar Farms: National Sugar Institute; Kagera Sugar Company limited.
- Agro Processing Industries: Manawa Ginneries, Pamba Engineering Limited, TANICA, Tanganyika Coffee Establishment Ltd.; and Roasting Units.

To improve irrigation performance in line with irrigation water management, the government has taken measures in water resource management, small scale land and water management interventions, multiple water use and development system and improved irrigation management through IWMI's (Ministry of Agriculture, 2003). The government has further sought funding for the expansion of irrigated agriculture through programmes such as the IFAD Mara Region Farmers' Initiative Project (MaraFIP), Participatory Irrigation Development Program (PIDP), World Bank, FAO, WFP, UNICEF, UNDP, IMF, and other institutions (Mbilinyi et al., 1999).

Through the Participatory Agricultural Development and Empowerment Project (PADEP), the government has encouraged projects including Watershed management for soil and water conservation, Conservation tillage, Increase productivity, Use of rainwater harvesting techniques, Improvement of traditional irrigation schemes, Rehabilitation of infrastructure, Initial processing of agricultural and livestock products, and Improvement of crop produce marketing (Ministry of Agriculture document, 2003). In 2010 the government implemented the National Irrigation Policy in an effort to encourage the nation to attain a reliable and sustainable crop production and productivity in order to improve food security and reduce poverty (Ministry of Agriculture, 2003).

4.2 Food security and food production

The March 2009 Rapid Vulnerability Assessment (RVA) conducted by the Food Security Information Team (FSIT) across the country and established that 279,607 people were food insecure in 40 Districts (in 11 regions). The September 2009 RVA has indicated further that there are over 1.5 million food insecure people in 63 districts in 15 regions. The rise in the food-insecure population between the two periods results mainly from low food production due to a failed masika season in areas of bimodal rainfall (two rainy seasons), below normal rains in areas with unimodal rainfall areas and a shortage of irrigated agriculture limiting labour opportunities and income for households dependent on casual labour (USAID, 2010). The food stocks of households who were food secure in March continued to be depleted and by September, some generally food secure households had slipped into the moderately food insecure category whereas moderately food insecure households became highly food insecure. The report recommended that the affected population is expected to require food assistance amounting to 56,740 Mt. Out of this amount, 5,674 Mt were recommended for free distribution to 156,989 poor people, and the remaining 51,066 Mt were recommended for subsidized sales beginning in November 2009 to 1,412,901 people who cannot buy food at market prices (USAID, 2010).

4.3 Parallel strategies to improve food security and production

The government established the National Irrigation Policy in 2010 which involves the construction of new irrigation schemes and rehabilitation of old schemes to improve food security and food production. The government is also updating the National Agricultural Policy.

4.4 Parallel strategies to use water (irrigation) to increase food production

The government established the National Water Policy (2002) and National Irrigation Policy in order to provide a baseline for focused development in the irrigation sector of Tanzania with the ultimate aim of increasing food production and overall productivity in the agricultural sector (National Irrigation Policy, 2010).

4.5 Reports on improving farmer access to markets

In the late 1970s and early 1980s, several less-developed countries raised producer prices for cereals relative to other competing opportunities thereby increasing incentives for food production. In Tanzania, this effort was unsuccessful due to the high cost of transport associated with the poor transport infrastructure which discouraged farmers from producing food crops. Recently the government has taken measures to subsidise agricultural inputs (Rweyemamu and Kimaro, 2006).

Table 2. Food insecure populations by region in Tanzania.

Region	Food-insecure population
Arusha	277,653
Manyara	166,093
Kilimanjaro	122,427
Tanga	177,460
Dodoma	259,190
Singida	47,031
Mwanza	71,620
Shinyanga	79,866
Mara	98,233
Pwani	34,832
Morogoro	63,399
Lindi	48,637
Mtwara	90,135
Iringa	8,398
Mbeya	25,915
Total	1,570,889

Source: *RVA September 2009*

The government of Tanzania has enacted an Agricultural Marketing System to help smallholder producers acquire the necessary tools to engage in favorable terms within an open market. This program has been empowering and linked farmers to markets, financial market support services, rural marketing infrastructure, and agricultural marketing policy development (Kawa and Kaitira, 2007).

