WATER AND POVERTY LINKAGES IN AFRICA:

TANZANIA CASE STUDY

by

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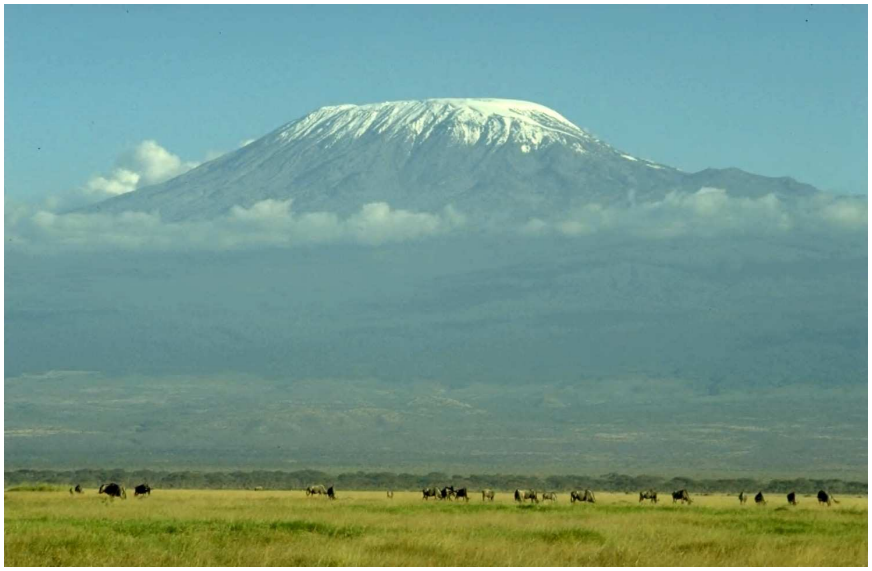

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SUMMARY

Water management holds the potential to address a multiple range of livelihood, poverty and development issues in Africa. There are a number of initiatives to realise this potential but, despite this, progress is slow in many areas. The African Development Bank commissioned Stockholm Environment Institute to conduct a study on water-poverty linkages with the aim of disentangling some of the water-poverty complexities and identifying new dimensions for progressive development in Africa. The study contains three country cases, including this report from Tanzania, in which the country-specific context of water-poverty linkages is discussed.

Tanzania has a high level of water dependence in its economy, with agriculture the largest sector and main source of livelihoods for the majority of the population; other key sectors, such as tourism and fisheries (the two largest sources of foreign exchange earnings), are dependent on healthy ecosystems, whose integrity in turn depends on water flows. Agriculture is dominated by rainfed farming and livestock, both of which are severely affected by unreliable rainfall and poor water management. Safe water supply and improved sanitation coverage in both urban and rural areas is low and the rate of progress in extending coverage is below that necessary for Tanzania to attain its MDG targets.

The water sector is undergoing rapid change, with a range of new policies and strategies and institutional reforms, including decentralization and the introduction of IWRM. Capacities to implement the reforms are severely constrained, especially at decentralized levels. Innovative approaches have the potential to greatly enhance the poverty impacts of water management, including:

- Poverty-focused **IWRM** that includes green water flows and the participation of the poor and that takes account of climate change adaptation.

- A stronger focus on **rainfed farming**, based around improved on-farm water management.

- Improved water access and ecosystems management for **livestock rearing.**

- Place **sustainable sanitation** centrally in planning and budget allocation processes.

- Build **decentralized institutional capacities** for water supply and sanitation development and give more choices in technologies and management systems.

- Improve sustainable management systems for water-dependent **ecosystems**, balancing multiple uses such as farming, fishing, power generation and tourism.

TABLE OF CONTENTS

LIST OF BOXES, TABLES, AND FIGURES

BOXES

TABLES

FIGURES

1. INTRODUCTION

Water is increasingly recognized as a major component in economic development and poverty reduction. Several recent papers[1] considering the importance of water in meeting the Millennium Development Goals (MDGs) have highlighted water's direct and indirect contribution to all of the goals and a majority of the targets, rather than just focusing on its central role in achieving the goal on environmental sustainability and the accompanying target on water supply and sanitation. This analysis illustrates the fact that water's interaction in the lives of the poor is complex in character and operates through multiple dimensions: improved livelihoods security, reduced health risks, reduced vulnerability, and pro-poor economic growth. Further, as well as its significance in poverty alleviation, investment in water infrastructure and management has a major impact on national economies[2]. Finally, there is increasing attention to the multiple values of water for society, including not only its importance in terms of ecosystem sustainability but also its cultural and social components.

This case study of water-poverty linkages in Tanzania aims to reflect current issues in water, poverty and development at the local, regional, and national scale. Along with an analysis of policies and strategies, programs and initiatives, and cross cutting issues, the report will present some on-going initiatives from a range of actors in water supply and sanitation, irrigation and agriculture, and ecosystems water management for development, among others. The Tanzania case study represents one of three country analyses on water and poverty linkages; Senegal and Ethiopia are the other two case studies. These country case studies seek to expand on themes and findings from a literature review on poverty and water with a geographic focus on Africa. Together, the country case studies and the literature review support an overall review on water and poverty linkages commissioned by the African Development Bank in December 2006.

2. COUNTRY BACKGROUND

Tanzania covers 945,000 km^2 and includes 1,300 km of coastline on the Indian Ocean, as well as 1,420 km of shoreline on Lake Victoria, 650 km on Lake Tanganyika, and 305 km on Lake Malawi[3]. The country's terrain consists of coastal plains, a central plateau, and highlands; a total of 80% of land cover is woodland, grassland, and bushland[4].

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[1] SIWI/UN Millenium Task Force on Water and Sanitation (2005). **Health, Dignity, and Development: What Will It Take?** SIWI, Stockholm, pp. 19-20; ADB, CIDA, DANIDA, EC, GTZ, Irish Aid, IUCN, SEI, Sida, SIWI, SDC, UNDP, UNEP and WHO (2006). **Linking poverty reduction and water management**. Poverty-Environment Partnership. UNDP, New York, pp. 20-22.

[2] For example, Sadoff and Gray (2006) examine the impact of hydrological variability on growth in Ethiopia and find it currently costs Ethiopia over one-third of its growth potential.

[3] FAO AQUASTAT (2005).**Irrigation in Africa in figures – AQUASTAT Survey 2005, United Republic of Tanzania**. http://www.fao.org/AG/aGL/aglw/aquastat/countries/tanzania/index.stm. Accessed on June 2007.

[4] Ibid.

Tanzania has a population of 39 million, growing at an annual rate of 1.8%[5]; the 2005 population density was 41 per km^2 [6]. According to the 2002 census, 77% of Tanzanians lived in rural areas, and 44.2% of the population was under 15 years of age[7]. Tanzania is categorized as a low human development country, with an index of .430, ranking 162 out of 170 countries in 2006[8]. The 2006 adult literacy rate was 69.4%[9]. Tanzania's 2005 infant mortality rate was 76.0 per 1,000 births[10], and life expectancy at birth in 2005 for males was 48 and for females 50[11]. The maternal mortality ratio in 2000 was 1,500 per 100,000 live births[12]. In 2000, 16.8% of deaths of children under 5 in Tanzania were due to diarrhoeal diseases[13].

Gross national income per capita is $340[14], with a GDP per capita, $PPP valuation (2006) of 594[15]. Tanzania's real GDP growth rate in 2006 was 5.7%, and the forecast for 2007 is 6.8%[16]. Agriculture comprises 46.1% of GDP, with finance and business services at 12.1% and trade, hotels, and restaurants at 11.6% the other largest components (Figure 1).

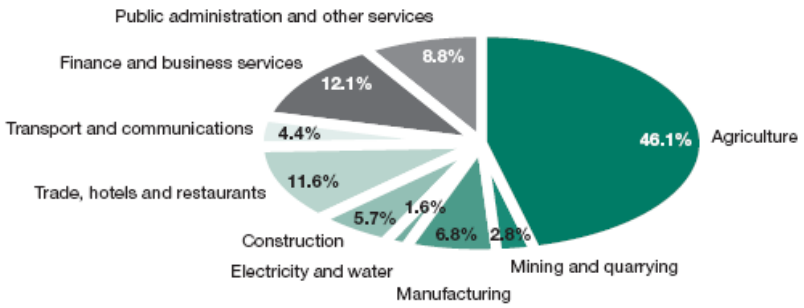

Figure 1: GDP by sector in 2005
Source: AfDB/OECD, 2007

[5] World Bank (2007). www.worldbank.org. Accessed May 2007.
[6] Government of Tanzania (2006). **Tanzanian figures 2005**. National Bureau of Statistics, Ministry of Planning, Economy, and Empowerment, June 2006.
[7] Government of Tanzania(2002). 2002 Census. http://www.tanzania.go.tz/census/
[8] UNDP (2006). **Human Development Report 2006.** UNDP, New York.
[9] World Bank (2007). http://devdata.worldbank.org/external/CPProfile.asp?CCODE=TZA&PTYPE=CP . Accessed June 2007.
[10] World Bank (2007). www.worldbank.org. Accessed May 2007. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/TANZANIAEXTN/0,,menuPK:287361~pagePK:141132~piPK:141109~theSitePK:258799,00.html. Accessed June 2007.
[11] WHO (2007). http://www.who.int/countries/tza/en/ . Accessed June 2007.
[12] WHO Statistical Information Service (2007). http://www.who.int/whosis/database/core . Accessed June 2007
[13] Ibid.
[14] World Bank (2007). http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/TANZANIAEXTN/0,,menuPK:287361~pagePK:141132~piPK:141109~theSitePK:258799,00.html . Accessed in June 2007.
[15] AfDB/OECD (2007). **African economic outlook 2004/2005: Tanzania**. www.oecd.org/dev/aeo
[16] Ibid.

It is estimated that 42% of Tanzania's land area is cultivable land, a total of 40 million hectares[17]; in 2002, 5.1 million hectares (13% of cultivable land) were actually under cultivation. Main food crops are maize, sorghum, millet, paddy, wheat, sweet potato, cassava, pulses and bananas[18]. Major agricultural exports are coffee, cotton, sisal, cashew nuts, and cloves[19]. More than 80% of the population is engaged in agricultural activities.

2.1 Progress towards the MDGs

Estimating progress towards achieving the MDG targets for water and sanitation is extremely difficult in Tanzania, as different sources give very different estimates of coverage levels. According to the World Bank Water and Sanitation Programme[20], Tanzania's MDG target for water supply coverage is 64%, and its target for sanitation coverage is 95%, but the very high sanitation figure is based on a 2002 estimate of 90% sanitation coverage that does not take into account the quality of the sanitation. The latest estimate on coverage rates for improved drinking water and improved sanitation[21] are given in Table 1 below.

