

Opportunities for Agricultural Water Management interventions in the Mkindo watershed in Tanzania

Key Findings

- The livelihood systems in the Mkindo watershed are very diverse, depending on water in different ways for irrigated- and rainfed agriculture and livestock keeping. Existing water management ranges from gravity based furrow system, to supplemental irrigation from rivers by manual lifting with buckets, to motorized pumps.
- There is a large amount of water flowing through the watershed, and rainfall is between 800-1200 mm y⁻¹ but management of water and access to water is not always equitable, so farmers and livestock keepers perceive there is a lack of water.
- Currently there is no organization that coordinates the various land and water related activities across the catchment.
- There are opportunities to improve livelihoods through agricultural water management (AWM) solutions, but some solutions may marginalize particular communities or livelihoods even further if the focus is on high-input technological interventions.
- A mix of solutions that cater for rainfed agriculture as well as irrigated agriculture for various livelihoods and locations will benefit more people.
- Most AWM solutions explored have potential positive social impacts, but environmental impacts may be more ambiguous.
- The overall impact of more intensive crop production taking place in the middle and low section of the watershed, may increase groundwater levels and decrease surface water flow. Yield could be increased with 5-135% for cereals, rice and maize, and 3-42% for vegetables compared to current total production.
- AWM interventions in isolation are unlikely to generate the full potential benefits possible unless combined with a range of social and institutional improvements.
- Existing institutional arrangements could help facilitate the adoption of AWM interventions, but the relations between different village structures and higher levels of government should be strengthened to help negotiate the multiple uses of water and land and potential negative impacts of interventions.
- Opportunities for improvement in AWM should be linked to access to capital and access to markets for farmers. Initiatives of micro finance exist and can be supported to reach further throughout the Mkindo watershed.

What are Agricultural Water Management interventions?

Agricultural water management (AWM) interventions are increasingly being promoted as a first step to enable positive development, alleviating food insecurity and poverty in the smallholder farming systems that dominate rural sub-Saharan Africa and South Asia. These AWMs range from in-situ soil and water management improvements (conservation tillage, terraces, pitting) to supplemental and full irrigation systems, drawing water from a wide variety of sources in the landscape. However, re-allocation of water can potentially undermine other uses of the same water, for other livelihood purposes or, indirectly, by reducing availability for support of different ecosystem services. This case study, in the Mkindo watershed in Tanzania, aimed to create a baseline of resource-based livelihoods and to assess the local hydrology. Scenarios were developed through consultations with local watershed experts to identify potential impacts of various AWM



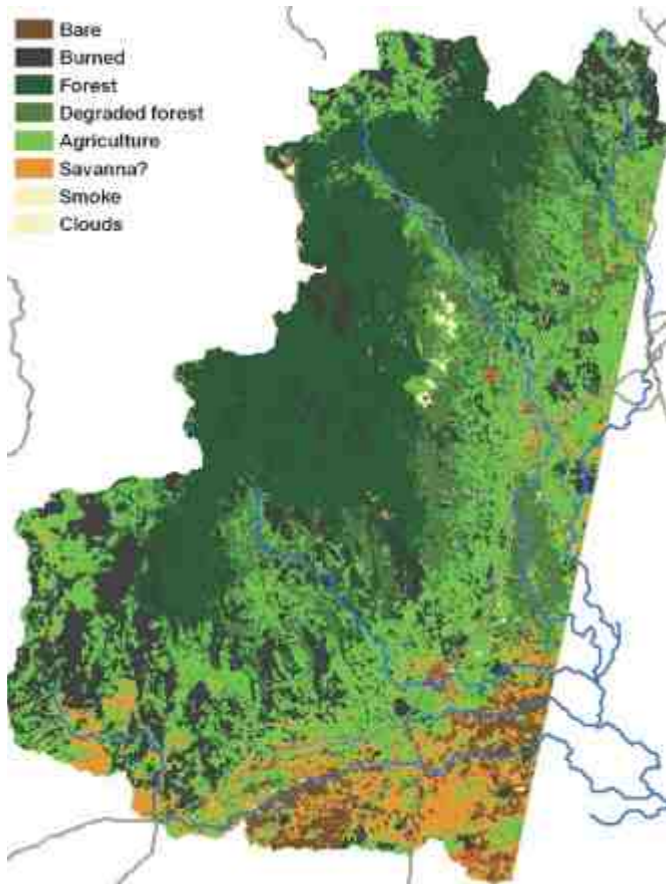


Figure 1: Land use map of the Mkindo watershed

interventions on the various livelihoods and water resources in Mkindo. The same scenarios of AWM interventions were also used for quantifying changes in water balance and crop yields in the watershed. An assessment of watershed-level relevant formal and informal actors identified opportunities and constraints for AWM implementation as well as potential options for negotiating negative externalities of AWM interventions.

