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Conflict of water use between hydropower and irrigation in Tanzania: the conundrum of sectoral policy approaches to water resources development

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Abstract

More than 80% of the Tanzania's population is employed by agriculture, largely more than 95% being on smallholder scales. Currently out of 1 million ha of irrigable land, only 25% of the area is under irrigation, fully or supplemental. On the other hand about 69% of the electrical energy in the national grid is hydropower. Two large power sytems, Mtera-Kidatu in Rufiji basin and Nyumba ya Mungu-Hale-New Pangani Falls (NYM-H-NPF) in Pangani basin are located downstream the irrigation schemes. In the past 14 years there have been uprising conflicts over water between irrigation in upstream and hydropower in the downstream with heavy accusation for over-abstraction of water by smallholders to meet irrigation expansion. Contemporarily, Tanzania views irrigated agriculture as one of the most important strategies for attaining food security and poverty reduction as elaborated in country's poverty reduction strategy paper (PRSP). Indeed the challenge is attaining such a poverty reduction strategy in a non harmonized sectoral water related development that eventually feed into the PRSP. This paper critically discusses the problems of water use as a result of policy oriented sectoral development approaches with reference to hydropower and agriculture sectors in the Rufiji and Pangani basins in Tanzania. An approach for linking water related developments that impact other sectors within the environment of integrated water resources management (IWRM) is explored and suggested.

Keywords: agriculture, irrigation, hydropower, water use conflicts, food security, poverty reduction, integrated water resources management.

Introduction

Irrigation is viewed as one of the important sectors towards improving food security and poverty reduction among rural communities in Tanzania (NAP, 1997). Irrigation contributes into agriculture sector which employs more than 80% of the countries population and contributes about 65% of export revenue generation (Semboja and Wangwe, 1995). However, the sector growth has not been satisfactory and irrigation development, an important aspect of agricultural development strategy, has been stagnating in the last decade. Agriculture grew by 3.7 percent on average for the last ten years (Keenja, 2004). This is about 6.3 percent less to the required growth rate of 10 to 11% for the sector to enable the country attain economic growth, food security and poverty reduction by 2010. Apart from other reasons for the poor growth in agriculture, unreliable weather plays a major role making irrigation a *sine qua non* to gap fill rainfall dependent agricultural production. Contemporarily, less than 25% out of one million ha of irrigable land is under fully or supplemental irrigation.

Hydropower is one of the important engines for the countries economic growth. About 69% of the electric energy in the national electric grid is hydro. In spite of the fact that electric and coal energy all combined together forms only 1% of the total energy demand, of which about 92% is met from fuel wood and 8% from petroleum (Kahumba, 2003), the protection of major hydropower plants in Rufiji and Pangani basins is necessary because of the unlikely future funding of similar hydropower projects of such magnitude. The three decades it has taken to develop 561MW (Kahumba, 2003) of hydropower in the two major river basins is a proof of unlikely immediate development of large hydropower schemes in near future. However, the developed capacity is only about 12% of the country's hydropower potential of

about 4500MW[1] (Wangwe and Semboja, 1995; Kitova, 2001). Realisation of such potential would allow the country to meet growing energy demand beyond 2025. While it is unthinkable toward realisation of such immense potential, existing hydropower generating facilities have been poorly performing in the last decade due to unreliable rainfall. The hydroelectric power (HEP) systems being downstream irrigated farms, water shortages in HEP storage dams has been a strong source of competition with no amicable solution between the two sectors. There is a strong likelihood of such conflicts being avoided during planning of water related development projects in the river basins. This is because most of the water related development projects were implemented either based on sectoral, regional or district interests with no due consideration to other sectors and associated future impacts. The current water policy has identified this gap and seeks to address cross-sectoral interests in water, watershed management and integrated and participatory approaches for water resources planning, development and management. Also the policy lays a foundation for sustainable development and management of water resources in the changing roles of the government from service provider to that of coordination, policy and guidelines formulation, and regulation (URT, 2002). However, for such policy to be pragmatic, institutional legal framework need to be in place to enforce the policy. While conflicts between irrigation and HEP have been widely discussed, the impacts associated with such conflicts have not been well explored in the past (Kashaigili et al., 2003; Maganga et al., 2004).

This paper discusses the problems of water use by reviewing the impacts of sectoral approaches in water resources related development projects in river basins. It draws an example from Rufiji and Pangani basins where large irrigated area and major hydropower

[1] Wangwe and Semboja (1995) and Kitva (2001) indicate hydro potential for the country to be 4500MW while Kahumba (2003) shows the potential to be 3800MW. Recent hydropower developments, including New Pangani Falls (68MW) and Kihansi hydropower (180MW) increased installed capacity from 313MW to 561MW in the last 10 years. If that remain to be the current state of developed hydropower then remaining potential for hydropower development would be 3939MW.

generating facilities are located. An approach for linking of river basin development projects into river basin IWRM is outlined. The paper is divided into eight sections. Section two describes the two case river basins followed by the description of river basin water resources management institutions in section three. Section four is about the conflicts over water use in the river basins narrowed to irrigation and hydropower. Section five describes the conflicting policies in river basin water resources management. The conflicting policies are supported by the description of impacts of such development policies in relation to irrigation and hydropower in section six. Finally section seven suggests an approach to linking development activities in IWRM in river basins followed by concluding remarks in section eight.