Table 1: Tanzania's progress towards meeting the MDG targets for water and sanitation

				IMPROVED DRINKING WATER COVERAGE						IMPROVED SANITATION COVERAGE		
	POPULATION			Total		Urban		Rural				
YR	Total (mill)	Urb (%)	Rur (%)	Total (%)	HH connects.	Total (%)	HH connects.	Total (%)	HH connects.	Total (%)	Urban (%)	Rural (%)
1990	26.2	22	78	46	10	85	33	35	3	47	52	45
2004	37.6	36	64	62	18	85	43	49	3	47	53	43

Source: WHO (2006)

In a December 2006 report, WSP-Africa noted: '*if the committed resources from the Government of Tanzania and donors materialise on time, and are spent efficiently, Tanzania should be able to achieve the MDG targets [for water and sanitation]*'[22]. A 2005 WaterAid analytical paper[23] considers the same question, and concludes meeting the water target will depend almost entirely on the Government of Tanzania; for sanitation, the NGO predicts the target can be met in rural areas, given Tanzania's

[17] FAO AQUASTAT (2005).**Irrigation in Africa in figures – AQUASTAT Survey 2005, United Republic of Tanzania**. http://www.fao.org/AG/aGL/aglw/aquastat/countries/tanzania/index.stm. Accessed on June 2007.
[18] Ibid.
[19] Government of Tanzania (2006). **Tanzanian figures 2005**. National Bureau of Statistics, Ministry of Planning, Economy, and Empowerment, June 2006.
[20] WSP (2006). **Getting Africa on track to meet the MDGs on water and sanitation. a status overview of sixteen African countries**. WSP-Africa, Nairobi, page 84.
[21] WHO's definition of improved drinking water is water drawn from the following sources: piped water into dwelling, plot or yard; public tap/standpipe; tubewell/borehole; protected dug well; protected spring; rainwater collection. Improved sanitation is: flush or pour–flush to a piped sewer system, septic tank, or pit latrine; ventilated improved pit latrine; pit latrine with slab; composting toilet.
[22] WSP (2006). **Getting Africa on track to meet the MDGs on water and sanitation. a status overview of sixteen African countries**. WSP-Africa, Nairobi.
[23] D. de Waal and D. Nkongo (2005). **$2 billion dollars – the cost of water and sanitation millennium development targets for Tanzania**. WaterAid, London.

historic high latrine coverage rates since public information campaigns began thirty years ago, though in urban areas it foresees a bigger challenge. To meet the water target, WaterAid that recommends the Government of Tanzania (GoT) undertake fiscal decentralisation, devolving both planning and expenditure for rural water supply to local councils. It also calculates that 3,000 new water points will need to be added per year, stressing the need to '*prioritise investment in low-cost water supplies*' (such as point sources from shallow wells and springs and small piped schemes from boreholes or spring to public taps) and advising the development of large-scale piped schemes only in areas where there are no other feasible options. In addition to being less expensive, the smaller schemes would also be more equitable and sustainable, according to the report.

As mentioned above, access to water and sanitation plays a role, either direct or indirect, in most of the MDGs. Tanzania's progress in meeting MDGs 1-6 are outlined in Table 2. Progress toward the country's National Strategy for Growth and Reduction of Poverty (NSGPR) or *Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania* (MKUKUTA) targets is also given.

Table 2: Indicators for Millennium Development Goals 1-6

	1990 (or closest available)	2006 (or closest available)	2010 MKUKUTA Target	2015 MDG target	2010 MKUKUTA Target - at current trend	Target - with better policies, instit. and addtional funding
Goal 1: eradicate extreme poverty and hunger	2015 target = halve 1990 level of income poverty and malnutrition					
Income - % below the national poverty line	39%	36%	24%		Uncertain	Yes
- % below dollar a day poverty line	61%	58%		31%		
Child malnutrition - % of children under 5 underweight	29%	22%		15%		
- % of children under 5 stunted	43%	38%	20%		No	Uncertain
- % of children under 5 wasted	6%	3%	2%		Yes	Yes
Goal 2: Achieve universal primary education	2015 target = net enrollment of 100%					
Net enrolment in primary school	51%	91%	99%	100%	Met	Yes
Goal 3: Promote gender equality, empower women	2015 target = equal gender ratio					
Girls / boy ration for enrolment in primary school	1.01	0.99	1	1	Met	Yes
Girl / boy for enrolment in secondary school	0.70	0.81	1	1	Yes	Yes
Goal 4: Reduce child mortality	2015 target = reduce 1990 child mortality by two thirds					
Under five mortality (per 1000)	141	112	79	47	No	Uncertain
Infant mortality (per 1000)	92	68	50		No	Uncertain
Goal 5: Improve maternal health	2015 target = reduce 1990 maternal mortality by three fourths					
Reduce maternal mortality by three quarters (per 100,000 births)	529	578	265	132	No	Uncertain
Births attended by skilled staff (% of total)	53%	46%	80%		No	Yes
Goal 6: Combat HIV/AIDS, malaria, other diseases	2015 target = halt and begin to reverse AIDS etc.					
HIV prevalence in the total population (%)	n.a.	7.0		<7.0		
HIV prevalence among 15-24 year pregnant women	n.a.	7.6	5		No	Uncertain

Source: Tanzania Joint Program Document, Development Partners Group, December 2006

The MKUKUTA also lists operational targets for the year 2010 for the water and sanitation sector, with these cited in a 2006 sector situation analysis[24]:

"*In line with the time frame for the five-year MKUKUTA, operational targets for the water, sanitation and waste management have been defined for the year 2010:*

- *increased proportion of rural population that has access to clean and safe water from 53% in the year 2003 to 65% by the year 2009/10 within 30 minutes of time spent on collection of water;*
- *increased urban population with access to clean and safe water from 73% in 2003 to 90% by the year 2009/10;*
- *increased access to improved sewerage facilities from 17% in 2003 to 30% in 2010 in respective urban areas;*
- *95% of people with access to basic sanitation by 2010;*
- *reduced water related environmental pollution levels from 20% in 2003 to 10% in 2010;*
- *reduce households living in slums without adequate basic essential utilities;*
- *100% of schools to have adequate sanitary facilities by 2010; and*
- *reduce cholera out-breaks by half by 2010."*

These targets reflect an integrated approach to the water and sanitation challenges: addressing both rural and urban areas and also addressing the health and environmental impacts of poor coverage. The national approach to water supply and sanitation consequently provides a clear framework for priority setting and monitoring of progress for the sector. The challenges relate to ensuring that there are effective systems to deliver these national targets.

2.2 Water as a priority in development

In April 2007 discussions with Ministry of Water (MoW) officials, it was emphasized that the MoW and the sector as a whole is in the middle of a period of systematic change, with a new approach around the Sector-wide Approach to Planning (SWAP), which provides a resource allocation framework for five years. The new strategy of implementation through decentralization and the districts was noted, as well as the MoW's changed role from implementers to facilitators: setting policies, guidelines, M&E, regulatory environment, approval of plans and setting financial allocation frameworks to ensure policy conformity. But, critically, MoW has no direct sanctions control over resource allocations to districts; thus the effectiveness of its facilitator role will depend on relations with Prime Minister's Office – Regional Administration and Local Government (PMO-RALG), which does have control over allocations.

The policy and institutional changes are encoded in the 2002 National Water Policy (which amended the first National Water Policy of 1991), which is the central policy

[24] S. Hesselbarth and D. Mashauri (2006). **Situation Analysis of the Water Sector in Tanzania.** Government of Tanzania, Dar es Salaam, p. 3.

instrument, as well as the 2005 National Water Sector Development Strategy, the 2006 Water Sector Development Programme (WSDP), and three sub-sector programmes for rural WSS, urban WSS and water resources (all 2006). The National Irrigation Master Plan (NIMP) was launched in 2002, with the intent of attaining the Agricultural Sector Development Strategy's objectives in a context of sustainable irrigation development through effective use of national resources as part of the overall approach to increasing agricultural productivity and profitability.

These changes in the water sector are in the context of wider policies and changes, especially decentralization, with planning now taking place at district level and finance channeled from the Ministry of Finance through PMO-RALG to districts.

The goal of the national water resources programme is to create good governance through stakeholder participation. The NWP states that management of water resources will be according to the following principles[25]:

- separation of service delivery and water resources management;
- management responsibility is devolved to river basins, catchments, and water user groups;
- planning is an inter-sectoral process involving all stakeholders;
- the value of water is recognized through charges for water use and pollution discharge;
- environmental water allocations are needed to ensure river health; and
- trans-boundary waters are managed through a cooperative approach

The June 2005 PRSP for Tanzania identified water as one of seven priority sectors (and agriculture as another) where spending will have a "*greater impact on poverty reduction*"[26]. The PRSP adopts an "outcomes approach" which looks at the contributions of all sectors, including water, towards specific outcomes on growth and poverty reduction. It also seeks to stimulate greater levels of internal investment in the priority sectors. Improved water management and enhanced levels of service provision are stressed in relation to improving health and the living environment, with regard to improvements to productivity in agriculture and rangelands management for livestock and in relation to the reduction of vulnerabilities that the poor face. Sanitation is given a balanced prioritization along with improvements to water supplies. The approach to vulnerability is particularly noteworthy in the PRSP, reflecting a nuanced view of poverty reduction, including the recognition of the role of local communities in mitigating vulnerability factors: "*Strategies will be put in place to mitigate the effects of natural disasters, halt desertification and promote water conservation practices. Sustainable use of natural resources through community-based natural resource management and enhanced district level planning will be pursued*"[27]

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[25] Government of Tanzania (2006b). **Water sector development programme, 2006-2025**. Ministry of Water.
[26] Government of Tanzania (2005). **National Strategy for Growth and Poverty Reduction.** Vice President's Office, Government of Tanzania, Dar es Salaam, p. 2.
[27] Ibid, p. 47.

Water is consequently recognized as a key issue within the national development and poverty reduction policy framework, with a high priority within the PRSP, a clear national-level overall policy and effective sub-sectoral strategies for urban and rural water supply and sanitation, irrigation and water resources management. The main issue for the integration of poverty reduction into the water sector is consequently not the overall policy framework, but is rather whether the institutional, human and financial resources needed to deliver on this policy framework exist. Tanzania faces a classic "implementation gap" similar to that found in many African countries, where achieving poverty reduction goals and targets is contingent upon substantial capacity development across all aspects of water resources management. This key conclusion can be illustrated in relation to different aspects of the management of water.

Tanzania is committed to the development of IWRM and there are nine river basin boards covering all rivers in country; though these basin boards are relatively recent, some have received support and are growing in capabilities. GoT policy is for these boards to control conflicts and balance demands through use of water use licenses. The establishment of the capabilities to achieve this policy goal will take time and require support as the new river basin boards develop.

A critical weakness identified in the system is capacity at the district level, although there are institutional weaknesses elsewhere as well. A programme of capacity development in engineering, financial management and other areas for districts is being instituted to address this problem. Further, the MoW has set guidelines that specify minimum institutional capacities before districts will be eligible to receive capital grants. District level water and sanitation teams are being set up, which will become the focal point of implementation support and technical capacities; these teams will come under the jurisdiction of district councils.

Resource allocation in WSDP estimated financing needs as $3,366 million in the period 2006–2025 (it should be noted that this financing need estimate does *not* include irrigation or hydropower development, which fall under the jurisdiction of other agencies). The allocation framework gave the largest sums to capital investments ($2.79 billion, split between water resources, RWSS and UWSS), with management and operational support (more-or-less recurrent costs for the MoW and other agencies) as $300 million and sector institutional strengthening and capacity building as $144 million. Thus the allocations to capacity building are not insignificant, though they are still only $7 million/year if evenly distributed over 20 years.

Sanitation is largely neglected in national-level planning. The approach at present in this area focuses on awareness raising and capacity building, but it is weak and sanitation is often low in demand priorities, from the lower levels up. The national government can ensure funds allocations to districts to ensure national targets are met, but this necessitates negotiation with local authorities and may be problematic.

The GoT strategy also recognizes the role of the private sector, with the policy priority to increase private sector participation in the sector. Present activities in this area involve increasing private contractor involvement in implementation of GoT investments, including specific support to well drillers. The need for an independent small-scale private sector is also acknowledged, and GoT will increase support in the future for small-scale private-sector service providers (SPSPs). Currently, the SPSP sector is very small and has low capability; problems include difficulty in accessing capital and concerns over risks with investments.

Agriculture

Since the 1980s, the Government has formulated a number of policies and strategies to provide guidance on achieving the strategic goals of social and economic development in the country; although water was not always mainstreamed into GoT policies in the past (Box 1), it is now better integrated into Tanzania's agricultural policies. Among the most relevant to the agriculture sector are the Tanzania Development Vision (TDV) 2025 (2000), the National Strategy for Growth and Reduction of Poverty (NSGPR, or *MKUKUTA*) and the Agriculture and Livestock Development Policy (1997). More recently, the GoT has published the Rural Development Strategy (RDS, 2001) and Agricultural Sector Development Strategy (ASDS, 2001). The Rural Development Strategy includes four strategic interventions: (i) promoting widely shared growth, (ii) increasing opportunities and access to services, (iii) reducing risks and vulnerability, and (iv) good governance. The RDS also proposes specific objectives to promote sound irrigation infrastructure, including three strategic interventions to create a sounder institutional framework for the irrigation sector: (i) the formation of Water Users Organisations, (ii) assistance for Water Users Organisations to access credit, and (iii) organization of relevant training modules for members of Water Users Organizations.

