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Integrated water resource management as climate change adaptation strategy in the Great Ruaha river catchment of Tanzania

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This paper presents analysis of the impacts of climate change to the livelihoods of people and the importance of Integrated Water Resources Management approach as climate change adaptation strategies for the sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental objectives. The analysis was based on the study which was conducted in the Great Ruaha River Catchment. Both quantitative and qualitative methods were used for data collection and analysis. The analysis shows that, climate variability leads to changes in the quantity, timing, intensity and duration of rainfall contributing to water stress in many areas and making people more vulnerable. The analysis also shows that, water-related adaptation measures to climate change can be provided with the Integrated Water Resource Management (IWRM) for efficient, equitable and sustainable development and management of water resources and water demands.

Key words: Great Ruaha catchment, climate variability, integrated water resources management.

INTRODUCTION

Increasingly it is becoming recognised that water management requires an integrated approach, through integrated watershed management" which includes natural resource management along with social measures and infrastructure development (Galaz 2007; Kundzewicz et al., 2008; Bates et al., 2008). In principle, restoring and protecting freshwater habitats and watersheds and managing natural floodplains is a key element of such an approach (Glick et al., 2009).

Reduction of pressure on freshwater resources would be beneficial regardless of the scale of the future impact (Kundzewicz et al., 2008), whereas activities such as river regulation, wetland drainage, intensive agriculture, and deforestation degrade freshwater habitats and lower adaptive capacity (Krysanova et al., 2008).

It has been widely suggested that an ecosystem approach including wetland and floodplain management and restoration should not be viewed as an alternative to technological approaches such as reservoirs and irrigation systems, but as a complement to them (Mata & Budhooram 2007). However, there appears to be a lag between our understanding of interconnected freshwater resources and adaptation strategies implemented by policy makers (Galaz 2007). Watershed management should be planned according to local conditions. For example, planting of some tree species could have negative impacts on water flow in some areas (Bhandari et al., 2007).

In South Africa, Working for Water" programmes have been initiated to remove invasive tree species from water catchments where water-thirsty species have reduced the annual river flow by approximately 7% in South Africa (Mukheibir 2008). Similar impacts have been seen in China, where the monoculture tree species chosen for plantations were not suitable for the area (McVicar et al., 2007).

This paper therefore, presents the importance of Integrated Water Resource Management (IWRM) as climate change adaptation strategy in the Great Ruaha River Catchment (GRRC) a sub-basin of Rufiji basin. IWRM is an internationally accepted approach for efficient, equitable and sustainable development and management of water resources and water demands to ensure productive and healthy ecosystems by integrating social, economic, physical, and biological needs and values (GEF-ADB, 2006).

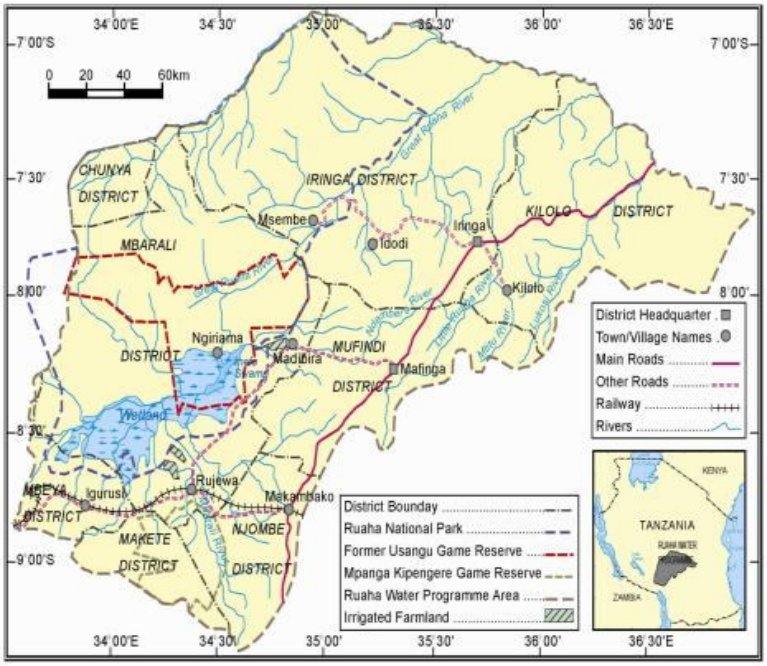


Figure 1. Locational map of study area.

METHODOLOGY

In view of the amount and the details of information required in a limited period of time the methodology was based on Participatory Rural Appraisal (PRA). Both quantitative and qualitative methods were used for data collection and analysis in the Great Ruaha River Catchment ((Theis and Grady, 1991; Kothari, 2004).