In December 2005, the government re-structured government ministries in a deliberate attempt to improve access by smallholder farmers as well as small and medium enterprises to services including markets by dissolving The Ministry of Cooperatives and Marketing and replacing it with the Ministry of Agriculture and Food Security. The Ministry has been renamed and is now known as the Ministry of Agriculture, Food and Cooperatives – MAFC. Another key ministry in regard to access to market is the newly formed Ministry of Infrastructure Development – MID, which replaces the former Ministry of Works –MoW (VECO, 2006)

In 2006, the VECO Tanzania National Stakeholders' Workshop on Smallholder Farmers' Access to Markets in 2015 concluded that there is relatively good market growth potential in Tanzania for the agricultural products. However, in order to utilise these advantages fully and increase 'access to market' performance, there is need to improve the factors that affect performance in a negative manner. A number of factors which inhibited smallholder farmers' access to markets in Tanzania were identified

and included: policy thrust, unreliable infrastructure, over reliance on rain fed agriculture, poor agronomy practices, limitation on access to capital, low labour due to shift of people to urban areas, poor post harvest handling, packaging and processing technologies and global markets conditionality. By 2009/2010, farmers' access to markets had improved as a result of advanced extension services, good quality of inputs (seeds, fertilisers, pesticides, farm implements, etc), attitude towards agriculture, knowledge and innovation, mindset of farmers, education on entrepreneurship development (VECO, 2006), improved policy issues towards agriculture, farmers organisations, capacity-building improvement, market linkages, subsidy, technology, research development and agro-processing, access to rural finance, environmental conservation measures, rights to resources, and investment ownership and infrastructure.

Part B – Rufijji Basin & the Mbeya sub-catchment

5. Socio-political characteristics

5.1 Principal Stakeholders in public, government and private sector including NGOs

Principal stakeholders are small-scale farmers, ward development committees, district councils, extension officers, Water User Associations (WUAs), Rufijji Basin Water Office (RBWO), researchers, natural resources officers, Engineers and irrigation managers, Integrated Water Resource Management in Tanzania (IWRM), the MWI and the Ministry of Agriculture and Food Security.

5.2 Water management organizations

Water management organizations are essential for the development of both urban and rural areas as well as agricultural sector in order to promote equitable allocation and distribution of water resources. The water management organizations at the sub-catchment level include Water User Associations (WUAs), RBWO, district irrigation office and Integrated Water Resource Management committee.

5.3 Agricultural support organizations (government, cooperatives, micro-finance)

Agricultural is the foundation of the Tanzania economy therefore support in agricultural sector is inevitable. The following are agricultural support organizations where farmers can get loans and support: Microfinance institutions (MFIs) such as Savings and Credit Cooperative Organizations (SACCOSs), SACAs and non-governmental organizations (NGOs) such as IFAD, unregistered grassroots organizations (CBOs and SGs), community banks, Government through the ministry of water and irrigation, WB assistance.

5.4 Land tenure systems

In Tanzania, land is currently divided into three categories: general land, reserve land and village land. General land is governed by the Land Act IV and is directly under the Land Commissioner; reserve land is ruled by statutory law (e.g. Forest Reserves are governed by the Forest Act 2002); and village land is governed by the Village Act V and is placed under the village administration (Shivji 1999).

Ministry of Agriculture and Food Security has a Land use Planning Division which deals with rural land for settlements, crop cultivation and grazing. It has divided the country into seven zones. The zones deal with rural agriculture development for their catchments. The zones will then prepare more detailed zonal land use plans taking into consideration national and zonal concerns. It is expected that the zonal land use plans will then be used to prepare the regional and district land use plans, which in turn may be used to prepare urban and village plans.

5.5 Water use legislation

Water use legislation seeks to enable equitable water allocations among stakeholders and for environment as a whole. Through the 2002 National Water Policy, the government has stated how water should be used. The 2010 National Irrigation Policy has also stated on the use of water for irrigated agriculture together with environmental conservation. According to the National Water Policy (2002) use of water for irrigation must be licensed and follow guidelines, discharge permits, codes of conduct, standards, Environment Impact Assessments, and agreements, treaties and protocols for trans-boundary water resources to facilitate water resources management. Water use permits are granted through WUAs which have been mandated to manage irrigation water according to village bylaws on water allocation and distribution. Water-use priorities are in line with the national priorities; the first priority is for basic human needs in adequate quantity and quality. Other priorities include agriculture (irrigation) and livestock feeding.