Architecture of the river basins

Rufiji basin

The Rufiji river basin is the largest river basin in Tanzania draining an area of about 177,000 km^2 and is located between latitudes $5^0$35' and $10^0$45' South and longitudes $33^0$55' and $39^0$25' east. The basin receives annual rainfall of about 600mm to above 1400mm in dry lowland and mountainous areas respectively. Two major rivers drain the basin, the Great Ruaha River (GRR) and Kilombero River. The GRR originates from a number of large and small streams at the northern slopes of the Poroto and Kipengere mountains in the southern highlands between Mbeya and Iringa. It flows to the Usangu plain where several other rivers flowing from the highlands join it; namely Mbarali, Kimani Chimala and Madibira whereas the small ones include Umrobo, Mkoji, Lunwa, Mlomboji, Ipatagwa, Mambi and Mswiswi rivers. The Kilombero River originates from three main tributaries; the Ruhudji, Mpanga and Kihanzi rivers. The Kilombero River joins into Luwegu River to form the Rufiji River. In the Usangu plains the GRR supply water to about 40,000ha of large and smallholder rice irrigated farms in the flood plains during the rain season and more than 2,500ha of

smallholder dry season irrigated crops in the upper reaches of the flood plains. From the flood plains the rivers recollects into a number of seasonal and permanent wetlands forming a perennial wetland at Ihefu. The rivers emerge through a rock outcrop into a single channel which flows into the Ruaha National Park (RNP) providing the main water source to the park. As the GRR flows down, it is joined by Little Ruaha River before being joined by the Kisigo River and then it flows into Mtera reservoir (3,200km^2 surface area), which has installed HEP capacity of 80MW and is used to regulate water supply downstream to Kidatu hydropower station. As the river flows downstream the Mtera dam, on the way it is joined by the Lukosi and Yovi rivers before flowing westward to the Kidatu reservoir (1km^2 surface area), with installed HEP capacity of 204MW. From Kidatu dam the river flows to Kilombero plains before joining the Rufiji River, just above the greatest HEP potential of Steigler's gorge, collecting *en route* the Kitete and Sanje rivers into the Indian Ocean (Sokile and Mwaluvanda, 2005).

Pangani basin

The Pangani river basin covers an area of 42,000 km^2 and is located between latitudes 3^{0}00' and 5^{0}36'south and longitudes 36^{0}38' and 39^{0}00'east. About 50% of the basin receives rainfall ranging from 500-600mm per year between November-December and March-May of between 1000-2600mm. The catchment area generates about 1830MCM per year. The Pangani River itself has two main tributaries, both of which rise in the basin's northernmost portions. The first of these, the Kikuletwa, rises on the slopes of Mount Meru and the southern slopes of Mount Kilimanjaro, while the second, Ruvu, rises on the eastern slopes of Mtount Kilimanjaro and Lake Jipe. Other tributaries to the river include Weruweru, Rau and Kikafu. These rivers join at Nyumba ya Mungu, a reservoir of some 140 km^2 (Røhr and Killingtveit, 2002 as cited by IUCN, 2003). It is estimated that a total area of about 29, 000ha

is irrigated by smallholder and large schemes upstream of Nyumba ya Mungu reservoir. Downstream the reservoir, the Pangani River flows into a flat and dry Maasai plains and is joined by Mkomazi in the south pare and Western Usambara Mountains at Korogwe and further East is joined by Luengera River. The Pangani River passes into Hale and New Pangani Falls generating 21 and 68MWs of HEP's before entering the Indian Ocean at Pangani town (Mtalo and Kilingtveit, 2003).

River basin water resource management institutions

Since 1994 water resources in river basins is under the River Basin Water Offices (RBWOs). This was an outcome of the 1981 amendment No. 10 of the Water Utilization (Control and Regulation) Act No. 42 that devolved the responsibility of water management to the basin level and nine basins were formed as result (Figure 1), Rufiji and Pangani being among the nine basins. The Pangani and Rufiji RBWOs became operational from 1991 and 1993 respectively. The major management functionalities of the RBWOs which are also responsible to river basin boards are to oversee all matters concerning development, management and regulation of water resources in the basin. These include among others to monitor the available water resources in the basin using existing hydrometric network stations and installation of new ones where necessary; regulation of existing and issuing of new water right permits for water abstractions; issue, administer and collect the water abstraction fees associated with the issued water rights; mediating and resolving water conflicts within the basin; and conducting research in collaboration with research partners in basin water resources. In spite of the fact that in Tanzania two sources of management occur for water resources; the central government and that provided by regional government, the RBWOs cater a basin-wide approach cutting across different administrative regions.