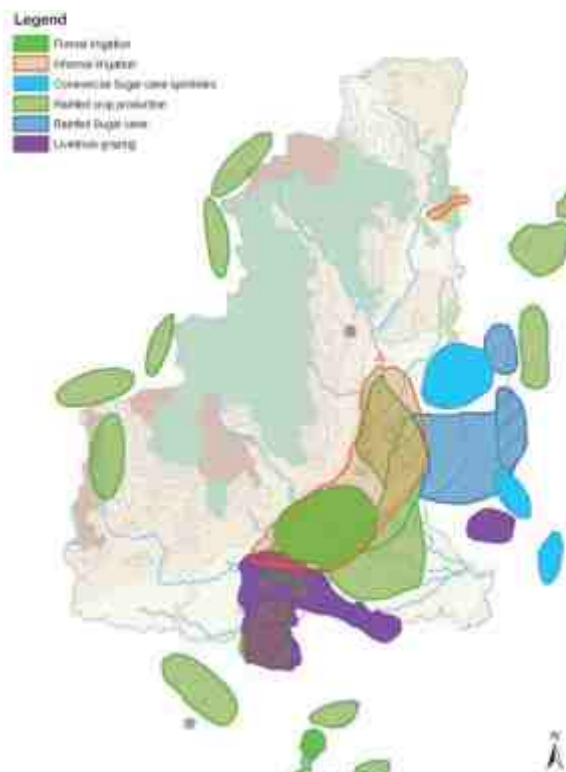


Figure 2: Agricultural Water Management map

Water and land for agriculture in Mkindo

The Mkindo watershed has an area of 913 km² and is located in Morogoro province in the Wami-Ruvu basin on the upper slopes of the Nguru mountains range. There are three distinct regions: the mountainous forest area of the catchment, the mid section where most agriculture takes place and the agro-pastoral low land (Figure 1a). The average annual rainfall in the catchment is between 800 and 1200 mm y⁻¹ of which 37% leaves the area as evapotranspiration and 63% as runoff or groundwater recharge. About 80% of the population depends on small holder farming as their main source of income. Both men and women are involved, with men mainly producing paddy rice and rainfed maize and women irrigated vegetables. Most of the agriculture is concentrated in the mid-section through individually organized irrigation or a small official irrigation scheme using a gravity-based furrow system. Figure 2 illustrates the current water management in the area. Farmers who have access to the formal irrigation scheme harvest rice twice a year in comparison to those with access to more informal irrigation or rainfed farmers who harvest only once. Some small-scale farmers work as outgrowers or as labourers for the company 'Mtibwa Sugar Estate Ltd.', which also uses large amounts of water for the irrigation of sugarcane. In the lowland section livestock keeping is the main source of income, complemented with rainfed crops. In the rainy season water is sufficient, but in the dry season water is increasingly scarce. This water scarcity forces livestock to migrate to other areas within or outside the watershed. There are tensions between livestock keepers and farmers because both need access to water during the dry season for different purposes. Overall, farmers with access to the official irrigation schemes do better financially than those dependent on rainfed agriculture, who are still more secure than those dependent on livestock keeping.

Institutional networks supporting water resource management

People have organized themselves in village committees, for forest-, water-, or land-management. These different groups perform important functions with regards to the management of natural resources, but they lack resources and the institutional capacity to fulfil these functions effectively. Village leaders often link otherwise disconnected groups, but currently no organization coordinates the various land and water related activities across the entire catchment. The national government is in the process of establishing Water User Associations (WUA's) that could bring together actors from different parts of the catchment and the formal governance system. However, at the moment this process seems to follow a top-down approach and might potentially fail to acknowledge the existing informal organization of water users. The links between the village committees, as well as those between committees and higher levels of government could be strengthened to facilitate the coordinated development of land and water resources across the catchment. Participation of different users of water and land when planning future developments in the catchment would help to decrease the conflicts that have occurred in the past. Figure 3 shows how some institutions in the watershed are central at connecting other actors who are themselves disconnected. These organizations could provide an opportunity to coordinate activities across the catchment or to facilitate the adoption of future AWM interventions.

What potential impacts could AWM interventions have?