5.6 Access to markets

In Tanzania, physical access of food to market is affected by inadequate infrastructure, mainly transportation network. Food production is concentrated in the southern highland regions and peripheral areas of the country whereas markets are located mainly Dar es Salaam, the central corridor and northern areas. Due to the size of Tanzania, there are often long distances between food producing and deficit areas. Because of the inadequate transportation network, there are high costs of transportation involved. These, in turn, serve to reduce the return on produce at the farm. High distribution costs are also reflected in high food prices in food-deficit areas affecting access to food by low income rural as well as urban populations (USAID, 2010). With free-market access, food buyers have entered rural areas to supply urban and external markets. As a result, farmers' income has improved and improved attitudes towards agriculture, knowledge and innovation, the mindset of farmers (VECO, 2006), entrepreneurship development, establishment of farmers associations, market linkages, adoption of technology in agriculture and establishment of rural finance.

5.7 Access to capital/credit (microfinance facilities)

Farmers' access to capital is limited due to high risks associated in agriculture. However the government has taken some initiatives to improve farmers' access to capital. These include the development of microfinance institutions such as Savings and Credit Cooperative Organizations (SACCOSs). The government also plans to establish a bank which will be able to give loans to farmers for agriculture.

6 Physical characteristics

6.1 Climate

The study area receives a unimodal type of rainfall starting from early November and ends in June. The annual rainfall is about 1500 mm in the highlands and ranges from 600– 800 mm in the lowlands (SMUWC, 2001). Over time, water flow in rivers has been contributed by rainfall stored in soil by the conserved environment. According to Lankford (2000), the use of ground water is not commonly used in this area.

6.2 Drainage (rivers, lakes, swamps)

The Mkoji sub-catchment is drained by the River Mkoji and four other major perennial rivers as well as several seasonal streams. All of these flow into the central plain. The River Mkoji is a sub-catchment of the Great Ruaha River which itself is part of the Rufiji River Basin. The Mkoji sub-catchment covers an area of about 3,400 km^2; most of the sub-catchment lies within Mbarali and Mbeya Rural Districts.

Smaller portions of the sub-catchment lie within the Makete and Chunya Districts in Iringa and Mbeya Regions, respectively (Steven, 2004).

6.3 Soils

The upper zone of the catchment is highly populated and has high rainfall, deep soils and intensive agricultural production. In this zone, both rainfed and some irrigated agriculture are practiced. The rainfall pattern and the types of soil in upper zone allow for crop cultivation all year round.

6.4 Land use

The major use of the land in Mkoji sub - catchment is for domestic, agriculture and livestock keeping. The land ownership is generally communal and the government has given power to the villages' government to provide land ownership for better management and responsibility of proper use. However, under Section 4 (1) of the Land Act, 1999, all land in Tanzania belongs to the State.

6.5 Major crops (commercial, subsistence)

Mkoji sub-catchment is potential for agriculture with rice, maize, wheat, millet, beans, tomatoes, onions, groundnuts and potatoes being major crops. However the area is not fully exploited due to low irrigation whereas the middle areas and the lower plains are fully exploited in both seasons due to being potential for irrigation.

6.6 Major water users and permit holders

Water is mostly used for agriculture, domestic, hydro power generation and livestock keepers. The permit holder of the Mkoji sub-catchment is the Rufiji Basin Water Office (RBWO) and the water-user committees are responsible for distributing water among authorized intakes in the river system(s) under their jurisdiction.

6.7 Amount, nature and location of irrigation activities (source of water, crops)

There are five major perennial rivers and several seasonal streams, all of which drain in to the central plain (Steven, 2004). The major source of water for the sub-catchment is the Lunwa and Mkoji. Mkoji sub - Catchment River flows at a rate of 0.354 m3/s during wet season (December-April) and 0.097 m3/s during the dry season (May-November). Lunwa River flows at a rate of 1.769 m3/s and 0.535 m3/s during wet and dry seasons.