However, practical planning of water resources takes place at four levels: National; basin; district; and community or user level (URT, 2002).

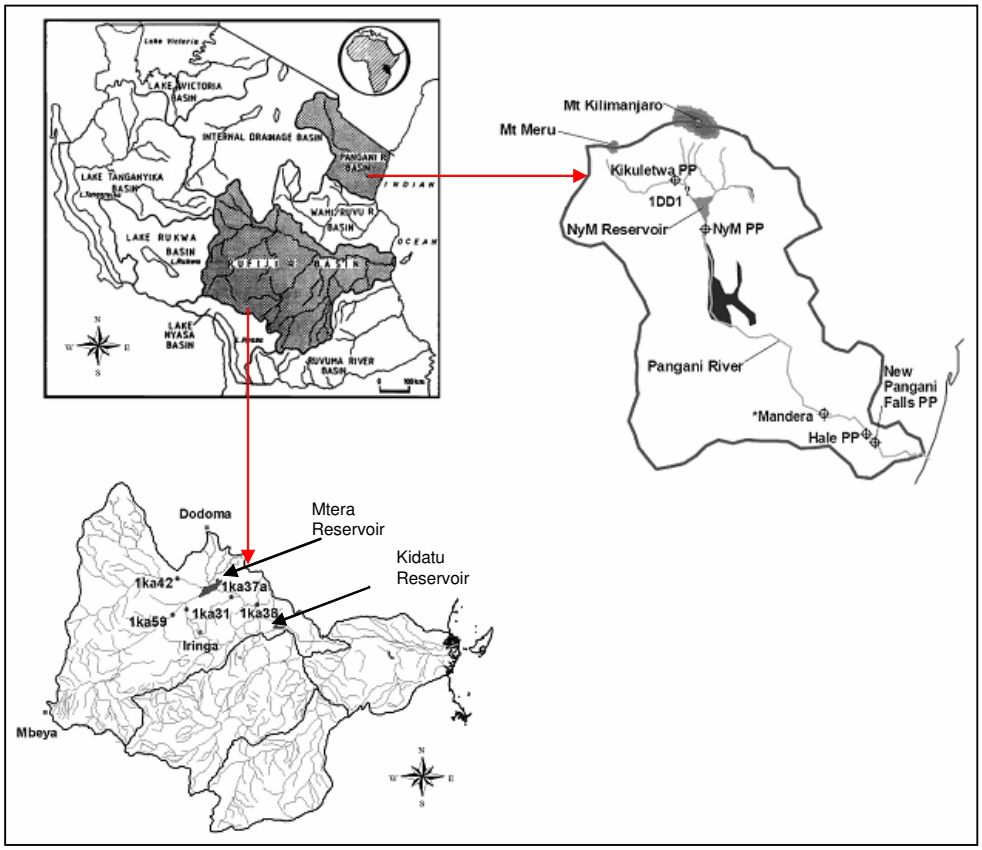

Figure 1: Rufiji and Pangani river basins (adapted from Maganga et al., 2004, Yawson et al., 2003 and Rohør and Cllingtveit, 2003)

Within the basin, lower management units of water resources are mainly water user associations (WUAs) which are organized in water catchments and are responsible for managing allocation of water resources at local level, managing equitable allocation of resources during drought, and mediating local disputes (URT, 2004). The advantage of WUAs is the improved coordination between water users and basin water officers as compared to coordination with respect to individual water users. Apex Water Bodies (AWB) in water catchments is the anticipated culmination of current WUAs. The AWB as a

federation of the lower level WUAs, will be charged with responsibilities in the basin such as: the implementation of rotation schedules and water distribution plans in the catchments along its streams and rivers, and among its WUAs; planning and development of land and water use in the catchments, particularly with regard to better use and regulation of its scarce water resources (Sokile and Mwaluvanda, 2005). The Mkoji sub-catchment in the upper parts of GRR sub-catchment is a pioneered case of an Apex Body within the Rufiji basin and if successful it will be implemented to other river basins in Tanzania including the Pangani basin.