The ASDS proposes an agricultural growth rate of 5% per annum for the 3-year period 2005-2007, and sees irrigation development as a means to ensure long-term and sustainable improvements to productivity in the sector. This is in turn seen as a pre-requisite for reducing rural poverty, but the ASDS is not clear on mechanisms to ensure that the rural poor enjoy the benefits of irrigation development: it in effect lacks targeting to the specific needs and potentials of the rural poor.

The ALDP gives the core strategic direction for the agricultural sector, including priority to irrigation development with an emphasis on smallholder traditional irrigation schemes that are based on run-of-river and rainwater harvesting technologies. Despite this, the ALDP has not given a coherent direction so that the potential of irrigation in boosting agricultural productivity and incomes can be realised. This has been recognized with the development of the National Irrigation Master Plan (NIMP), which was launched in 2002. The GoT is also in the process of formulating a National Irrigation Policy and Strategy that will provide a framework for the sector's future development.

The NIMP sees sustainable irrigation development as a means to realise the ASDS's objectives to increase agricultural productivity and profitability. According to the NIMP,

the total irrigable area of Tanzania is 29.4 million hectares, but these lands have varying levels of potential. Out of the total, 2.3 million hectares are categorized as high-level potential, 4.8 million hectares are of medium-level potential and 22.3 million hectares have low-level potential for irrigation. In consequence, irrigation would be marginal over most of the lands defined as potentially irrigable. The area of land that has irrigation developed on it as of June 2006 was only 264,388 hectares; a small proportion (just over 5%) of even the high and medium potential area. The GoT recognizes the need to significantly improve the rate of expansion of the irrigated area, setting a target to increase the developed irrigated area by 2010 to a cumulative figure of one million hectares. This target is to an extent aspirational, however, and the financial and capacities to achieve a quadrupling of the irrigated area in a few years are not in place. The NIMP sets a more realistically achievable target that 405,400 hectares covering 626 schemes will be developed for irrigated agriculture by 2017. Whichever target is considered, the GoT clearly recognizes the need for a major expansion of the areas under irrigation in the coming years.

Box 1: The bypass of water in agricultural policies

Between 1973 and 1995, the Tanzanian government implemented a major soil and water conservation programme in the semi-arid central part of the country. An evaluation undertaken in 1995 provided examples of some interesting weaknesses of most of the SWC programmes of that. Some conclusions were made (Hatibu et al., 1999), for example:

(i) In the dry land of central Tanzania, crop yields are reduced more by the shortage of soil-moisture rather than by loss of soil. Hence, there should have been more emphasis on rainwater management within the croplands rather than erosion control.

(ii) On-farm soil and water conservation measures promoted by the programme over the last twenty years have done very little to increase land productivity within the crop lands.

Further, legislation on water rights and uses are not well harmonized with national water policies. The Agriculture Sector Development Strategy (ASDS) states that *'the Government in close collaboration and consultation with the private sector will enhance the efficiency of water utilization, especially rainwater, through the promotion of better management practices'*. This will be achieved by developing and implementing a comprehensive programme for integrating soil and water conservation, rainwater harvesting and storage, irrigation, and drainage**.** As a result, rainwater harvesting features prominently in the national irrigation master plan adopted in 2003 (GoT, 2003).

Sources:
N. Hatibu et al. (1999); Government of Tanzania, 2001; Government of Tanzania, 2002b; Government of Tanzania, 2003.

3 WATER RESOURCES AND MANAGEMENT IN TANZANIA

3.1 Water resources and demands

Tanzania hosts large lakes, wetlands, river systems and significant amounts of rainfall, holding large potentials for development in different sectors. On a national level, approximately 1,071 mm/yr average over the country, equivalent to 1012 km^3/yr. The blue flows, i.e. the flowing waters in river, lakes and wetlands, constitute approximately 10%, or 96 km^3/yr (Figure 2). Part is internally generated, and circa 10% of blue flows are externally generated. Most of the rainfall is used to support lakes and wetlands systems, as well as the vast areas of savannah grasslands, woodlands and forest (60% of land area). Rainfed agriculture uses a fraction (1.5%) of overall resources on 40% of the country's land area. Only a small fraction of the total water resources, approximately 0.2 % of total resource is used for irrigation (Figure 2). As Tanzania is on the coast, there is limited demand from downstream users. However, several lakes and rivers are trans-boundary and have to be managed accordingly. Both blue and green water resources are currently stressed by a range of factors (Box 2).

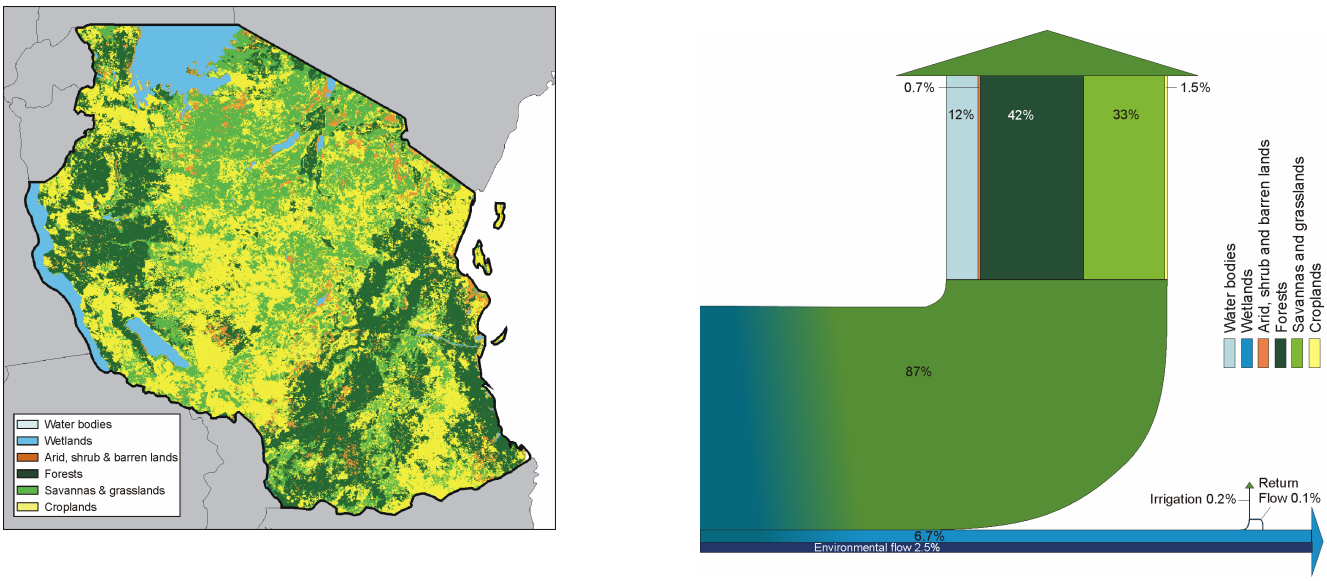


Figure 2: Land use (right hand) is governing the water resources of Tanzania. Total rainfall and incoming external renewable water are divided into green flows and blue flows (left) depending on land use.

Tanzania's lakes and swamps cover 5.4 million hectares and comprise 5.8% of the country's total land area; approximately 50% of surface runoff drains directly into the Indian Ocean, and the other 50% is surface water drainage to the internal drainage basins of lakes Rukwa, Bubu, Eyasi, and Manyara and drainage to the transboundary lakes Victoria (shared with Kenya and Uganda; Tanzania has 51%), Tanganyika (shared with Burundi, Zambia, and DR Congo; Tanzania has 41%) and Nyasa/Malawi (shared with

Malawi and Mozambique; Tanzania claims 18%)[28]. Other transboundary water resources include the Ruvuma, Kagera, Mara and Songwe rivers and the Chala and Jipe lakes[29]. In total, about 43% of the country's water resources are transboundary[30], meaning that relations with the other riparian nations is a major issue in water management at the national level.

Box 2: Major environmental threats to Tanzania's water resources

A 2006 World Bank[31] overview of water resources in Tanzania enumerated the following list of major threats to water resources sustainability:

- Climate change;
- Over abstraction, diversion and storage of flows, without adequate consideration of downstream consequences;
- Excessive rates of groundwater abstraction;
- Pollution from multiple sources (e.g. agriculture and livestock, municipalities, industry, and mining);
- Increased siltation of dams from cultivation, overgrazing, deforestation, and urbanization;
- Wetland loss and degradation caused by encroachment; and
- Water hyacinth infestation

Source: World Bank, 2006.

Tanzania has two rainfall patterns. Rainfall is unimodal in the central, southern and southwestern highlands, with rains occurring from October/November to April. The coastal area, the northeastern highlands, the Lake Victoria basin and the islands of Unguja and Pemba have bimodal rainfall regimes, with the short rains taking place from September/October to December and the long rains falling from March to May/June[32]. Mean rainfall varies from 250 to 1,000 mm, with higher rainfall (1,000-3,000) in the northeastern Lake Victoria basin and southern highlands[33].

Currently the blue water amount of water resources available for human use in Tanzania is estimated at 2,700 m^3 per capita[34], but by 2025 this is projected to drop to 1500 m^3, due to expected population increases, at which point the country will be considered water

[28] Government of Tanzania (2006b). **Water Sector Development Programme, 2006-2025.** Ministry of Water, Government of Tanzania, November 2006, pp. 10-11; FAO AQUASTAT 2007).
[29] World Bank (2006). **Water resources in Tanzania: sustainable development of Tanzania's water resources**. www.worldbank.org. Accessed in June 2007.
[30] AfDB/OECD (2007). **African economic outlook 2004/2005: Tanzania**. www.oecd.org/dev/aeo, p. 510.
[31] World Bank (2006). **Water resources in Tanzania: sustainable development of Tanzania's water resources**. www.worldbank.org. Accessed in June 2007.
[32] FAO AQUASTAT (2005).**Irrigation in Africa in figures – AQUASTAT Survey 2005, United Republic of Tanzania**. http://www.fao.org/AG/aGL/aglw/aquastat/countries/tanzania/index.stm. Accessed on June 2007; Government of Tanzania (2006). **Tanzanian figures 2005**. National Bureau of Statistics, Ministry of Planning, Economy, and Empowerment, June 2006.
[33] M. Ndege (2007). Strain, water demand, and supply directions in the most stressed water systems of eastern Africa. http://www.idrc.ca/en/ev-31143-201-1-DO_TOPIC.html . Accessed June 2007.
[34] AfDB/OECD (2007). **African economic outlook 2004/2005: Tanzania**. www.oecd.org/dev/aeo, p. 510.

stressed[35]. Agriculture is the largest consumer of blue water, with water for irrigation accounting for 85% of the blue water withdrawal (Figure 3). Almost all of this abstraction is surface water; groundwater accounts for less than 1% of irrigation water[36].