The Great Ruaha River originates from a number of large and small streams at the slopes of the Poroto Mountains and Kipengere range, Southeast of Mbeya from where the bulk of the flow is generated (Figure 1).

This is one of areas in Tanzania which have been impacted by climate change. The drying up of the river in Uporoto Mountains has potentially deleterious effects on the Great Ruaha River which arises in the highlands of the Usangu catchment, which is located in the rift valley in south-west Tanzania.

The waters of the Ruaha form a crucial input into the livelihoods of communities in the upper catchment as well as the lower catchment. The waters support in rice, vegetable production and livestock keeping. The wildlife habitats of Ruaha National Park and surrounding game reserves are dependent on the Ruaha River for their very survival. Furthermore, the waters of Ruaha flow into Mtera and Kidatu Dams, which produce a large proportion of electricity to the national grid. Further down the water is used for large-scale irrigation of various crops (sugar and rice) and for smallholder production of rice, maize and vegetables other products in the vast Kilombero Valley, a potential but still sleeping breadbasket for East Africa.

Various studies have indicated that the Great Ruaha River flow regime has changed significantly with time despite the fact that wet season flows show no long-term trend. The changes in the river hydrology are mainly dry-season flows which have been declining since the early 1970s. Part of the Great Ruaha River, between the perennial swamp (Ihefu) and the stretch through the Ruaha National Park has been drying up since early1990's. The declining and drying of the river had impacted on the biodiversity and other water uses. Drying up of Great Ruaha river has been attributed to unsustainable agricultural practices such as valley bottom cultivation and inefficient irrigation practices particularly in smallholder farms (URT, 2012).

Since climate variability adds to the existing water stresses and scarcity on the Great Ruaha ecosystem the study was based on the integrated ecosystem approach which is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The justification of using this approach was based on the fact that, the GRRC conveys the connectivity of "ecosystems" in the larger landscape.

Here land, water and other resources are the continuous variables that link through this landscape. Whatever happens to any one of these elements, in whatever part of the landscape, will affect it as well as other variables. The communities in this study area all depend on land, water, resources to live, produce goods and discharge wastes. However, the capacity of

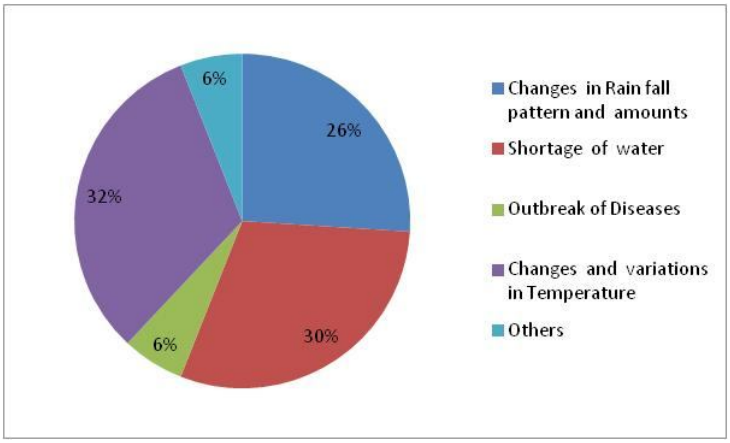


Figure 2. Climate Variability and Impacts.

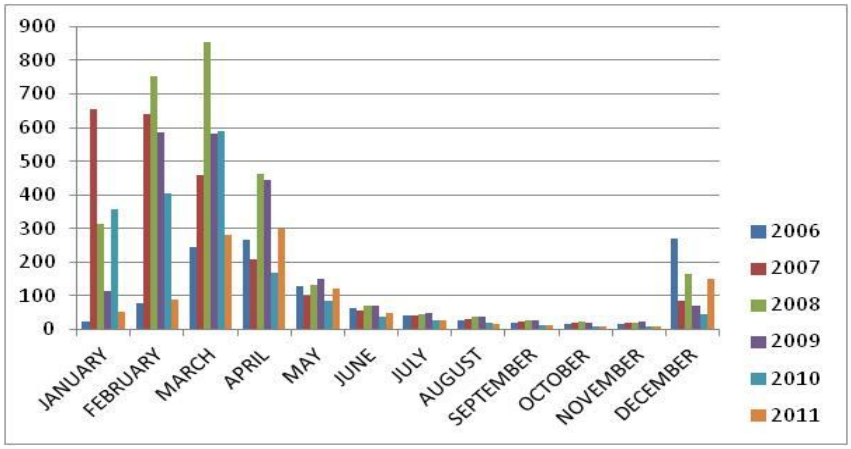


Figure 3. Monthly flows of Kimani river (2006-2011).

ecosystems to support life and process wastes must be maintained and preserved, or else there will occur serious problems that will be manifested in many ways e.g. shortage of water flows.