The ongoing national "Kilimo Kwanza" initiative in Tanzania, an affirmative action to prioritise the agricultural sector, has ear

Table 1: Impacts of AWM technologies explored during focus groups with local experts

Technology	Social impacts			Environmental impacts		
	Equity	Gender	Poverty Reduction	Water Quality	Water Quantity	Natural Resources
Gravity based furrow system for paddy rice production	+ / -	-	+	-	-	-
Diesel pumps – irrigating from rivers	+ / -	+	+	-	-	-
Livestock watering ponds	+	+	+	NA	+	+
Livestock watering canal	-	+	+	NA	NA	-
Large scale irrigation for cash crop production	-	NA	Unclear	-	-	-

marked the Morogoro province as the main bread basket of the country. Hence, there are elaborate plans to expand and or develop new irrigation schemes in the province. In Mkindo catchment, for example, plans have been finalised to expand the existing 150 ha of paddy irrigation to 2 720 ha. The potential impacts of different AWM intervention scenarios were discussed during a consultation with watershed experts and are shown in Table 1.

The development of new irrigation schemes could increase the income of farmers who have access to the scheme and reduce poverty in the area. The increased inequalities between those who do and those who do not have access might lead to more tensions related to water use, especially in the dry season when water is scarce. Focusing only on high technology interventions, such as the irrigation scheme, could potentially by-pass the majority of farmers who depend on rainfed agriculture and marginalise certain vulnerable groups, such as livestock keepers even further. Multiple different AWM interventions (for example livestock water points combined with irrigation schemes) in the same watershed have the potential to improve the livelihoods of a wider number of beneficiaries than a single improvement. This finding was reinforced at a follow-up stakeholder dialogue held in Dar es Salaam where 11 out of 13 expert participants agreed that multiple agriculture water management interventions in a single area bring more positive impacts than single interventions.

Most AWM solutions explored have potential positive social impacts, but environmental impacts may be more ambiguous. Some of the negative effects of the AWM interventions in the table are based on potential long term impacts on the water flows in the watershed. Scenarios were also assessed for potential water resource and yield impacts through hydrological modeling where

four types of AWM interventions were compared to existing water balance and crop yields:

- Improved rainfed cereal production, with soil moisture conservation and fertilizer additions
- Intensification on existing irrigated areas, increasing to 2 seasons per year on existing irrigation areas
- Expansion of irrigated land, (from current 20% of agricultural land to 50%)
- Increase of small reservoirs to storage of 20% of rainfall and doubling of crop land

Figure 4 shows the impacts on land use and yield. For all four scenarios more use of ground and surface water in the middle and lower sections will result in a 10-20% decrease in the surface flow, whereas groundwater will recharge (Figure 5). Despite significant yield increase for the Improved rainfed scenario with substantial shift in surface to groundwater flows, the actual changes in water balance flows are quite marginal, being less than one tenth of the annual rainfall. The actual surface water impact corresponds to 100 mm and groundwater impacts correspond to 80 mm. In fact all scenarios, independent of AWM intervention explored,

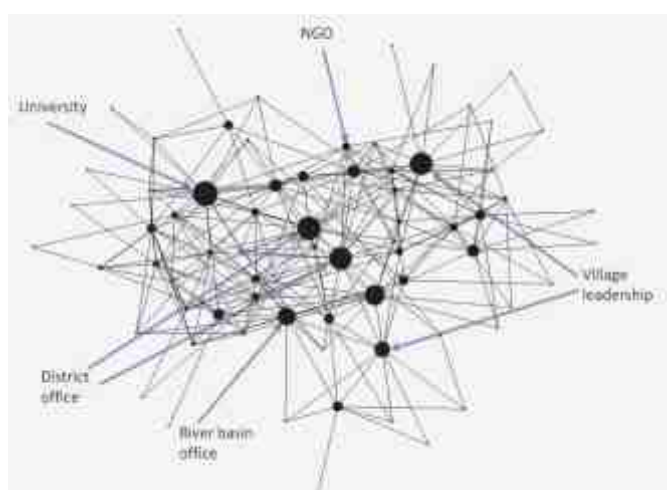


Figure 3: Social network of Mkindo watershed showing centrality of actors and the three main actors involved in water management