Conflicts of water use in Rufiji and Pangani basins

Rufiji and Pangani river basins have a more similar typology of water uses. In Rufiji basin five major water uses are conspicuous (Lankford and Franks, 2000): (i) rainfed and domestic uses in the slopping upper catchments of GRR sub-catchments; (ii) paddy irrigation in flooded areas of Usangu plains; livestock in the *mbuga* (flat) grassland of the Usangu plains; (iii) river-line wetlands; (iv) Ruaha National Park; and (v) Hydropower in Mtera- Kidatu system. Similarly, water resources in the Pangani basin need to balance competing users for: (i) coffee and banana cultivation on the slopes of Kilimanjaro and Meru mountains (ii) water requirement in the lowland paddy farms; (iii) exported flower cultivation around Arusha town; (iv) further downstream water is required in hydropower plants at NYM-H-NPF to generate electricity for various needs, including several industries in Arusha and Moshi towns (IUCN, 2003). As a consequence of these competing needs, sectoral water demands are not being met, water levels in storage reservoirs have gone down, and competition for water between farmers and hydro-power generators and between groups of farmers has intensified (IUCN, 2003). The competition for water among sectors poses serious challenges particularly when population and economic growth increases. Aggravated by sectoral planning and

development, these competitions are source of conflicts over water use in river basins. Apart from other inter and intra-sectoral conflicts existent in the basins, the conflicts between irrigation and hydropower production are of particular interest in this paper.

Hydropower generation being downstream in both river basins, increased upstream water use particularly irrigation have been a source of tension for water use conflicts. While irrigated agriculture is important for supporting rural livelihood of people, poverty reduction and improving household's food security as articulated by the nation's agriculture sector development policy and PRSP (URT, 1997 & 2000), hydropower is an engine to economical development especially in urban areas. Due to increasing population growth, expansion in irrigated land has been a necessity to abate rising food demands. For example in the upper catchments of the Rufiji basin in Usangu plains irrigated area increased from about 100 ha in 1930 to about 40,000ha in 1999 (Franks, et al., 2004) to support about 30,000 households which directly depend on rice farming and more than 500,000 people who depend indirectly on the natural resource base of the plains. Such expansion of more than ten percent yearly increase on average means increased water need for irrigation from limited available water resources. Rising water demands for irrigation in Usangu has been substantiated as a prime cause of drying up of the GRR yearly in the period between September and January since 1994 (SMUWC, 2001). During that same period Tanzania experienced a crisis of insufficient power supply in cities and towns and power rationing had to be instituted between 1994 and 2000. Arguably in such contexts irrigation expansion significantly impacted on downstream flows especially during the dry season. The coincidence between the start of GRR flow cessation and the opening of large National Agriculture Food Co-operation (NAFCO) irrigation scheme in Kapunga is taken as an evidence of lower water yield downstream of the irrigation schemes on account of expanding irrigated land (Lankford and Franks, 2000;

Sokile et al., 2003; SMUWC, 2001). However, in spite of all these facts on the impact of irrigation development to downstream river flows, there is also an evidence of mismanagement of the hydropower reservoirs by unnecessary spills of Mtera dam between 1991 and 1992 to cater hydropower generation in Kidatu station (Yawson et al., 2003). The Mtera reservoir being designed to store runoff during the rain season and release regularly collected runoff to Kidatu for hydropower production, rainfall shortage during 1993/94 season failed to generate sufficient flows to refill the reservoir to full supply water levels to meet power production in subsequent months during the dry season. Therefore, factually, irrigation upstream of hydropower is not the only cause of reduced water levels in the dams as other factors such as drought and poor operation of Mtera reservoir played a role (Maganga et al., 2004). However, continuous flows of the rivers during the dry season to a certain extent could have minimized the problem of electric power shortage.

Conflicting policies in river basin water resources development

Most of the conflicts over water resources use in river basins are a result of uncoordinated efforts in planning and development of water resources related projects. The development of water resources related projects has been pursued sectorally, regionally or on district basis. The new water policy (URT, 2002) identifies previous uncoordinated effort among sectors as the main cause of conflicts over water use in the last two decades. In 1975 for example the Government through a parliament act established the Rufiji Basin Development Authority (RUBADA) charged primarily with multi-sectoral water resources development such as hydropower, irrigation, and water supplies throughout the Rufiji basin. Its role was not specifically to manage the water resources of the Rufiji basin (SMUWC, 2001). Since its inception RUBADA functioned only in one basin, water related developments in other river basins including the Pangani remained on the hands of different sectors and ministries

responsible for such specific development and the ministry of water (Sokile et al., 2003). In spite of the fact that RUBADA is still surviving, it has remained potent because the RBWO is the most conspicuous river basin institution although it is not known which of the two bodies have authority over the other (Sokile et al., 2003).

From the perspectives of integrated water resources management (IWRM) in river basins, the institutions that are involved in water management are loosely connected and lack basic coordination (Sokile et al. 2003; URT, 2004; Kashaigili et al., 2003). Such lack of coordination is evidenced from a number of water related river basin developments (Table 1) implemented and coordinated by different institutions with no clear linkage between them. For example while water supply is under the regional urban and district water supply agencies, irrigation is under the Ministry of Agriculture and Food Security (MAFS), and hydropower is under Tanzania Electric Supply Company (TANESCO) in the Ministry of Energy and Minerals with almost lack of coordination between them (DANIDA/ World Bank, 1995). Similarly, while the ministry of Natural Resources and Tourism (MNRT) is responsible for the conservation of biodiversity in water bodies, it is the regional planning authority of the Ministry of Planning and Development which oversees construction of facilities and hotels along the shorelines of lakes, rivers, islands and oceans (Sokile et al., 2003). This is contradicting as river basins cuts across various administrative boundaries and any development of water resources in river basin need to take into account the trans-regional nature of most river basins.