7. Monitoring structure and reporting

7.1 Monitoring of poverty

Monitoring of poverty is coordinated by the MKUKUTA (National Strategy for Growth and Reduction of Poverty) secretariat through three sections such as; i) Growth and reduction of income poverty, ii) Improved quality of life and social well-being, and iii) Governance and accountability of the catchment through water users associations. This is done in three multi-stakeholder Technical Working groups that include Research and Analysis, Surveys and Routine Data, and Communication. Available data include Mkoji Poverty and Human Development Report, Status Reports on Growth and Poverty Status, Views of the People Report (2007, 2010) and Periodic reports on specific research topics.

7.2 Traditional monitoring of water resources /rainfall, crop production, fisheries, livestock

Traditionally, water resources were not monitored efficiently. Traditional monitoring of water resources in Tanzania is poor because it relies upon unlined furrows for domestic use and irrigation for crop production purposes. These furrows draw from an extensive network of canals that is without any

facility for regulating flow. As a result, water is 'wasted' through leaching and more water is abstracted than is actually required. The efficiency of the traditional furrows may be as low as 20 percent (NIVA 91). Monitoring of rainwater harvesting is limited in Tanzania but, in the Makanya watershed of the River Pangani Basin, traditional rainwater harvesting for agriculture is monitored by diverting the runoff generated from the Pare Mountains (several kilometres away). After diverting the runoff from the main gully into distribution canals, further water management practices are done in individual fields. Traditional monitoring of water resources for fisheries is through traditional fishing communities under certain conditions which regulate access and enforce fishing rules.

7.3 Food production (crops, livestock, fisheries)

According to Temu and Ashimogo (1999), estimated food production volumes are reported and its primary data can be obtained from local markets. Actual volumes handled by the private markets are harder to obtain. Rough estimates, however, show that official markets handle between 25 and 36% of the marketed surplus of food produced and can be found from the Region offices (Mbeya). The remaining proportion has been handled by the open market.

7.4 Meteorological stations and available records

The spatial distribution of meteorological stations is limited in Tanzania. It is unclear whether the current network is adequate. In the Mkoji sub-catchment, the main meteorological station is Mbeya Meteorological Station; sub - stations include Uyole agromet, Tanganyika Wattle Co. Ltd, Igawa Maji, Ichenga Agriculture, Makete Bomani, Matamba Primary School, Rujewa Mission, Kimani, Mbarali Irrigation Scheme, Madibira Maji and Ihimbu in the Great Ruaha River Basin. Available records may extend over 30 years and can be located in the Mbeya Office of the Meteorological Agency of Tanzania. Historical rainfall data from rainfall stations are found from Rufiji Basin Water Office (RBWO), Sustainable Management of Usangu Wetland and its Catchments (SMUWC) and Tanzania Meteorological Agency databases. Meteorological stations around the area of interest (Mkoji sub-catchment) are shown in the Table 3.

Table 3: Meteorological stations in and around Upper Great Ruaha River Catchment

Station Code	Station name	Easting	Northing	Period of Records
9833020	Mbeya Maji	551343	9015065	1961-2004
9833001	Mbeya Met	551340	9012854	1937-1999
9834008	Mbarali Irrig. Scheme	642035	9042584	1957-2003
9834010	Kimani	628299	9023374	1962-2003
9833025	Uyole Agromet	571468	9017984	1971-2003
9833002	Chunya Agriculture	545892	9057084	1934-2000
9833015	Kawetere Forestry	554980	9021694	1951-1992
9833003	Allsa Farm	571468	9018020	1971-1998
9933004	Rungwe Tea Estate	564051	8986632	1934-1998
9833000	Mbeya Boma	549475	9016173	1928-1989
9934024	Ichenga Agriculture	695767	8949366	1958-2001
9834006	Igawa Maji	652158	9030664	1964-2003
9934018	Tanganyika Wattle Co.	695204	8972077	1928-2003
9834000	Madibira Maji	701500	9091900	1954-1991
9833031	MATI Igurusi	593485	9029364	1984-2004
9933013	Rungwe Sec. School	565919	8986629	1949-1971

9933028	Igembe Pr. School	549453	8998483	1962-1988
9834003	Rujewa Mission	646690	9039900	1943-1981
9834013	Matamba Pr. School	611772	9012364	2000-2003
9934049	Makete Bomani	635444	8968060	1985-2000

7.5 Hydrological stations

Historical river flow data from gauging stations located in the Great Ruaha River Catchment are found from the Rufiji Basin Water Office and Directorate of Water Resources databases. River gauging stations in the Great Ruaha sub-Basin are listed in the Table 4.