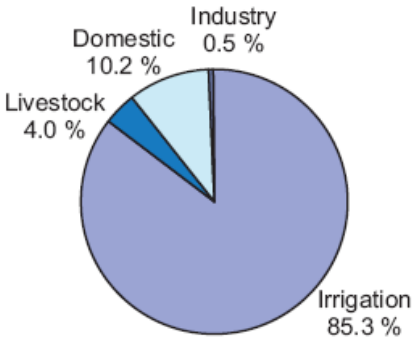


Figure 3: Water withdrawals, 2002
Source: FAO AQUASTAT (2005)

In terms of hydropower, Tanzania's gross theoretical capability is estimated at 39 TWh/yr, of which 3 TWh/yr is considered economically exploitable capability[37]. Less than 20% of this potential has been tapped: hydropower currently generates 557 MW, which represents 62% of the country's installed capacity (Table 3)[38]. Inadequate water flows, caused by low rainfall, illegal extractions, and poor enforcement of water rights, have hampered power generation: Pangani Falls has been operating at only 35% of capacity since its commissioning[39]. Electricity demand is expected to grow at 10-12% annually; Tanzania currently imports 12 MW of electric power (5 MW from Uganda and 7 MW from Zambia) to try to meet demand[40]. The World Bank estimates power rationing is the cause of huge losses to the Tanzanian economy, up to $1.7 million per day[41].

Table 3: Main dams in Tanzania

Name	River basin	Installed capacity (MW)
Kidatu	Rufiji	200
Kihansi	Rufiji	180
Mtera	Rufiji	80
Pangani Falls	Pangani	68
Hale	Pangani	21
Nyumba ya Mungu	Pangani	8
TOTAL		**557**

Source: FAO AQUASTAT, 2007

[35] World Bank (2006). **Water resources in Tanzania: sustainable development of Tanzania's water resources**. www.worldbank.org. Accessed in June 2007.
[36] FAO AQUASTAT (2005).**Irrigation in Africa in figures – AQUASTAT Survey 2005, United Republic of Tanzania**. http://www.fao.org/AG/aGL/aglw/aquastat/countries/tanzania/index.stm. Accessed on June 2007.
[37] UNESCO (2005). **Water: a shared responsibility**. UN World Water Development Report 2. UNESCO, Paris, p. 332.
[38] ESI Africa (2006). **The power sector in Tanzania**. Issue 2, 2006.
[39] World Bank (2006). **Water resources in Tanzania: sustainable development of Tanzania's water resources**. www.worldbank.org. Accessed in June 2007.
[40] ESI Africa (2006). **The power sector in Tanzania**. Issue 2, 2006.
[41] World Bank (2006). **Water resources in Tanzania: sustainable development of Tanzania's water resources**. www.worldbank.org. Accessed in June 2007.

There is serious conflict between water uses for hydropower and agriculture in the Pangani and Rufiji river basins. In both basins, upstream agriculture and irrigation increases will cause reduced flows to dams, particularly during periods of drought, leading the Tanzania Electricity Supply Company (TANESCO) to insist that all irrigation schemes located upstream of the Mtera dam be closed[42]. On a national level, there is tension between balancing the need to support smallholder agriculture for enhancement of income and livelihoods to achieve poverty reduction impacts against the strategic importance of hydroelectric power for economic development and growth[43]. This issue will be further addressed in Section 3.5 on IWRM, below.

3.2 Water supply and sanitation

As indicated above, Tanzania is roughly on track to meet the sanitation target and has the potential to meet the water target; Figure 4 summarizes household sources of drinking water as determined by the 2002 Population and Housing Census. In terms of the urban water supply target, the census indicated urban coverage rates for improved sources of drinking water at 91.7% for Dar and 83.6% for other urban areas. These are higher rates of access to improved water supplies than would be expected from other data sources; this may be due to the neglect of urban authorities in reporting private sources (largely boreholes and protected shallow wells)[44].

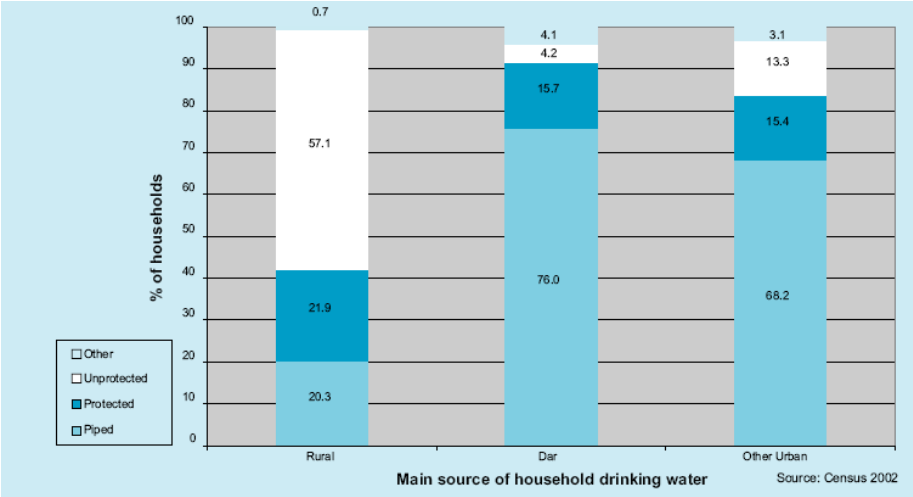


Figure 4: Percentage of households by main source of drinking water, based on 2002 Population and Housing Census
Source: WaterAid, 2005

Figure 4 also indicates that 42.2% of the Tanzania's rural population draws its water from an improved source. However, this coverage does not take into account distance nor time

[42] M. Ndege (2007). Strain, water demand, and supply directions in the most stressed water systems of eastern Africa. http://www.idrc.ca/en/ev-31143-201-1-DO_TOPIC.html . Accessed June 2007.
[43] M. Mdemu and M. Magayane (2005). **Conflict of water use between hydropower and irrigation in Tanzania: the conundrum of sectoral policy approaches to water resources development.** Center for Development Research, Bonn, Germany.
[44] WaterAid (2005). Water and sanitation in Tanzania: an update based on the 2002 Population and Housing Census. WaterAid, London.

required to fetch water from the improved source, which may limit the amount available, essential to realizing health benefits.

Table 4: Progress towards MDG and MKUKUTA targets

	1990 (or closest available)	2006 (or closest available)	2010 MKUKUTA Target	2015 MDG target	2010 MKUKUTA Target - at current trend	Target - with better policies, instit. and addtional funding
Goal 7: Ensure environmental sustainability	2015 target = integrate into Gov. policies, reverse loss of environmental resources, halve proportion of people without access to safe water and sanitation					
Proportion with access to clean and safe water in urban areas	92%	91%	90%	90%	Met	Yes
Proportion with access to clean and safe water in rural areas	36%	47%	65%	90%	No	Yes
Proportion of people with access to basic sanitation in urban areas	98%	96%	95%		Met	Yes
Proportion of people with access to basic sanitation in rural areas	91%	92%	95%		Yes	Yes

Source: Tanzania Joint Program Document, DPG, December 2006

In December 2006, the Development Partners Group (DPG) published the Tanzania Joint Program Document, which considered the status of progress towards MDG Target 10 as well as progress towards Tanzania's MKUKUTA WSS targets (Table 4). However, in examining this table, it must be remembered that the MDG target on sanitation specifies 'access to *improved* sanitation' (i.e., flush or pour–flush to a piped sewer system, septic tank, or pit latrine; ventilated improved pit latrine; pit latrine with slab; or composting toilet), whereas the DPG table has used the definition of 'access to *basic* sanitation'. This issue is further muddied by the questionnaire used in the 2002 Census: as WaterAid Tanzania has pointed out, the survey response options - pit latrine or ventilated pit latrine (VIP) - do not distinguish between improved and unimproved sanitation, noting '*the term VIP is too specific, and the term pit latrines too broad, as pit latrines cover both adequate and inadequate sanitation*' [45].

Urban water supply and sanitation

Tanzania is urbanizing quickly; at the current rate, by 2025 half the country's population will reside in urban areas[46]. As noted in Section 2 above, Tanzania's MDG target for water supply coverage is 64%; the 2004 data indicates urban water supply coverage is at 85%. Further, the December 2006 Tanzania Joint Program Document by the DPG puts urban coverage for clean and safe drinking water at 90%, judging both the MDG and MKUKUTA target met. This reflects household connection coverage of 43%, and other arrangements, including community taps, for the remaining coverage.

In April 2007 discussions with staff from Dar es Salaam's water utility, Dar es Salaam Urban Water and Sewerage Authority (DAWASA), it was noted that Dar es Salaam

[45] WaterAid (2005). **Water and sanitation in Tanzania: an update based on the 2002 Population and Housing Census**. WaterAid, London.
[46] Government of Tanzania (2006b). **Water Sector Development Programme, 2006-2025.** Ministry of Water, Government of Tanzania, November 2006.

residents with connections now have "rationing" where supply is only available for short periods. This was attributed in part to minimal investment over the last 40 years, though AfDB funding of the Dar es Salaam Water Supply and Sanitation Project (DWSSP) is enabling systematic rehabilitation of the existing infrastructure. DWSSP also supported important studies on how to better meet demand, including evaluation of water sources (surface and groundwater), as well as separate strategic plans for water supply and for sanitation, which will serve as the basis for a systematic expansion of the system. The model is to classify areas as A, B, C, D, depending on quality and completeness of coverage, then move them through categories by upgrading the system and expanding coverage, before rolling the system out to a new area.

As part of the wider sector policy of treating water resources as an economic good, DAWASA policy is for consumers to pay full recurrent and some capital costs. Currently, this entails a flat rate of 654 Tsh per m^3. Studies by DAWASA have shown a high willingness and ability to pay, where services are good and reliable. DAWASA staff estimated that Dar es Salaam residents not connected to the piped system or living in areas where supplies are erratic buy water from vendors for around 50 Tsh per 20 litres, meaning these customers are paying almost quadruple the price of those enjoying household connections. A previous study conducted in Dar, the 1998/1999 Water Vendor Survey, found 50 Tsh to be the lowest price observed for 20 liters; much more common were prices of 100 Tsh for the same amount, as well as observations of prices up to 200 Tsh for 20 liters[47].

Another urban water utility, Arusha Urban Water Supply and Sewerage Authority (AWASA), has addressed such equity considerations in its water charges (see Box 3). However, similar to DAWASA, AWASA is struggling to meet customer demand. The municipality has approximately 280,000 residents to serve, with a daily demand of 42,000 m^3. The utility relies on two local springs and fifteen boreholes; while these offer sufficient supply during the rainy season, during the dry season they only provide on average 35,000 m^3 per day. Like DAWASA, AWASA is searching for solutions to its shortfall, and is taking steps such as installing meters, identifying illegal connections, and leakage repairing.

Photo by Marianne Kjellén

Collecting water in Manzese

[47] M. Kjellén (2006). **From public pipes to private hands: water access and distribution in Dar es Salaam, Tanzania**. Stockholm University, Stockholm, p. 162.

Box 3: Pro-poor water tariffs in Arusha

The 2006 Human Development Report notes that block tariffs for water can be disadvantageous to the poor, since private water re-sellers often purchase water at the top tiers of the tariff structure, forcing those without household connections to pay the highest rates.[48]. The Arusha Urban Water Supply and Sewerage Authority (AWASA), which estimates a little less than half of the customers it serves rely on communal water points, has structured its block tariff fees to avoid this result: the utility charges the highest rates to commercial users, followed by lower rates for water obtained through household connections, and finally the lowest tariffs for water kiosk service providers and other communal users (schools, hospitals, etc.). For all categories of users, charges increase in blocks of higher usage[49]. Water charges by user group are as follows:

Commercial		Households		Institutions	
0-5 liters	345 Tsh	0-5 liters	300 Tsh	0-5 liters	300 Tsh
5-11 liters	435 Tsh	5-15 liters	350 Tsh	5-15 liters	325 Tsh
>11 liters	515 Tsh	>15 liters	400 Tsh	>15 liters	350 Tsh

Further, for poor and disadvantaged households (i.e. elderly, disabled, and ill) unable to pay, AWASA has instituted a program providing water at no cost. Using participatory methods, the utility identified 31 households in the area to receive water free of charge in 2004[50]; by 2007, 62 families were enrolled in the service[51]. AWASA also included flexible water delivery options to address access issues: recipients can use vouchers to obtain water from the closest water kiosk or may alternatively elect to receive their water through neighbor's taps.