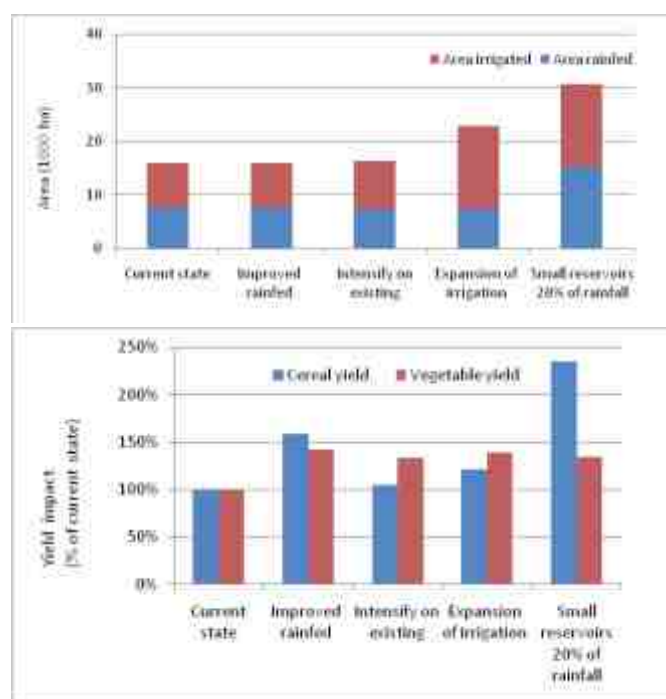


Figure 4: Current state and hydrological impacts of different AWM scenario, a: change of rainfed and irrigated area (ha) and b: associated change in cereal and vegetable yield

describe the same range of water balance impacts. The Improved rainfed and Expansion of irrigation scenarios evidently result in substantial yield increase due to the doubling of crop area. For Mkindo, there appears to be large scope to further develop AWM interventions in various ways without substantial negative water quantity impacts. This indicates a large potential for water productivity gains where yields increase with marginal or no reduction of downstream flows. Potential relocation of flows in time should however be monitored to ensure that the low flow season is marginally impacted by additional withdrawals.

The experts thought the combination of expanded irrigation schemes with livestock watering ponds would be a catalyst for more food production, more jobs, improved livestock products, and sustainable resource management. The hydrologic assessment supports the increase in production.

AWM interventions in isolation are unlikely to generate the full potential benefits possible unless combined with a range of social and institutional improvements. These could include farmer training on appropriate use of technologies or health implications of domestic use of water, but also strengthening the links between community management organisations, different livelihoods and government. Farmers who attended training about crop management have increased crop production without changing their AWM technology. Improvement of roads and micro finance will enable farmers to get most out of the AWM interventions. Similarly the scenarios indicate that improvements in water delivery intended to boost agricultural can also have additional positive benefits in terms of human health, through improved access to water for domestic consumption and better nutrition resulting from the increased local production of food. These additional benefits should also be considered when choosing options for different interventions in the management of water.

Currently small micro finance initiatives exist in some villages. These positive experiences could be built upon and extended to other areas to allow more people to make small investments in their farm. In terms of market access, accessibility in the area has

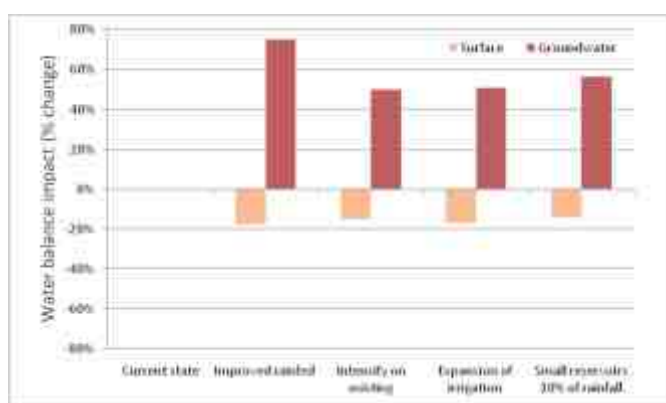


Figure 5: Impacts on surface and groundwater resources of the different AWM scenarios (as % deviation from current state)



Women participating in a baseline livelihood assessment in the Mkindo watershed

improved recently with the main road becoming a tarmac road. This connects the different villages with larger towns and markets, such as Morogoro and Dar es Salaam.

Further information available on demand:

Kongo, V., J. Barron, 2011. 'Application of SWAT for impact assessment of agricultural water management interventions in the Mkindo watershed, Tanzania'

De Bruin, A., S. Cinderby, 2010. 'Assessment of impacts of AWM interventions on resource-based livelihoods: Agriculture Water Management Scenarios in the Mkindo Watershed, Tanzania'.

De Bruin, A., S. Cinderby, 2010. 'Assessment of impacts of AWM interventions on resource-based livelihoods: Baseline Assessment of Current Livelihood Strategies in the Mkindo Watershed, Tanzania.'

Stein, C., 2010. 'A Social Network Perspective on the Governance of Green and Blue Water Resources: A Case Study of the Mkindo Catchment, Tanzania', MSc thesis Stockholm Resilience Centre Stockholm University

Acknowledgements

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