Table 1: River basin water related development sectors

Water related development sector	Hardware institutions	Ministry
Irrigation scheme construction	Zonal irrigation office and Irrigation division	MAFS
Domestic and Industrial water supply for towns and cities	Municipalities, Regional and District water supply agencies (Urban water supply and sewerage authorities)	MoWLD
Livestock drinking water supply	Livestock department	MoWLD
Fishery in rivers and wetlands	Fishery and wetland departments	Ministry of Natural resources and Tourism (MNRST)
Protected National Parks and Game Reserves	Tanzania National Parks (TANAPA) and Wildlife Department	MNRST
Hydropower development	TANESCO	Ministry of Energy and minerals
Forests in river catchments	Forestry Department	MNRST
Rural domestic water supply	Rural water supply and sanitation department	MoWLD
Biodiversity conservation in water bodies	Wetlands Division	MNRST
Recreational facilities and hotels along the shorelines of lakes, islands, rivers and oceans	National/Regional Planning Authority	Planning and Development

With regards to conflicting policies between hydropower and irrigation; the National Water Policy contemporarily stands to harmonize the other two national policies, agriculture and energy. However, such mediating role would be difficult to realize because of lack of legal framework to enforce the policy. The national water sector development strategy (NWSDS) circulated recently and the national water acts to be tabled in the parliament in the year 2005 will pave a way towards legal framework for the national water policy (NAWAPO). Despite

the fact that different sectoral policies are designed in line with the national medium and long term development goals, revision of different national policies at the same time could harmonize development goals articulated in policy documents to enable them cope with current pace of economic development of the nation.

While planning and management of river basin water resources would now have to rely on the new water policy (URT, 2002), the sister policies of agriculture and energy were lastly reviewed in 1997 and 1992 respectively. Such a non parallel review of core national developmental policies drag-feet implementation of IWRM because when such policies were formulated the country somehow theoretically pursued socialist economies making them difficult to achieve under the new liberal economic system. In the current economic transformations where investments in various sectors including agriculture and energy are passed to the private investors leaving the government with supervisory and regulatory framework, most small hydropower development projects to supply electric power to small agro-based industries identified in the energy policy would be difficult to come true. This is in spite of the understanding that agro-based industries provide a forward and backward linkage to smallholder farmers and for the nation to achieve poverty reduction through agriculture development, the two sectors have to be developed concurrently (Wangwe and Semboja, 1995). The conflicts in policies between agriculture and hydropower surfaces in spite of supportive statements for irrigation development articulated in the energy policy of 1992 to ensure availability of energy to smallholder irrigators in support of the national food self-sufficiency.

"Tanzania has an irrigable land of about 990,000[2] hectares but only 13.5% of this area is presently under irrigation. The National Food Self-sufficiency (NFS) programme envisages an average annual growth rate of irrigated land of 9.3%. Energy policy goals with respect to this endeavour will be to ensure that energy inputs in enough quantities at least cost are available to support irrigation. Attention will also be put to this availability of energy inputs to smallholder irrigation schemes (URT, 1992)".

Lack of coordinated planning of water resources related development led to development of large hydropower plants downstream potential irrigable areas, which by then was thought could be at the expense of individual smallholder farmers (URT, 2004) but turned to be at the expense of TANESCO and the government at large.

The conflicting developmental policies between agriculture and hydropower is traced back to 1980 when the Government commissioned the construction of Mtera dam and later in 1989 a generating turbine with 80MW capacity was installed. The then project financiers, Swedish International Development Agency (SIDA), had warned of any further development of irrigation schemes upstream of Mtera dam that could jeopardise power production in the Mtera/Kidatu system. On the contrary, earlier studies in the Rufiji basin such as FAO (1960) had even proposed construction of water reservoir upstream of Usangu irrigated flood plains. For unknown political and sectoral developmental reasons the storage dam was constructed downstream irrigation schemes. Because hydropower is virtually non consumptive user of water (except evaporation in storage reservoirs) construction of the dam upstream would enable released water from hydropower plant to be used for rice irrigation in Usangu plains facilitating a win-win situation for the two sectors. With irrigation intensification taking place in river basins due to its accorded importance for food security and poverty reduction (URT,

[2] Tanzania's potential irrigable area is about 1million ha. Currently 227486ha are under irrigation with a growth rate of about 5% between 1992 and 1999 and a growth rate of 44% between 1999 and 2004. An average growth rate of about 13% per year until 2017 is earmarked by MAFS (Keenja, 2004).