Urban sanitation is a major challenge. The 2002 Population and Housing Census reported that 83% of urban residents had household pit latrines, while 14% in Dar and 11% in other urban areas had flush toilets. The 2004 WHO data, which considered access to improved sanitation, estimates urban sanitation coverage to be 53%. By contrast, the DPG measured access to basic sanitation at 96% and judged the MDG and MAKUKUTA targets met.

Staff at both DAWASA and AWASA indicated sanitation was a serious problem that their organizations had been unable to sustainably address; in both locations, connection to sewerage systems was only 10-12%. In Arusha, 90% of the people living in villages were using pit latrines, whereas 9% have no latrine at all; a briefing document[52] providing these figures concludes '*the above information indicates that there is a lot of unmanaged liquid waste which pose environmental hazards through water and food contamination.*' As of early 2007, AWASA and the Arusha Municipal Council were working with the University of Dar es Salaam and the EU-funded Resource-Orientated

[48] UNDP (2006). **Human Development Report 2006.** UNDP, New York, p. 85.
[49] Information from E. Macha, AWASA Sanitation Engineer. April 2007 meeting, Arusha.
[50] AWASA (2005). **Implementation report on urban poor households identification to be provided with free water supply service in Arusha municipality**.
[51] Information from J. Archard, AWASA Public Relations Officer. April 2007 meeting, Arusha.
[52] Arusha Municipal Council briefing document, November 2006.

Sanitation concepts for peri-urban areas in Africa (ROSA) to identify sustainable sanitation options to address this problem.

Rural water supply and sanitation

The 2002 Census showed rural coverage for improved sources of drinking water to be 42.2%, and the 2006 DPG document estimated rural coverage for safe and clean drinking water at 47%. As noted above, the MDG target for water supply coverage is 64%. Figure 5 maps the location of rural household with improved water supply sources, with the areas with lowest coverage indicated by lighter shading.

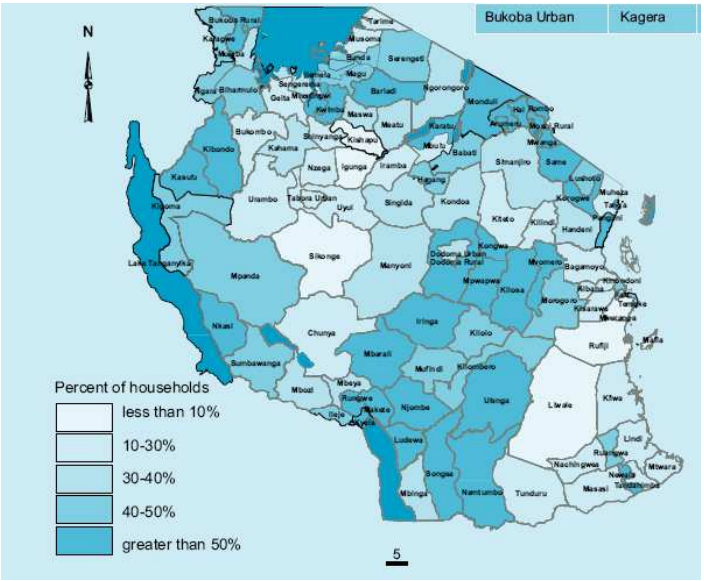


Figure 5: Rural households using improved water sources as their main source of drinking water
Source: WaterAid, 2005

The latest data show that rural coverage for improved sanitation has dropped from 45% in 1990 to 43% in 2004; Tanzania's MDG target for sanitation coverage is set at 95%. This reflects earlier official figures that estimate rural sanitation coverage to be much higher than the present estimates: the discrepancy is largely because the earlier estimates included all types of latrines regardless of whether they met international definitions of "improved sanitation". The present figure of 43% reflects more effectively the challenges that Tanzania faces in rural sanitation. Given that GoT does not subsidise latrine building, official efforts will have to focus on public information campaigns and health extension to promote achievement of the sanitation goal[53].

The rural water supply and sanitation sector is at present undergoing systematic change in approach and institutional responsibilities. A new 5-year resource allocation framework has been prepared by the Ministry of Water (MoW) in the form of a SWAP, with all

[53] D. de Waal and D. Nkongo (2005). **$2 billion dollars – the cost of water and sanitation millennium development targets for Tanzania**. WaterAid, London.

funds provided by GoT and by international development partners intended to be allocated through this framework. The role of the MoW will change from being the primary implementer of investments to being a facilitator, setting policies, guidelines and regulations, undertaking monitoring and evaluation, approving plans and setting the financial allocation framework to ensure policy conformity.

Reflecting wider decentralisation processes in Tanzania, the primary implementers of investments in water supply and sanitation will be the district level authorities, who are responsible for preparing and submitting plans that are based on local level consultations and participation. The plans are submitted to PMO-RALG, who allocate funds to the district level ones the plans are vetted for policy and budget conformity by MoW.

Two aspects of the new situation are of critical importance: (i) funds allocated to the sector are incorporated into overall district development funds; and (ii) the MoW has no direct sanctions over districts that do not conform to policies and budget allocations, but rather have to work through PMO-RALG, meaning that close and effective cooperation with PMO-RALG will be crucial in ensuring policy intentions become implementation reality in a context where districts have funding pressures from a wide variety of sectors. This is particularly a concern for sanitation, as water supply is usually a high priority in needs assessments whilst sanitation is generally considered less of a priority when compared to other needs.

One aspect of the approach to rural water supply planning and design in Tanzania is of particular significance from a poverty reduction perspective. The planning, design and construction of water supply schemes in rural areas are intended in principle to take account of the needs of water for livestock and, where relevant, other productive uses such as small industries (though the situation on home gardens is unclear). The MoW also indicated their recognition of the need for different technology choices in different places, to reflect local needs, water resource circumstances and development opportunities. The extent to which these principles are followed in practice is unclear, as this can make investments more expensive and there are no guidelines or procedures for calculating the costs and benefits of different investment alternatives.

The MoW identified this challenge as part of the wider capacity limitations at the decentralized levels, and the resource allocation in the Water Sector Development Plan does include funds for strengthening capacities and for operational and management support, particularly at district and local community levels. The scale of such funding is significant, at around $7 million a year for the 20 year period 2006-2025, but even this level of funding will be far less than that required to build effective capacities at the decentralized levels, especially in the next few years, the period during which the new reforms are intended to be institutionalized.

3.3 Agriculture

Agriculture is the backbone of the economy of Tanzania. It is expected to be the main contributor to the Tanzanian economy, at least in the medium term, despite the increasing

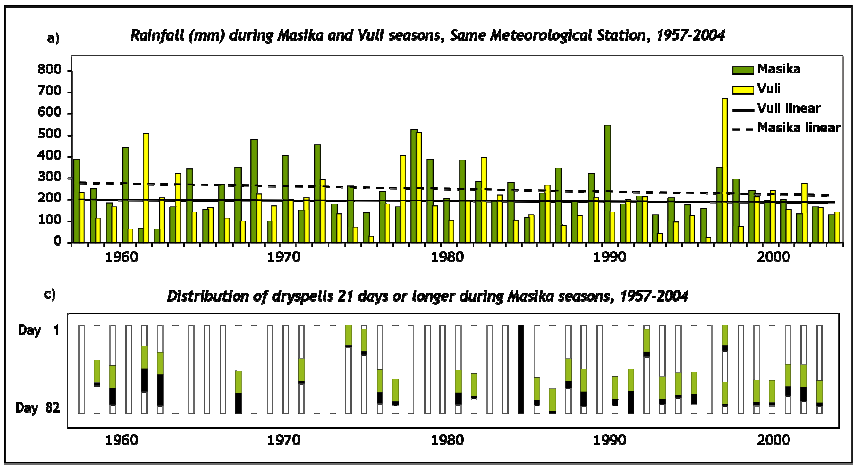
importance of other sectors like tourism, mining and industry. However, it staggers behind in its capacity to meet food demands from a growing population. Rainfed agriculture, with low input of fertilizer, technology and improved seeds, dominates. The current yield levels are low compared to achievable yields. The increased production has largely been realized due to expansion of land area. There is consequently a large untapped potential for increasing smallholder yields, improving water productivity without expanding agricultural land area at the same time. It has been proposed that potential yield levels are in the region of 3-5 t ha^{-1} with appropriate and well-tested crop management strategies, also for smallholder farming systems[54]. The largest potential for development, therefore, is the promotion and intensification of rainfed agriculture. Refocusing on rural development and agriculture may provide triple win solutions in increasing yields, improving water productivity and shifting rural and peri-urban poor out of poverty through livelihood improvements. Given the importance of rainfed agriculture – 99% of Tanzania's agricultural production is rainfed - it must be central to the country's climate change adaptation strategies (Box 4).

Irrigation also holds an untapped potential, and can act as a complement to the dominant rainfed systems. However, any irrigation development is often considered a trade-off between current land and water users and potential gains in irrigation. Usually 'potential irrigation land' is already in productive rainfed or other use, for example hosting important ecosystem habitats, providing local communities with informal goods and services, as discussed in Section 3.4 below.

[54] Rockstrom et al. (2007). Managing water in rainfed agriculture. Chapter 8 in "*Water for food, water for life: a comprehensive assessment of water management in agriculture*". International Water Management Institute (IWMI), Sri Lanka. (http://www.iwmi.cgiar.org/assessment/index.htm); Noble et al. (2006). Intensifying Agricultural Sustainability: An Analysis of Impacts and Drivers in the Development of 'Bright Spots'. Comprehensive Assessment Research Report No. 13, Comprehensive Assessment Secretariat, Colombo, Sri Lanka. http://www.iwmi.cgiar.org/assessment/files_new/publications/CA%20Research%20Reports/CARR13.pdf

Box 4: Coping with variability in rainfed farming

In Tanzania, 99% of food is produced in rainfed farming systems. Rainfed farming provides livelihoods and income for the majority of the population, especially in rural areas. Rainfall patterns form the basis for these livelihood systems. There are indications that rainfall has decreased during the last 40 years, seen for example in the data for Same Meteorological Station in northeast Tanzania (figure below).However, it is not only total amounts that determine the yields in rainfed farming, but also the seasonal distribution. Thus, the same seasonal amount of rainfall but with a different distribution can result in a complete crop failure or an average harvest. The within-season dry spells are critical for yields of maize. A dry spell during flowering is common in 9 of 10 seasons, and has been shown to lower potential yields by 19-40%. The former rainfall characteristics cannot be mitigated by the farmer unless irrigation is available. But within-season dry spell occurrence effects can be managed through relatively small changes in crop and water management strategies.



Sources: Enfors et al., 2007; Barron et al., 2003; Comprehensive Assessment , 2007

Current consumption in Tanzania is on average above the recommended daily minimum intake of 1,850 kcal/cap/day, but still below recommended levels for a healthy, physically active life at 2,500-2,700 kcal/cap/day (Figure 6). The composition of national average intake per capita is 95% of energy supply from vegetal products and approximately 5% from animal products. A fraction of the dietary energy is from fish and seafood[55]. Most food is produced within Tanzania, but net import is increasing, currently at 17% of total production[56]. According to available data, the average per capita daily intake has been stagnant.

Meeting the challenge of the MDG goal on hunger is dependent on available water resources for producing additional food. An estimate based on projected population growth and meeting the MDG hunger goal in 2015 with a balanced diet (80% vegetal,

[55] FAOSTAT (2007). **Food balance sheets**. www.fao.org. Accessed June 2007.
[56] Ibid.

20% animal energy intake) indicates that large amounts of water need to be allocated to agriculture and livestock (Figure 7). Currently, approximately 20 km^3 of water per year is needed for food production alone; including fodder and livestock requirements, approximately 40 km^3 of water is needed. To meet the hunger goal in 2015, assuming similar farming systems and water efficiency as today and using current UN population growth projections, indicates that 54 km^3/year of water - or doubling of current levels - is needed in agriculture. This does not include additional needs of fodder for livestock. To feed all, i.e. to wipe out hunger for the entire population, would possibly require another 3 km^3 per year in 2015. This is a vast quantity of water, and a formidable challenge for the water sector.