Table 4. Gauging stations, rivers and their location in Mkoji sub-catchment

Station code	**River name**	**Physical location**	**Grid location**		**Record Period**
			Easting	**Northing**	
1KA7A	Chimala	Chimala at Chitekelo	607306	9014062	1962-2004
1KA81	Great Ruaha	Great Ruaha at Salimwani	622243	9016503	1954-2004
1KA9	Kimani	Kimani at Great North Road	629292	9021393	1954-2004
1KA11A	Mbarali	Mbarali at Igawa	651576	9028530	1955-2004
1KA16A	Lunwa	Lunwa at Igurusi	593600	9019900	1956-2004
1KA27	Great Ruaha	Great Ruaha at Hauseman's bridge	674414	9124776	1956-1988
1KA33B	Ndembera	Ndembera at Madibira	704750	9090250	1957-2004
1KA45C	Ipatagwa	Ipatagwa at Great North Road	575438	9025171	1958-2003
1KA51A	Mlowo	Umrobo at Great North Road	574955	9024770	1958-2004
1KA50B	Mswiswi	Mswiswi at Wilima	584800	9025800	1959-2004
1KA59	Great Ruaha	Great Ruaha at Msembe	709328	9146923	1963-2004

7.6 Land-use change

Changes in land use over the 20th century primarily involved the conversion of rangelands and scattered settlements to crop farming, grazing, settlements, forestry and bee keeping, infrastructure, land and water uses conservation, and fishing. Main land uses in the Mkoji sub-catchment area are shallow root crops, scattered settlements, grazing and conservation.

8. Trends

8.1 Food production (crops, livestock, fisheries)

Food production has increased in areas under irrigation but decreased in upland areas due to drought. Major cereal crops such as rice have increased whereas maize production has declined.

8.2 Population and population density

According to the 2002 population census, Mkoji sub-catchment had a population of about 146,000 people with an average annual growth rate of 2.4%. The highest population density is found along the Tanzania-Zambia Highway and in the Southern highlands. Scattered villages are located in the plains.

8.3 Land – use change

Principal land-use changes in the Mkoji sub-catchment involve the conversion, where possible, of rain-fed agriculture land to land under irrigation and, in upland areas, the conversion of agricultural land to forests and grazing. On the other hand, hunting and bee keeping activities continue to decline.

8.4 Rainfall (annual, seasonal, extreme events)

Mean annual rainfall in the Mkoji sub-catchment is ~800 mm in wet years and ~450 mm in dry years. The area has a unimodal type of rainfall that falls between November and April. Heaviest rainfall generally occurs between December and March. The Great Ruaha upstream of the Kipengere Range, the Poroto Mountains in the Southern part of the basin and the highlands in Kilolo Divisions (next to the Udzungwa escarpment) in the eastern part of the basin receive the highest annual rainfall, 1400-1600 mm.

8.5 Temperature

Records of air temperature show that mean daily maximum and minimum temperatures range from 28°C to 32°C and 9.5°C to 19.5°C respectively. Highest values are recorded in October and November whereas lowest values are experienced in June and July.

8.6 River discharge

The major sources of water for the Mkoji sub-catchment are the Rivers Lunwa and Mkoji. The discharge of the River Mkoji is ~0.35 $m^3 \cdot s^{-1}$ during wet season (December-April) and the extractable water rights over this period are 0.3 $m^3 \cdot s^{-1}$. The flow during the dry season (May-November) is ~0.097 $m^3 \cdot s^{-1}$ and the extractable water rights are 0.086 $m^3 \cdot s^{-1}$. The discharge of the River Lunwa is ~1.8 $m^3 \cdot s^{-1}$ during wet season (December-April) and the extractable water rights are ~0.8 $m^3 \cdot s^{-1}$. River discharge during the dry season (May-November) is ~0.54 $m^3 \cdot s^{-1}$ whereas the extractable water rights amount to 0.14 $m^3 \cdot s^{-1}$.