1997 & 2000) inter-sectoral planning of water resources development is prerequisite as elaborated by the current water policy. In particular it is necessary to recognise that water resource management and use is intimately linked to management of other resources such as land, and that there therefore needs to be a holistic approach to resource management within the basins (Franks, et al., 2004).These conflicting development policies did not spared the Pangani river basin where the Pangani falls, Hale, and Nyumba ya Mungu hydropower station are downstream irrigation farms with a storage reservoir at Nyumba ya Mungu.

The important role irrigation can play for food security, increased productivity and income of farmers, necessitated the formulation and adoption of National Irrigation Development plan (NIDP) by government between 1997 and 2004. The NIDP concentrates on removing constraints towards irrigation development of both large and small schemes; undertaking detailed irrigation master plan studies; and implementation of schemes along major river basins (URT, 1997). The policy statements on irrigation being very supportive towards supply side of large privately and smallholder irrigation schemes would have impact on water availability for other uses including for hydropower production and the environment in the Rufiji and Pangani basins. Sustainably use of water in irrigation is implicitly depicted through WUAs and WCs as emphasized in the policy statements (URT, 1997).

A number of initiatives for sustainable IWRM in the Rufiji and Pangani basins are being implemented to solve problems of water use. In particular, the River Basin Management and Smallholder Irrigation Improvement Programme (RBMSIIP) with the support from the World Bank was implemented in Rufiji and Pangani basins since 1996 (RBMSIIP, 1996). It is a significant programme for the instutionalisation process of river basin IWRM by providing a support to RBWOs and formation of WUAs. While noticed achievements has been registered

under the RBM component of the programme, improvement of water use efficiency targeting smallholder farmers, the main objective under SIIP component, has remained questionable (Lankford, 2004). In some of the schemes there has been an abuse of provided improved diversion structures by enabling farmers divert all river flows during dry seasons (Lankford and Mwaluvanda, 2005) and increased conflicts over water use. This explains the emphasis placed on supply side than water demand management during design of the program. It is therefore important for all the sectors to sit and plan together for any water development project that impact other water use sectors. This goes in hand with streamlining the institutional set-up of water resource management in river basins. Such institutional set-up and relevant devices for sustainable IWRM and conflict resolution in river basins are discussed in detail in Lankford et al., (2004); Sokile et al., (2003); Kashaigili et al. (2003); Maganga (2003) and Lankford and Mwaluvanda (2005).

Impacts of conflicts as result of competition between irrigation and hydropower

There is clear evidence that Mtera dam was designed for collecting and storing runoff during rain season for water release to Kidatu hydropower during subsequent period in the dry season (Machibya et al. 2003; Yawson et al., 2003). Similarly the Nyumba ya Mungu reservoir in the Pangani basin was constructed to cater water releases to Hale and NPF hydropower stations. Mismanagement of water by non adherence to water release policies for the reservoirs in the early ninety's coupled with drought in following years caused a remarkable drawdown of water to minimum supply levels (Yawson et al., 2003; Mtalo and Killingtveit 2003) which resulted into electric power shortages in the country. Reduction of water flows into the HEP generating plants for the last 14 years has been the center of conflict between irrigation and hydropower sectors in the country. Similarly notable impacts of the conflicts between these water use sectors have been observed. Irrigation which is

practiced in the upstream of the river basins takes the advantage of abundant land and water resources at the expense of downstream hydropower production. In the Pangani basin with total installed HEP capacity of 95MW, water shortages in the dry season may cause power generation to drop to as low as 32 MW (Sarmett and Kamugisha, 2002; cited in IUCN 2003). It is important to note that more than 50% of irrigated area upstream is operated by smallholder farmers with non forward-backward linkages to TANESCO. As the RBO's trying to institutionalize river basin water resources management by the introduction of water rights and payment of water use fees, smallholder farmers in the basins view basin management suspiciously, with many regarding it as an effort to safeguard TANESCO's interests in reserving sufficient water for hydropower (Maganga et al., 2004). This is because farmers do not see the incentives in allowing water to flow downstream for HEP production that would only be used to supply urban dwellers.

The impact of conflict to irrigation has influenced processes towards the sustainable management of water resources in the river basins. This is true especially aftermath local and national-wide concerns about the Usangu wetlands which first surfaced in 1995 when power had to be rationed due to low water levels at Mtera reservoir (Lankford and Franks, 2000). As a result a number of studies, particularly under SMUWC and RIPARWIN in the Rufiji basin and various projects under a collaborative research programme between University of Dar es Salaam (UDSM) and the Norwegian Technical University (NTU) on water management in the Pangani basin that have shed light among river basin water professionals on the understanding of the functionalities of irrigation in the river basins and associated hydrological impacts to downstream flows. There is now a greater support from local and international agencies such as WWF and IUCN in trying to utilize study findings for strengthening river basin management institutions to enable sustainable IWRM. Of particular

relevance is the formation of WUA's and apex bodies in water catchments to precisely manage available water supplies in river basin in the upper catchments of the Rufiji basin. The WUA's are anticipated to be financial autonomous in future that would provide supporting role to RBWOs, which are poorly staffed and also are short of financial resources (Sokile and Mwaluvanda 2005). WUA's is a desirable institution at grassroots that would have substantial contribution for increased water use efficiency along with other water management strategies due to the sense of ownership by water users imparted from their participation during WUAs formation.