However, there are numerous options for dealing with these water and food challenges. On a national level, 54 km^3 of water represents only 5% of the total current rainfall of 1053 km^3 per year averaged across the country. Thus, there are water management options on a *national level* that must be explored in order that the full water resource in the landscape can be accounted for, including both so-called green and blue water. Secondly, on a *farm scale*, there is ample evidence and experience that shows how agricultural productivity, both in water and per area yields, can be improved over low-yield systems currently in use by farmers today[57].

The principal challenge may emerge at the catchment and basin levels, where various competing users will determine trade-offs in available water. This is also where national policies and strategies are to be operationalised and institutional and human capacity will be critical in advancing the agricultural sector to meet development goals whilst safeguarding water resources for sustainable multiple uses.

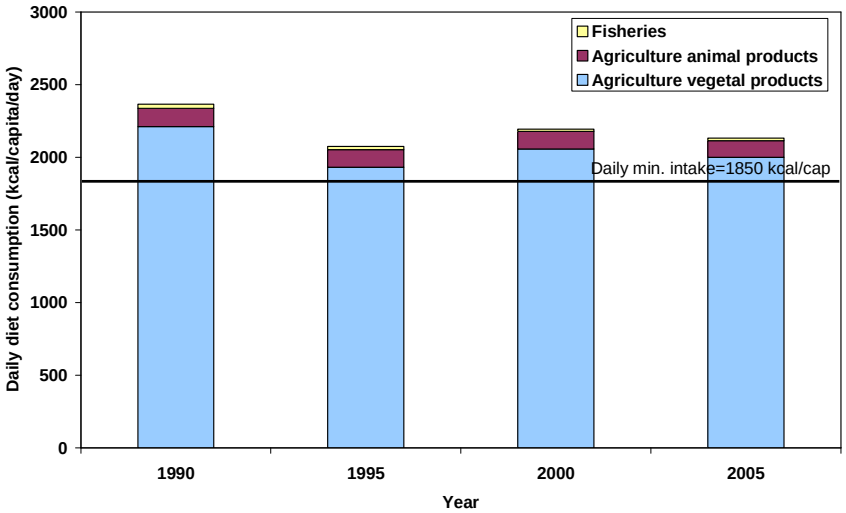


Figure 6: Daily average calorie intake per capita 1990-2005 in Tanzania for vegetal, animal and fishery food supply
Source: based on data from FAO, 2007

[57] Comprehensive Assessment (2007). **Managing water in rainfed agriculture**. Rockstrom, J., Hatibu,N., Oweis, T, Wani,S., Barron,J., Bruggeman,A., Farahani, J., Karlberg, L., Quiang,Z. Chapter in "*Water for food, water for life: a comprehensive assessment of water management in agriculture*". International Water Management Institute (IWMI), Sri Lanka.http://www.iwmi.cgiar.org/assessment/index.htm

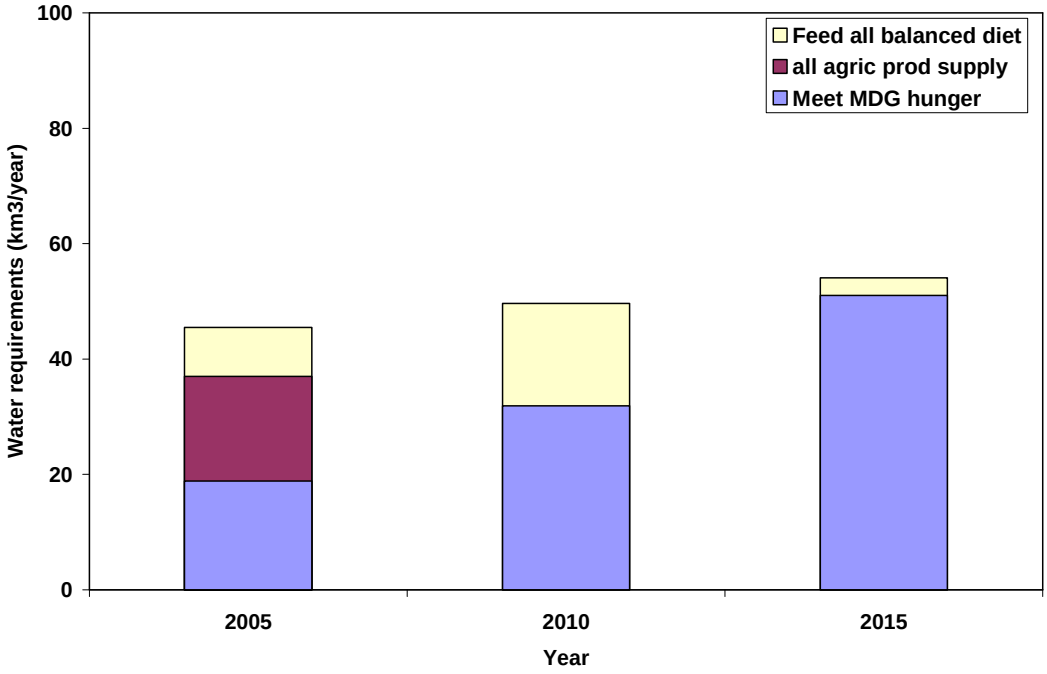


Figure 7: Water requirements for total dietary water requirements for Tanzania 2005 to 2015 with projected improved dietary balance, increase in per capita daily energy intake and meeting the MDG on hunger (staples)
The water required to feed total population a balanced diet of 2 700 kcal/cap/d is shown as line.
Source: based on data from FAO, 2007

Box 5: Doing by seeing: farmers' joint learning moves development

Smallholder farming in Arumeru, Arusha is a labour intensive and unpredictable source of income and livelihood support. Yields of staples such as maize and beans are one-quarter of achievable yields, in the range of 0.5 $^{-1}$ ^{t} per ha for maize. In 1997 a small project started with 8 farmers tried a more sustainable soil management system, partly to regenerate fertility but also to improve soil structure that had deteriorated through the use of tractor-pulled or hand-tilled land preparation. Both of these factors reduce crop water availability and water productivity and lower yields. Through the introduction of conservation farming with minimum tillage and buildup of soil organic matter, soils were slowly regenerated, crop water productivity improved and yields increased. This provided households with improved food security as well as surplus to sell, thus increasing household income and enabling further investments in on- or off-farm activities. When neighbors saw these benefits, more farmers started experimenting, eventually converting their farms to conservation farming methods. 'Learning–by-seeing' was an important feature of the spread of upgraded farming systems, as was a strong community willingness to share its knowledge with others. The successful adaptation of the conservation farming is, by and large, a community effort, enabled through a small group of innovative farmers.

Sources: FAO, 2005; Rockstrom et al., 2007

Photo by Johan Rockström

Conservation tillage in Tanzania

3.4 Water in maintenance of ecosystem goods and services

It is estimated that natural resource use is the main source of livelihood for 76% of the rural population in Tanzania[58]. Ecosystem goods and services are also of crucial importance to the livelihoods of the poor, who are typically more dependent on these flows than middle income or wealthy households. IUCN has estimated the economic value of these flows in the Pangani River basin; as can be seen from Table 6 below, the value per household of these flows is substantial.

Table 5: Overall average value per household derived from harvesting of aquatic resources

	Highlands	Upper basin	Kirua Swamp	Pangani Estuary	TOTAL (Tsh)	TOTAL (US$)
Food and medicinal plants	63	815	2,383	170	3,431	3.01
Reeds, sedges and grasses	2,120	2,433	2,852	0	7,405	6.50
Palms	0	4,269	4,434	86,721	95,424	83.70
Mangroves				7,890	7,890	6.92
Reptiles, mammals and birds		6	8		14	0.01
Fisheries		392	33,883	693,012	727,287	637.97
Average total income per household	**2,183**	**7,915**	**43,560**	**787,793**	**841,451**	**738.11**

Notes: at 2005 exchange rate (US$1 = Tsh 1140); averaged across user and non-user hhs; includes value added in processing
Source: adapted from Pangani River Basin Management Project, 2005

[58] P. Assey et al. (2007). **Environment at the heart of Tanzania's development: lessons from Tanzania's National Strategy for Growth and Reduction of Poverty – MKUKUTA.** IIED, London.

Tourism

Tourism is one of Tanzania's fastest-developing sectors: in 2006, receipts from tourists are estimated to have increased 6.7%[59]. In the period 2000-2004, gross receipts from the tourism industry have been more than US$700 million each year[60]. Another indicator of the sector's growth is international arrivals, which have steadily increased annually from 2002[61]. It is a sector that creates new livelihood alternatives for local communities, including the poor, and that adds significantly to overall economic growth. The poverty reduction potential of tourism development is consequently considerable, though care has to be taken to ensure that the benefits reach the poor and are not diverted overseas. Tourism development can place considerable demands on water supplies at a local level: tourists will not tolerate the intermittent water supplies that are the daily routine of many Tanzanians. Conversely, the industry can provide the economic and other incentives to improve water supplies that benefit local communities as well as the industry.

Tourism can also provide the economic base for sustainable resource management. As one of Tanzania's biggest draws in its game parks and diverse wildlife, management of water resources to maintain wildlife habitats is critical to the industry. Similarly, control of water pollution in areas around coastal areas and islands and protection of coastal ecosystems are also crucial to the sector's viability. Water for ecosystems maintenance consequently directly affects the poor through their heavy reliance on ecosystem goods and services flows, while simultaneously impacting the Tanzanian economy through an indirect effect on its tourism sector.

There is little doubt that tourism, the world's largest and most rapidly growing industry, will continue to affect Tanzania's water resources, with impacts on the poor that can be positive or negative depending on how the impacts are managed and the income from tourism is distributed. There is great scope for working in close partnership with the tourism industry to ensure that it is based on sustainable resource management and that it contributes both directly and indirectly to poverty reduction.

3.5 Integrated Water Resources Management

A World Bank report on Tanzania's water resources highlighted the paradox of the current situation: the existence of what it terms 'acute conflict' among water uses, such as irrigation, livestock, hydropower, and environmental needs, '*yet, many rivers, lakes and groundwaters remain under-developed or under-utilized*.' Added to this is the tendency to neglect the vital green water flows in water management. Addressing this complex situation through the full and sustainable development of available water resources, mediating between the interests of competing users, employing mechanisms to ensure maximum efficiency in utilization of the resource: these interconnected tasks are the aim of Integrated Water Resource Management (IWRM). To explore the role of IWRM in

[59] AfDB/OECD (2007). **African economic outlook 2004/2005: Tanzania**. www.oecd.org/dev/aeo
[60] Government of Tanzania (2004). **Economic survey 2004.** Planning Commission.
[61] Government of Tanzania (2006a). **Tanzanian figures 2005**. National Bureau of Statistics, Ministry of Planning, Economy, and Empowerment, June 2006.

promoting effective, efficient, and equitable water resource usage, two catchments are analyzed below: the Pangani river basin in northern Tanzania, and the Mkoji sub catchment of the Rufiji river basin in central Tanzania. Both of these areas have demand from multiple users (domestic water for basic human needs; ecosystem goods and services for livelihoods; irrigation; and hydropower) and both have evidence of detrimental impacts from insufficient environmental flows in the past.

Pangani Basin

The Pangani River basin is located in the northeastern corner of Tanzania, extending along the Kenyan border. The Pangani River is 500 km in length, and its basin covers a total of 43 650 km^2, 95% of which is located in Tanzania. The basin stretches over four Tanzanian administrative regions (Arusha, Kilimanjaro, Manyara and Tanga). The Pangani faces a number of threats from diverse sources; the major ones are given below in Box 6. Detrimental effects of inadequate environmental flows in the past include the drying up of parts of the Kirua Swamp and the problems with saltwater intrusion in the estuary; there may also have been some decline in farming and fisheries in the near-shore environment due to decreased flows of freshwater.