9. Adaptation strategies (to development and climate variability and change)

9.1 Traditional knowledge of adapting to rainfall variability

The poor are generally the most vulnerable to climate variability because of their limited land holdings and the fact that they spend much of their time as labourers. Their ability to cope during food shortages is impaired and they often spend what little funds they have on renting small farms for agricultural production. Among the major coping strategies of the most vulnerable group to droughts are engagements in casual off-farm activities such as water vending, brick making, providing non motorised transport (bicycle) and trading of firewood and charcoal.

9.2 Crop rotation, changes (minimal risk vs. maximum returns)

Agronomic practices in the Mkoji sub-catchment include mixed cropping; intercropping, planting of drought resistant crops, crop rotation, growing high value crops, relay cropping, mulching, timely weeding, and pest and disease management. Farmers indicated that planting drought-resistant such as millet and sorghum and early maturing varieties such as beans are important strategies during drought years as a measure of reducing risks while maximising returns. In the Upper Mkoji, farmers also use residual moisture following the rainy season to cultivate different types of vegetables that have higher market values. Crops which are grown in rotation are paddy and maize whereas beans, tomatoes, vegetables, and sweet pepper production are grown during periods of low rain and drought. The most common mixed cropping system identified was maize and beans, in which both crops are planted at the beginning of the season.

9.3 Use of agricultural advisors/ extension/ support workers

Agricultural extension services have mostly been provided and financed by the public sector and by several non-governmental organisations (NGOs). Farmer-led initiatives have, over time, supplemented extension service delivery of the public extension services with cost-sharing. These experiences have, however, not been formally integrated into the extension system nor has their potential to reduce public expenditure and improve quality of extension service been considered.

As the government continues to face financial difficulties, it has begun to reconsider the issue of public extension service and is currently entertaining the possibilities of gradually divesting the public sector of extension, leaving the private sector and users to take an increasing responsibility.

9.4 Use of climate information (e.g. seasonal forecasts)

Climate information at Mkoji sub-catchment is used to forecast the agricultural season and the risk of a climate-related natural disaster. Climate information is used in developing sustainable practices as climate variability contributes to land degradation and there is a clear need to consider how climate induces and influences land degradation. It is also used to assess potentials and constraints in dryland farming and identifying agricultural options to safely increase cropping intensity and yields, decrease risks and offering other advantages while reducing land degradation.

9.5 Use of water information (development maps)

Water information used by farmers is generally supplied through water user associations. For the protection of the water resources, farmers are trained in the management of homestead tree nurseries and mobilised to plant trees within the catchment area.

9.6 Drought mitigation (dams, rainwater harvesting)

At Mkoji sub catchment, farmers are not using dams and rainwater harvesting strategy as a drought mitigation measure but many farmers has asked the government to construct water harvesting structures such as charcodams for the purpose of increasing water supplies especially during periods of water shortages.

9.7 Examples of the failed strategies

Among the strategies put forward by the government against climate change risks are the construction of drainage systems to reducing flood and encourage water re-use, reforestation and replanting of mangroves, adopting new crops and agricultural methods, water harvesting, substituting cows for camels and radio early warning systems. These strategies have, however, not had much impact around Mkoji sub catchment (Red Cross, 2005)

10. Literature review

10.1 Complementary initiatives and research projects (past and present)

Complementary research projects that have been conducted in the Mkoji sub-catchment include:

- Crop water productivity of an irrigated maize crop in Mkoji sub-catchment of the Great Ruaha River Basin, Tanzania. This project was done by Department of Agricultural Engineering and Land Planning, Sokoine University of Agriculture, P.O. Box 3003, Morogoro, Tanzania and it was published in Agricultural Water Management journal volume 85, issues 1-2 in 2006.
- Unchartered innovation? Local reforms of national formal water management in the Mkoji sub-catchment, Tanzania. This project was done by UNESCO-IHE Institute for Water Education, P.O. Box 3015, 2601 DA Delft, The Netherlands; International Water Management Institute (IWMI), Private Bag X813, Silverton 0127, Pretoria, South Africa; International Water Management

Institute (IWMI), P.O. Box 5689, Addis Ababa, Ethiopia; and School of Development Studies, University of East Anglia, Norwich NR4 7TJ, UK published in Agricultural Water Management journal volume 85 of 2006.