Turning to HEP, abstraction for irrigation in the upstream of the basins have had serious consequences to TANESCO as the sole hydropower production and supply firm in the country. The fall of water level in Mtera dam was one of the factors for power rationing in the period between 1993 and 2000 with serious negative impacts on various important productive sectors in the country. It is during the period 1993/94 when the contribution of the energy and water supply sectors together to the GDP dropped by about 3% (Semboja and Wangwe 1995). Also unfavorable weather and erratic power supply were the main factors that contributed to the decline of the GDP from about 4% in 1993 to about 3% in 1994 (Semboja and Wangwe 1995). Manufacturing is another sector that was severely impacted by the problems of power supply. As a result of reduced hydropower generation, TANESCO had to shift into thermal energy in order to suppliment the hydropower demand in the country which as result increased the country's fuel importation bill due to higher prices of oil.

In trying to meet increasing power demand and avoid completely reliance on hydropower, the government with a financial support from the World Bank consolidated a thermo generating unit at Ubungo with 110MW and implemented the *Songo Songo* gas project to run a gas

turbines also located in Ubungo in Dar es Salaam which became operational in 2004. However the country suffered financial consequences in this transition period from completely hydropower dependent to hydro-thermo dependence firstly due to surging oil prices in the world market and secondly due to a controversial contract with the IPTL[3], a privately owned energy firm contracted to sell electric energy to TANESCO at exorbitant prices that would adversely impact the nation's economy. Despite the government and the International Commission for Sustainable Investment Development (ICSID) intervention on the controversy, the capacity charges of US$2.6 million per month TANESCO pays to the firm are still higher beyond reasonable doubts given the fact that during the same period of the controversy with the power utility firm, the government had to commit financial resources set aside for development of relatively economically viable energy supply from traditional sources such as the *Mnazi Bay* gas project to increase the capacity of gas driven generating plants. The committed financial resources include a World Bank grant of US$ 15 million provided to the government in 1992 to partly finance the development of *Mnazi Bay* gas project. The funds were used to buy the gas turbines that were installed at Ubungo in Dar es Salaam (Yona, 2004).

The ultimate effect of hydropower problems is a discouraging environment for private investments in some important economic sectors with direct impacts on the country's economic development. Private investors have been reluctant to invest due to higher power tariff charges as compared to neighbouring East African countries. While the energy sector

[3] IPTL is the Independent Power Tanzania Limited. It is a privately power firm with shareholders by Malaysian Mechmar company and VIP Engineering & Marketing Limited of Tanzania. The firm entered into agreement to sell thermo generated electric energy to TANESCO. Before completion of the construction of IPTL, TANESCO realised the charge for generated energy would be extremely expensive and would cause financial loss to TANESCO and the Nation. Having realized such shortfall, the Government suggested to TANESCO to take the dispute to ICSID which ruled in favour of TANESCO by reducing the capacity charge from US$4.5 million per month as demanded by IPTL to US$ 2.6 million per month and waiving out a compensation of more than US$ 53 million demanded by IPTL from accumulated charges from September 1998 to January 2002 when the firm started producing electricity (Yona, 2004).

policy encourages private energy investors, especially small HEP, un-guaranteed water supply hinder the implementation of energy-dependent development projects. Seemingly, such a challenge would be the major obstacle if existing TANESCO HEP facilities would have to go private. As a result of water shortages for example in the Pangani basin, electricity generation has to a greater extent continued to decline. In April 1999, the NPF facility generated 45 million kWh. In April, 2002, it generated 25 million kWh which is about 33% drop in three years time. This has a direct impact on investment attractiveness (IUCN, 2003).

Linking water resources development activities into IWRM in River basins

The major aim of IWRM is to ensure a coordinated development and management of water, land, and related resources by maximising economic and social welfare without compromising the sustainability of vital environmental systems (Rodgers et al., 1998). For the last two decades many governments globally embarked on implementing IWRM programs which are generically similar all over the world on major salient features for management of water at river basin level such as: management at the lowest appropriate level; demand-driven approaches; ownership and participation by all stakeholders; and promotion of knowledge and information exchange aimed at institutional sustainability and conflict prevention (Africa Water Task Force, 2002, cited in van Koppen, 2003). However, three important aspects make the implementation of IWRM in sub-Saharan Africa (SSA) different from elsewhere the world. Firstly Africa's relative abundance of water resources ,with the exception of North and South Africa, but its scarcity of economic means to harness available water resources; secondly the importance of agriculture and agricultural water development for economic growth and poverty eradication; and thirdly the need for systems of water rights and financial resource mobilization that are separated and suit the African

reality in which large water users are relatively few, while the bulk of water users are scattered smallholders (van Koppen, 2003).