RESULTS AND DISCUSSION

Climate variability and impacts

Figure 2 shows local peoples' perception on impacts of climate variability in Kimani village. Most respondents (88%) reported that, climate variability is attributed to changes in rainfall patterns, shortage of water and temperature variations. It was noted that, changes in the quantity, timing, intensity and duration of rainfall contribute to water stress in many areas and making people more vulnerable. The rainfall variability corresponds to the stream flow patterns in the study area (Figure 3). The stream starts rising in November/December, experience a maximum flow in March-April and have their recession period from May to October/November.

Application of IWRM to sustain agricultural production

Agricultural Sector is the leading sector of the economy of Tanzania and accounts for over half of the GDP and export earnings. In the year 2002 the sector contributed about 48.2% of the GDP. Over 80% of the poor are in rural areas and their livelihood depends on agriculture. Moreover, about 82% of the population live and earn their living in rural areas with agriculture as the mainstay of their living. This implies that improvement in farm incomes of the majority of the rural population is a precondition for reduction of rural poverty in Tanzania.



(a). Flood Irrigation (b). Bottom Valley Cultivation
Figure 4. Small holder irrigated agriculture in Usangu Plains.

Main challenges in the study area include unsustainable agricultural practices such as valley bottom cultivation and inefficient irrigation practices particularly in smallholder farms (Figure 4).

To reduce the negative effects of traditional irrigation practices by improving irrigation efficiencies, various initiatives have been undertaken by the Government of Tanzania in collaboration by other development partners. But all these initiatives have not improved significantly water use efficiency at field level.

As results there water use conflicts among irrigators (upstream and downstream irrigators) and other water users (Wildlife, Energy) downstream of GRR. This calls for integrated planning so that water, land and other resources are utilised in a sustainable manner. For the agricultural sector IWRM seeks to increase water productivity (i.e. more crops per drop) within the constraints imposed by the economic, social and ecological context of a particular region or country. A major shift in focus under IWRM is the concept of demand management (i.e. managing water demand rather than simply looking for ways to increase supply).

Application of IWRM to sustain wildlife habitats in Ruaha National Park

The GRRC has many stakeholders who benefit from it but of late it has been facing resource use conflicts among its users. Among the silent users are the fauna and flora that is dependent of the water for survival. The drying up of the Great Ruaha River has been damaging the Ruaha ecosystem, disrupting the natural distribution and behaviour of wildlife between food and water which has, in turn, led to increased conflicts with local people in the unprotected areas outside the Park. In some dry season elephants could find water below the dry surface of the Ruaha river bed (as they do below sand rivers in the dry seasons).

This indicates the extent to which the entire water table has been falling. Overcrowding of hippo seeking refuge in the last remaining pools has predisposed them to infectious disease where fighting and mixing of different groups, together with the competition for limited resources, has increased their susceptibility to disease. Figure 5 shows how the river flows in Ruaha National has been declining.

Therefore, Ruaha ecosystems can benefit from applying an IWRM approach by giving environmental needs a voice in the water allocation debate. At present these needs are often not represented at the negotiating table. IWRM can assist the sector by raising awareness among other users of the needs of ecosystems and the benefits these generate for them. Often these are undervalued and not incorporated into planning and decision-making.

Application of IWRM to sustain inflows to Mtera hydropower systems

The drying up of GRR has had big impact on power



River flows in RNP during the wet season



River flows in RNP during the dry season

Figure 5(a). Drying up of Great Ruaha river in Ruaha National Park.

Figure 5(b). Visual flow chart at Msembe-RNP.

Year	**2001**						**2002**					
Flow												
Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	Total Rainfall=706mm, approximately 4 weeks of no flow. Highest flow February to April. Peak in March. Expansion of wet season irrigation in upstream.											
Year	**2002**						**2003**					
Flow												
Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	Total Rainfall=619mm, approximately 6 weeks of no flow. Highest flow January. Extremely poor flows											
Year	**2003**						**2004**					
Flow												
Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	Total Rainfall=532mm, approximately 15 weeks of no flow Highest flow April and May. Poor Flows											
Year	**2004**						**2005**					
Flow												
Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	Total Rainfall=574mm, approximately 5 weeks of no flow. Highest flow March and April.. Poor flows.											
Year	**2005**						**2006**					
Flow												
Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	Total Rainfall=555.5mm, approximately 14 weeks of no flow. Highest flow May.											
Year	**2006**						**2007**					
Flow												
Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	very heavy rain all season like el ninio approximately 4 weeks of no flow. Highest flow January to March good flows.											
Year	**2007**						**2008**					
Flow												
Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	Normal rainfall approximately 12 weeks of no flow. Highest flow March and April.											
Year	**2008**						**2009**					
Flow												
Month												
Remarks	Normal rainfall and better management upstream approximately 6 weeks of no flow Highest flow April.											
Year	**2009**						**2010**					
Flow												
Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	Normal rainfall however, river flowed all year due to good management up stream											
Year	**2010**						**2011**					
Flow												
Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Remarks	Longest no flow ever recorded river never had significant flow 19 weeks of no flow											