- Crop water productivity of an irrigated maize crop in Mkoji sub-catchment of the Great Ruaha River Basin, Tanzania (2006). The research project was done by Henry E. Igbadun, Henry F. Mahoo, Andrew K.P.R. Tarimo and Baanda A. Salim from Sokoine University of Agriculture, Tanzania and published in Agricultural Water Management journal, 2006, vol. 85, issue 1-2, pages 141-150 in 2006.
- Simulation and evaluation of impact of existing irrigation scheduling practice for maize crop in Mkoji sub-catchment of TANZANIA. This research was done by Igbadun et al., in 2006.
- Stakeholder-oriented valuation to support water resources management processes Confronting concepts with local practice (2006).
- Integrated Water Resource Management in Tanzania: interface between formal and informal institutions. This research project was done by Charles. S. Sokile, Willy Mwaruvanda, and Barbara van Koppen and presented in the International workshop on 'African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa', 26-28 January 2005, Johannesburg, South Africa.
- Catchment management and poverty alleviation (CAMP). This research was done by UK department for international development/ forestry research program ZF0150/R7937 in collaboration with Sokoine University of Agriculture, Tanzania
- Knowledge sharing and communication tools for dialogue issues on productivity of water in agriculture: case study of Mkoji sub catchment in Usangu plains, Tanzania. This was done by Kasele Sydney Steven as a Dissertation submitted in partial fulfilment of the requirements for the degree of Master of Science in agricultural education and extension of Sokoine University of Agriculture, Tanzania in 2004.

10.2 Reports on food security and food production

No reports are available on food security at the sub–catchment scale but reports are available at the national scale. According to Tanzania Food Security Information Bullet, in no. 01/2004, the country faced a worsening food security situation following a poor harvest in 2002/2003. The reported national food deficit was ~500,000 MT of grain for 2003/4 based on an estimated availability of food of 8,000,000 MT with a domestic utilization of 8,500,000 MT as a result of inadequate rainfall (Kimbisa, 2004). According to the Poverty and Human Development Report (2005), food poverty has declined from 21.6% in 1991/1992 to 18.7% in 2000/2001. Food poverty expected to continue to decline to 10% by 2010. In March 2009, a report by the Food Security Information Team (FSIT) across the country established that 279,607 people (from which 25,915 people was reported from Mbeya region) were food insecure in 40 Districts (in 11 regions). The September 2009 RVA indicated that there are over 1.5 million food insecure people in 63 districts in 15 regions. The food-insecure population increased between the two periods mainly because of poor food production resulting from the failed masika season in some parts of bimodal areas and below normal rains in some parts of unimodal areas (USAID, 2010). In conclusion, according to the food security reports, the status of food security is not stable, the main cause of food insecurity being shortage of rainfall.

10.3 Analyses of environmental flow requirements

There are several positive environmental impacts that are expected due to implementation of water use for irrigation projects. Amongst them are: improved skills for farmers; improved soil fertility and better land management; higher degree of environmental awareness; increased productivity; increased land,

soil and water conservation; value added due to water use. It is also recognised that negative environmental and social impacts are also likely to be generated in the course of implementation of the project (PADEP, 2003). Typical negative environmental impacts include land degradation, contamination of stored water, water and land use conflicts, loss of natural habitats and loss of fauna and flora.

10.4 Parallel strategies to use water (irrigation) to increase food production

Strategies at the catchment level seek to educate farmers through researchers, extension services and water users association leaders about (1) enhancing agricultural water productivity in order to reduce conflict among water users and increase profitability; and (2) agronomic practices that reduce poverty and ensuring food security (Ministry of Agriculture, 2009).

10.5 Reports on improving farmer access to markets

Few smallholder producers understand how markets work, and even if they do, they do not have the information they need to participate effectively. Through an investment programme, entitled Agricultural Marketing Systems Development, the constraints to effective operation of the agricultural marketing system were removed. This helped smallholder producers acquire the tools needed to participate on favorable terms in the open market. The programme consists of four components: (1) these are producer empowerment and market linkages, (2) financial market support services, (3) rural marketing infrastructure, and (4) agricultural marketing policy development. The producer empowerment and market linkages component was designed to transform agriculture from a subsistence activity to a profitable enterprise in the mindset of smallholder producers by building the management and marketing capacity of these producers and small-scale traders and processors (Kawa and Kaitira, 2007).

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