Any implementation of IWRM in river basin need to understand such complex nature in SSA and has to integrate social, economic, environmental and institutional dimension as well. The interrelated dimensions of IWRM makes upstream environmental degradation affects downstream economic water use, institutional setting affects protection of basic needs of different groups in society, environment itself is also economically important for economic sector such as tourism. Equally important in IWRM is the dimension of space, time and nature of stakeholders (actors). These dimensions affects water needs and availability depending on location in the river basin, period in a year and different stakeholders involved. While some stakeholders such as water users would be involved because of their interests are affected, others such as government agencies and experts are involved because they control the means for management. However all the stakeholders in a river basin are interdependent because firstly water use of one actor affects available water quality and quantity for others; secondly what is good for one actor might be bad for another; and thirdly actors need each other to realise their objectives (no actor can realise its objectives without cooperation of some others). Such interdependency makes linking water related development activities into IWRM planning imperative. Such linking could be achieved through simple generic IWRM planning stages (Table 2) that can be operationalized into specific conditions of a river basin.

Table 2: Practical IWRM implementation in river basins

Stage		IWRM strategy
I	Inventory of current situation	The current affairs of water resources in a river basin such as available water resources, water uses and users is analysed by stakeholders. The analysis is tied with socio, economic, environmental and institutional dimensions of the river basin.
II	Development of problems and concerns	Stakeholders deliberate on main concerns affecting water management and use in a river basin by creating long lists of IWRM concerns and ranking them. Stakeholders can structure top most priorities into problem trees to facilitate cause and effect relationships and necessary concerted actions to solve the problems. Also stakeholders may select most promising actions from the problem trees.
III	Identification of implementation strategies	Based on the problem trees and the priority list of actions established, promising actions are combined into a strategy. For each of the selected actions an analysis of impacts and implementation aspects is done. Impacts can be reviewed by scoring with signs such as positive and negative to imply expected contributions from all actions on all sub systems.
IV	Implementation of actions of plans	For the implementation of actions, a large range of responsible actors is identified, ranging from local water users (such as farmers and livestock keepers), to district and national government agencies, international donors and NGOs. Voting may be done by stakeholders on the priority of actions for which various stakeholders have primary responsibility for implementation
V	Monitoring and evaluation	While monitoring and evaluation is effective once the actions of plans have been implemented, at this stage stakeholders can formulate a blue print on monitoring and evaluating different implemented IWRM action plans when comes in effect.

The first stage entails analysing the current situation of a river basin where river basin stakeholders make comprehensive assessment on concerns in the basin in relation to social, economic, environmental and institutional sub-systems of IWRM and the way such concerns are related to location, time and the stakeholders (actors) dimensions in the river basin. Once

the first step is complete the stakeholders move to a second stage of identifying IWRM planning concerns such as current and future necessary changes and categorisation of concerns in relation of basin water uses such as essential and priority concerns. After analysing the current situation and IWRM planning concerns identified, the river basin stakeholder move into the third stage of developing strategies to address identified concerns in the second stage of planning IWRM. During this stage stakeholders analyse anticipated impacts of proposed strategies to the different river basin subsystems and dimensions and how such impacts can be taken onboard during implementation of the strategies. The fourth stage involves implementation of actions where a range of responsible actors is identified to take part in the different strategies identified. Monitoring and evaluation as the last stage of IWRM planning in a river basin aims at scrutinising the impacts of actions implemented in relation to expected goals in the planning. The planning of IWRM is a continuous process where the later stage may initiate former stages if the outcomes of impacts of IWRM plan are not as anticipated initially. A similar iterations process is pertinent for the first three stages where the third stage feeds into the second and first stages and also the second stage has a feedback into the first stage. Planning of IWRM can be organised in a series of stakeholder's workshops involving all actors in a river basin.

Concluding remarks

It is unquestionable about the role irrigation will continue to play for food security and poverty reduction among smallholder farmers in the country. Supply of hydroelectric energy is also vital for creating forward and backward linkages between agriculture and agro-processing industries that can contribute to broad based economic growth of the nation. While population growth will increase demand in food and hence land and water resources, strategies for improved productivity of land and water resources have to be implemented in

river basins. Without such strategies it would be difficult to realize vast potentials available for irrigation and hydropower production in the basins. Similarly investment into renewable energy resources such as solar and wind energies in isolated rural areas could be a viable strategy toward meeting energy demand and conserving the environment. The huge potential for both agriculture and hydropower which are yet to be realized in the two basins makes harmonization of all water resources development into IWRM frameworks imperative where all the stakeholders in the river basins are involved at all stages of IWRM. Failures to integrate water resources development within IWRM will further exacerbate water use competition and conflicts with disastrous river basin water resources development than ever we experienced.

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