key:- Blue=flowing: red=dry: Black = Some weeks of no flows

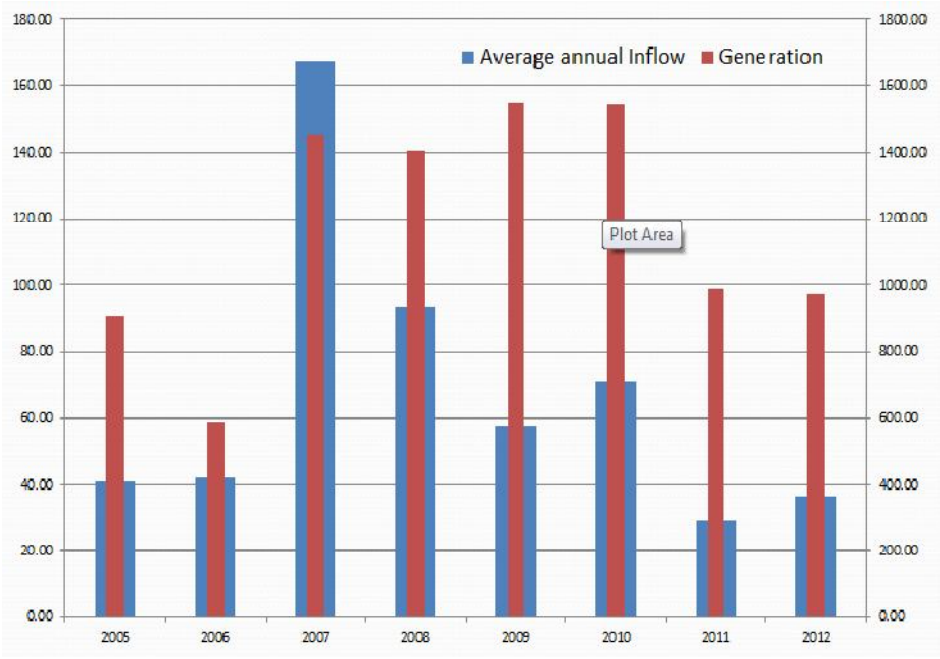


Figure 6. Correlation of inflows and power generation.

generation at both Mtera and Kidatu hydropower systems (Figure 6). This has resulted to power rationing and conflict between energy sector and other water user groups in upstream of Mtera reservoir. This implies that, greater integration in management of water resources may help to reduce conflict between water users by ensuring agreed efficiency of use in competing sectors.

Requirements for successful implementation of IWRM to sustain inflows

Water is vital for human survival, health and dignity and a fundamental resource for human development. The Great Ruaha water resources are under increasing pressure. Growth in population, increased economic activity and improved standards of living lead to increased competition for, and conflicts over, the limited freshwater resource. In order to sustain stream flows, the implementation of IWRM should comply to the following key requirements.

Stakeholder participation

Water is a subject in which everyone is a stakeholder. Real participation only takes place when stakeholders are part of the decision-making process. A participatory approach is the best means for achieving long-lasting consensus and common agreement. Participation is about taking responsibility, recognizing the effect of sectoral actions on other water users and biodiversity and accepting the need for change to improve the efficiency of water use and allow the sustainable development of the resource.

Socio-economic aspects of water

Water has a value as an economic good as well as a social good. Treating water as an economic good is an important means for decision making on the allocation of water between different water use sectors and between different uses within a sector. This is particularly important when extending supply is no longer a feasible option. In IWRM, economic valuation of alternative water uses gives decision makers important guides to investment priorities but it should not be the only consideration. Social goals are important too.

Conclusion

The Great Ruaha water resources are under increasing pressure due to increased economic activities requiring water as an input such as in hydropower generation, irrigated agriculture, tourism, wildlife activities. Water scarcity is perceived at many places due to climate variability and multiplicity of competing uses. Therefore, IWRM should be implemented for capturing society's views, reshaping planning processes, coordinating land and water resources management, recognizing water

quantity and quality linkages, conjunctive use of surface water and groundwater, protecting and restoring natural systems.

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