Box 6: Issues impacting water resource management in the Pangani basin

The following have been identified as areas of major concern regarding water resources management in the basin:

ISSUES	CAUSES
Threats to water supply	o Climate change o Forest degradation o Inefficient uses o Pollution
Increasing water demand	o Population o Economic growth
Power generation shortages	o Upstream water abstraction o Siltation of dams
Conflicts over water resources	o Different sectors o Upstream and downstream users
Environmental degradation	o Reduction in water flows
Insufficient funding	o Inadequate government funding o Lack of income from users
Cultural heterogeneity	o Diversity of users

Source: Pangani River Basin Management Project, 2005

The main uses of water in the basin[62] include:

(i) Domestic use, including a number of households that use the river itself directly as a source of water for drinking and bathing;

[62] PWBO/IUCN (2007). **Pangani river system: state of the basin report - 2007**. PWBO, Moshi, Tanzania and IUCN Eastern Africa Regional Program, Nairobi, Kenya, pp. 22-23.

(ii) Agriculture, with 80% of the basin's population relying either directly or indirectly on agriculture for their livelihoods;
(iii) Livestock, with most rural households keeping some livestock, including chickens, cattle, goats, and sheep;
(iv) Hydropower, with three stations located on the river;
(v) Mining, including extraction of tanzanite, phosphate, limestone, and gold; and
(vi) Other sectors, such as agro-processing (sisal, tanneries) and timber, paper products, chemicals, textiles, metal works and bottled water production.
(vii) Ecosystems maintenance in flows, quantity and quality for natural habitats

With these competing demands, the Pangani Basin Water Office (PBWO) classifies the basin as water-stressed.

To implement an IWRM approach, the PBWO has undertaken a series of studies to develop a comprehensive picture of the basin. The reports issued include aspects of hydrology; basin delineation; scenario selection, river health assessment, estuary health assessment, and socio-economic assessment. The PBWO has benefited from strong support from the international community in this endeavor, with financial support from IUCN's Water and Nature Initiative, UNDP, and the GEF, among others.

With the basin water usage patterns as a baseline, IWRM principles can be employed to ensure the most efficient, effective, and equitable allocations. This involves taking a holistic approach in evaluating the range of impacts resulting from water management decisions. For agriculture, for example, the returns on the use of traditional furrows versus more modernized irrigation techniques can be analyzed to determine how best to achieve water use efficiency gains in irrigation; however, this analysis must also take into account the fact that leakage from furrow systems that are conventionally seen as less efficient actually benefit additional users downstream, potentially meaning more gainers than losers than might be the case with more technologically-advanced non-leakage systems. Similarly, examining cultivation techniques in upstream areas can quantify the costs and benefits to downstream users, thus possibly suggesting the feasibility of a payment for environmental services scheme, which can not only serve as a mechanism for increasing options in the basin but also as a way to address poverty in the upland areas (a concept currently being explored by the IFAD-funded Green Water Credits project in the Tana river basin in neighbouring Kenya).

The analysis of agricultural patterns and the accompanying costs and benefits can then be weighed against other users. With cultivation taking place upstream from hydropower installations, the impact on hydroelectric generation is obvious. The costs to the economy of insecure power supplies, which discourage private investment, must be factored in, as well as the losses due to investment under-utilization, given the failure of the facilities to operate at installed capacity.

The IWRM process can act as a framework to enable cost-benefit beyond the conventional market pricing systems that may not accurately reflect values of environmental goods and services, especially for poor and resource–limited users. In

some cases, the value of environmental flows can be measured, such as in Table 5 above, which quantifies the values of these flows to households. In other areas, valuation may be more difficult: for example, what is the level of benefits derived from the ecosystem services of upper basin forest cover providing flood mitigation, and what would be the costs of replacing this service through other means? Similarly, the valuation of services provided by mangroves, which require freshwater flows, in providing flood protection must be determined, as well as the value of their filtering function in promoting healthy coral reefs, with accompanying benefits both in terms of biodiversity and in economic benefits through tourism.

By taking a holistic look at both total resources and demand across users, strategies to maximize water resources usage in the basin can be developed, thus deriving the most value across stakeholders. It also ensures that the specific needs and interests of the poor are recognised and that the poor themselves can be actively involved in the decision-making process.

The Pangani IWRM process is a direct effect of the enabling national policy framework discussed above, in which IWRM, greater stakeholder participation and actions to efficiently manage water resources are all identified as priority issues. The process could not have been initiated without the political willingness and understanding of water as an important aspect in development. The environmental flow approach endorsed in the Pangani IWRM process is stemming from the view that ensuring blue water flows between different stakeholders will be sufficient to have a solid and sound development strategy in the Pangani basin. By introducing a more holistic approach to land and water resources, other potential development strategies may be realised, shifting Pangani from a 'water stressed' situation to a 'water efficient' basin.

Rufiji Basin, Mkoji Sub Catchment

The Mkoji sub catchment of the Rufiji basin shares much of the same complex mix in terms of user demand and limited resource as outlined above for the Pangani. The IWRM approach followed the GWP (2000) for valuation of economic, social and environmental costs and benefits of water. Complementary to these were the sustainable-livelihoods analyses to ensure understanding of the underlying inter-linkages between resources use and demands with livelihoods. The IWRM process here has strongly advocated a participatory action research approach. Through different stakeholder consultations - in different steps - the main stakeholders were identified and consulted on issues on water as well as on the valuation of water provided goods and services. The Mkoji sub-catchment is divided into three main land use systems:

- The upper part with almost year-round agriculture, including supplementary irrigation systems of high value crops;
- The middle zone, dominated by paddy rice cultivation systems
- The lower zone, where livestock rearing is mixed with some rainfed agriculture.

There were clear differences in levels of poverty, with the upper location having approximately 50% of households classified as poor, the middle location with 75% poor households, and the lower location with 92%. The river has experienced decreased flow rates, in particular during dry seasons, largely due to irrigation expansion upstream.

Of great significance is the recognition in the IWRM process of the value of green water, i.e., the consumptive use of water for rainfed land use systems, in agriculture and natural vegetation. For example, by comparing water resources and water uses for different seasons (Figure 8), it emerged that water stress has both spatial and temporal dimensions. The temporal dimension is due to the rainfall patterns. During wet seasons, rainfall is usually abundant and water stress is more a spatial concern, i.e., reallocation between different spatial uses. During dry seasons, uses exceed rainfall, especially for the middle location, where mainly natural vegetation uses green water (supplied as residual soil moisture from the wet season). Conflicts between water users were mostly identified in dry seasons, when water stress was absolute, at the middle and lower locations; some of these disputes over water had to be settled in court.

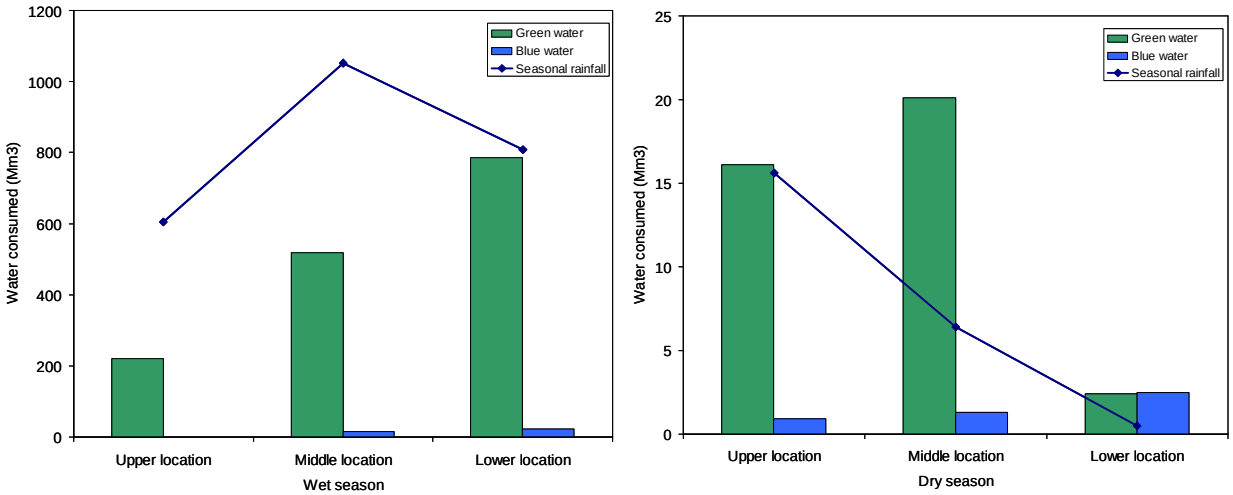


Figure 8: Green and blue water uses of rainfall during wet (left) and dry (right) season for upper, middle and lower locations in Mkoji sub-catchment
Note difference on Y axis scale in figures
Source: based on Hermans et al, 2006, Table 2, p. 20

Water as a means to livelihoods was estimated through stakeholder consultations and livelihood assessments. It emerged that in all three locations water is a fundamental production input supplying households with more than 90% of their income. Water was used both as blue water for irrigation, paddy and supplemental irrigation and livestock drinking, and as green water for rainfed (and paddy), as well as rainfed grazing and fodder production (Figure 9).

By considering green water values in the IWRM process, rainfed agriculture and livestock systems were also included and consulted in the process. Due to these inclusions, the dialogue and tradeoffs were more easily established in the stakeholder consortium. However, the issue of well-functioning institutions to govern and manage IWRM processes and continuous outcomes cannot be compensated for by well-functioning stakeholder consultations: both stakeholders and institutions are necessary to manage water resources efficiently for development,

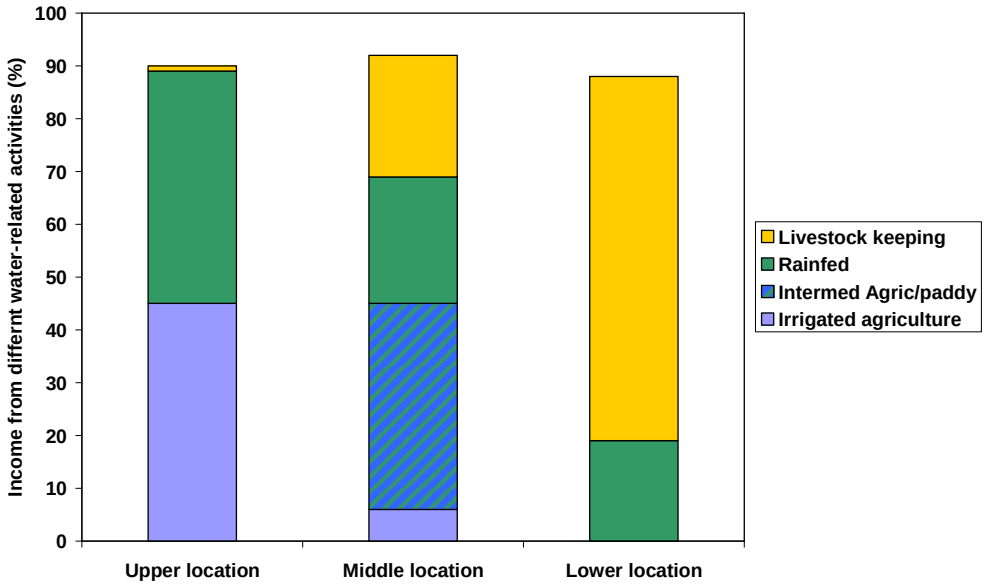


Figure 9: Dependence on water related activities for household incomes at upper, middle and lower locations of Mkoji catchment
Source: after data after Hermans et al., Table 4, p. 22.

4. CONCLUSIONS

The water sector in Tanzania is going through a period of profound and structural change, with new policies and strategies in key sectors such as water supply and sanitation and irrigation, a more coherent representation of water issues in the latest PRSP, a commitment to IWRM that is reflected in emerging processes in several basins, a commitment to generate higher levels of internal capital and engage the private sector and, not least in importance, a devolution of responsibilities for many aspects of water management to local government institutions and local communities.

These changes reflect wider reform processes, such as decentralisation and stimulating higher levels of private sector participation. There are still some structural problems not being addressed, with the institutional fragmentation of water across different ministries at the central level a particularly key issue. Despite this, the general setting for advancing

the links between water management and poverty reduction in Tanzania is favourable, and indeed to an extent is already happening (as reflected in the latest PRSP).

There are a number of strategic areas where these poverty-water links could be more effectively developed. The areas identified here reflect the strategic directions of change in Tanzania, with specific opportunities for advancing and directing the change process to more effectively target poverty reduction in different aspects of water management policies, strategies, institutional reforms and investment programmes.

Tanzania's commitment to the development of **IWRM** in all major river basins has been noted as an important process in the early stages of development. Progress in the basins where the process has started is encouraging, but further action is needed to ensure that the IWRM process must more effectively include **green water** in their analysis, water allocation and stakeholder consultation processes. There is the potential for further conflicts and the great danger that the needs and interests of the poor will not be adequately taken into account if this does not happen. A different but equally important issue is the need to understand and incorporate climate change adaptation into IWRM.

Agriculture is the most important strategic area for both water management and poverty reduction in Tanzania, representing both the main user of water and the key sector for the livelihoods of the majority of the poor. The analysis above noted the dominance of rainfed agriculture in Tanzania, with most of poor farmers likely to continue to be dependent on rainfall for the foreseeable future. The plans to expand the irrigated area are important for national food security and the economy as a whole, but few poor farmers will directly benefit from this expansion of irrigation. The key strategic areas for action in agriculture are consequently, firstly, to **improve on-farm water management in rainfed farming** and, secondly, improving water access and ecosystems management for **livestock rearing**, as it is these two areas where the greatest potential for improved livelihoods and food security amongst the rural poor lies.

There is an urgent need to place **sustainable sanitation** far more centrally in the planning and budget allocation processes. The sector policy framework does identify sanitation as a priority issue, but there are concerns over the level of understanding as to what constitutes improved and sustainable sanitation. Existing levels of funding and institutional commitment to sanitation are significantly below those needed to ensure a rapid increase in coverage in both urban and rural areas. Sanitation needs to move to the very top of the agenda, and requires far more effective institutional and political support than is presently found: in effect it needs champions who are prominent enough to mobilize the commitments needed to ensure that Tanzania's sanitation challenge is met.

Commitments to improved **water supply** provision are clearer, including at decentralized levels where strategic and planning decisions are increasingly made. There are still challenges in this field, the most important of which is **institutional capacities at decentralized levels** to ensure that local communities are aware of the full range of technology choices to meet their needs. This includes ensuring that all uses, including productive uses, are accounted for in technology choice and investment design. There is

also a need to provide more substantial support to small-scale private sector service providers, to develop more effective operation and maintenance systems and to ensure effective, pro-poor tariff systems are developed.

The need to ensure the long-term sustainability of many ecosystems in Tanzania for both the needs of the poor and overall economic development (for example, in relation to tourism) has been noted. The present situation is a matter of concern and effective, ecosystem-based approaches to combined land and water management are needed that go beyond traditional protected areas thinking to look at maintaining the integrity of water flows through the whole ecosystem. This issue includes integrating a better understanding of environmental goods and services into decision-making over investment priorities and resource management systems.

ACKNOWLEDGEMENTS

The authors would like to thank Evans Ntagwabira of AFDB's Tanzania Office for all the support and assistance he provided to make our mission successful. Further, we would like to offer our appreciation to Gabriel Saelie, Damas Shirima, W.K. Christian, A.K. Kigingi and Ali Nnunduma of the Ministry of Water, G. M. Kalinga of the Ministry of Agriculture, Food and Cooperatives, Dominick de Waal of WaterAid, Hamza Sadiki, Pangani Basin Water Officer, Anthony Massawe of DAWASA and Emanuel Macha and Jane Archard Lyanu of AWASA for all of their help in providing information and offering insights into different aspects of water development in Tanzania. Lastly, we wish to thank Erik Willis of SEI for his assistance with the report's graphics.

REFERENCES

AsDB, CIDA, DANIDA, EC, GTZ, Irish Aid, IUCN, SEI, Sida, SIWI, SDC, UNDP, UNEP and WHO, 2006. Linking poverty reduction and water management. Poverty-Environment Partnership. UNDP, New York.

AfDB/OECD, 2007. African economic outlook 2004/2005: Tanzania. www.oecd.org/dev/aeo

Agrawala, S., Moehner, A., Hemp, A., van Aalst, M., Hitz, S., Smith, J.; Meena, H., Mwakifwamba, S.M., Hyera, T., and Mwaipopo, O.U., 2003. Development and climate change in Tanzania: focus on Mount Kilimanjaro. OECD, Paris.

Assay, P. et al., 2007. Environment at the heart of Tanzania's development: lessons from Tanzania's National Strategy for Growth and Reduction of Poverty – MKUKUTA. IIED, London.

AWASA, 2005. Implementation report on urban poor households identification to be provided with free water supply service in Arusha municipality. AWASA, Arusha.

Barron, J., Rockstrom, J., Hatibu, N., and Gichuki, F., 2003. Dry spell analysis and maize yields for two semi-arid locations in East Africa. Agr. For. Met. J. 117:23-37.

Bwalya, M. 2005. Soil and water conservation to conservation agriculture practices: Experiences and lessons from the efforts Eotulelo Farmer Field School, a community based organization. Sustainable Development Department, Food and agriculture Organization (FAO) http://www.fao.org/docrep/008/ag141e/AG141E00.htm#TOC

Development Partners Group, 2006. Tanzania Joint Program Document.

Enfors. E., Gordon, L., 2007. Analyzing resilience in dryland agro-ecosystems: Analysing resilience in dryland agro-ecosystems: a case study of the Makanya catchment in Tanzania over the past 50 years. Land Degradation and Development (in press)

ESI Africa, 2006. The power sector in Tanzania. Issue 2, 2006.

FAO AQUASTAT, 2005. Irrigation in Africa in figures – AQUASTAT Survey 2005, United Republic of Tanzania. http://www.fao.org/AG/aGL/aglw/aquastat/countries/tanzania/index.stm. Accessed on June 2007.

FAOSTAT, 2007. Food balance sheets. www.fao.org. Accessed June 2007.

Government of Tanzania, 2006a. Tanzanian figures 2005. National Bureau of Statistics, Ministry of Planning, Economy, and Empowerment, June 2006.

Government of Tanzania, 2006b. Water Sector Development Programme, 2006-2025. Ministry of Water, Government of Tanzania, November 2006.

Government of Tanzania, 2005. National Strategy for Growth and Poverty Reduction. Vice President's Office, Government of Tanzania, Dar es Salaam.

Government of Tanzania, 2004. Economic survey 2004. Planning Commission, Government of Tanzania.

Government of Tanzania, 2003. Study on Irrigation Master Plan. Government of Tanzania, Ministry of Agriculture and Food Security, Dar es Salaam.

Government of Tanzania, 2002a. 2002 Census. http://www.tanzania.go.tz/census/

Government of Tanzania, 2002b. Water Policy. Government of Tanzania, Ministry of Agriculture and Food Security, Dar es Salaam.

Government of Tanzania, 2001. Agricultural Sector Development Strategy. Government of Tanzania, Ministry of Agriculture and Food Security, Dar es Salaam.

Hatibu, N.; E.A. Lazaro; H.F. Mahoo; F.B. Rwehumbiza and A.M. Bakari (1999). Soil and Water Conservation in Semi-Arid Areas of Tanzania: National Policies and local practices. Tanzania Journal of Agricultural Sciences Vol. 2 (2): 151 – 170.

Hesselbarth, S.and D. Mashauri, 2006. Situation Analysis of the Water Sector in Tanzania. Government of Tanzania, Dar es Salaam.

Hermans, L., Renault, D., Emerton, L., Perrot-Maître, D., Nguyen-Khoa, S., and Smith, L., 2006. Stakeholder-oriented valuation to support water resources management processes. FAO, Rome.

Kjellén, M., 2006. From public pipes to private hands: water access and distribution in Dar es Salaam, Tanzania. Stockholm University, Stockholm.

Mdemu, M. and Magayane, M., 2005. Conflict of water use between hydropower and irrigation in Tanzania: the conundrum of sectoral policy approaches to water resources development. Center for Development Research, Bonn, Germany.

Ndege, M., 2007. Strain, water demand, and supply directions in the most stressed water systems of eastern Africa. http://www.idrc.ca/en/ev-31143-201-1-DO_TOPIC.html .

Noble, A. D., D. A. Bossio, F. W. T. Penning de Vries, J. Pretty and T. M. Thiyagarajan, 2006. Intensifying Agricultural Sustainability: An Analysis of Impacts and Drivers in the Development of 'Bright Spots'. Comprehensive Assessment Research Report No. 13, Comprehensive Assessment Secretariat, Colombo, Sri Lanka. http://www.iwmi.cgiar.org/assessment/files_new/publications/CA%20Research%20Reports/CARR13.pdf

Pangani River Basin Management Project, 2005. Maximising the economic value of water resources. Policy briefs for water management, Pangani River Basin, Tanzania, Issue No. 1, March 2005. www.panganibasin.com

PWBO/IUCN, 2007. Pangani river system: state of the basin report - 2007. PWBO, Moshi, Tanzania and IUCN Eastern Africa Regional Program, Nairobi, Kenya

Rockström, J., Hatibu, N., Oweis, T, Wani, S., Barron, J., Bruggeman, A., Farahani, J., Karlberg, L., Quiang, Z., 2007. Managing water in rainfed agriculture. Chapter 8 in "*Water for food, water for life: a comprehensive assessment of water management in agriculture*". International Water Management Institute (IWMI), Sri Lanka. (http://www.iwmi.cgiar.org/assessment/index.htm)

Rockström, J., Kaumbutho, P., Mwalley, J., Nzabi, A.W., Temesgen, M., Mawenya, L., Barron, J., Mutua, J.,Damgaard-Larsen, S., 2007. Conservation Farming Strategies in East and Southern Africa: Yields and Rain Water Productivity from On-Farm Action Research. Soil and Tillage Research (in press).

SIWI/UN Millenium Task Force on Water and Sanitation, 2005. Health, Dignity, and Development: What Will It Take? SIWI, Stockholm.

UN Millennium Project, 2004. "Millennium Development Goals Needs Assessments for Ghana, Tanzania, and Uganda". Background paper.

UNESCO, 2005. Water: a shared responsibility. UN World Water Development Report 2. UNESCO, Paris

UNDP, 2006. Human Development Report 2006. UNDP, New York.

D. de Waal and D. Nkongo, 2005. $2 Billion dollars – the cost of water and sanitation millennium development targets for Tanzania. WaterAid, London.

WaterAid, 2005. Water and sanitation in Tanzania: an update based on the 2002 Population and Housing Census. WaterAid, London.

WHO, 2007. WHO Statistical Information Service. http://www.who.int/whosis/database/core . Accessed June 2007

WHO, 2006. Meeting the MDG drinking water and sanitation target: the urban and rural challenge of the decade. WHO, Geneva

World Bank, 2007. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/TANZANIAEXTN/0,,menuPK:287361~pagePK:141132~piPK:141109~theSitePK:258799,00.html . Accessed June 2007.

World Bank, 2006. Water resources in Tanzania: sustainable development of Tanzania's water resources. www.worldbank.org. Accessed in June 2007.

World Bank, 2004. Environment at a glance 2004: Tanzania. World Bank, Washington, DC.

WSP, 2006. Getting Africa on track to meet the MDGs on water and sanitation: a status overview of sixteen African countries. WSP-Africa, Nairobi.

ANNEX: PERSONS CONSULTED IN TANZANIA

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