SEI STOCKHOLM ENVIRONMENT INSTITUTE

POLICY BRIEF

Opportunities for Agricultural Water Management Interventions in the Mwembeshi Watershed in Zambia

Key Findings

- **There are abundant opportunities to increase the current low yields and incomes of smallholder farmers through AWM interventions.**
- **The watershed population is concentrated along two main roads where smallholder farmers, subsistence farmers, and commercial farms are mixed. In these areas, various low- and high-technology AWMs drawing mainly from shallow and deep groundwater are used. The interior watershed is dominated by subsistence farming with largely traditional cropping systems and little AWM use.**
- **Intensifying irrigation on existing smallholder farmer's land (>5% area) or doubling the irrigated area could increase smallholder vegetable yields by around 170% to 11 t ha^{-1} with small decreases in surface and groundwater flows, by between 15-25%.**
- **More than 80% of the rural population in the watershed relies on rainfed agriculture. Improving rainfed cropping through soil and nutrient management could allow this majority to increase maize yields by 150% to 5.7 t ha^{-1} and vegetable yields by 80% to 7.5 t ha^{-1} with only marginal decreases in surface flows (around 8%) and groundwater baseflow (about 9%).**
- **Farmer organizations and cooperatives are widespread in the watershed. Those located near main roads are well linked to agricultural extension services. However, large populations of subsistence rainfed and less well-organized farmers are located in more remote areas of the watershed, limiting their connection to extension services.**
- **AWM interventions can capitalize on existing local traditional and official institutional structures to facilitate the adoption of new technologies.**
- **There is currently no organization that coordinates the various land- and water-related activities at the landscape scale, which limits the capacity to deal with existing water quality issues and potential negative impacts of AWM interventions.**

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-Sahara Africa and South Asia (see Figures 3 and 5). These AWMs range from *in-situ* soil and water management improvements (conservation tillage, terraces, pitting) to supplemental and full irrigation systems, drawing from a wide variety of water 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. In Mwembeshi watershed, potential opportunities and possible water-related impacts of AWM interventions were assessed. Scenarios were developed through national consultations of the Agricultural Water Management Solutions project (http://awm-solutions.iwmi.org/) to identify potential impacts of various AWM interventions on the water resources in Mwembeshi. 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.

Water and land for agriculture in Mwembeshi

The Mwembeshi watershed has an area of 4118km^2 and is located within the Central and Lusaka Provinces of Zambia (Figure 2). It is drained by the Mwembeshi River, which flows into the wetlands of Kafue flats and then the Kafue River, one of Zambia's major rivers. The great Northern and Western roads traverse across the watershed and have multiple feeder

Figure 1: Farming in Mwembeshi

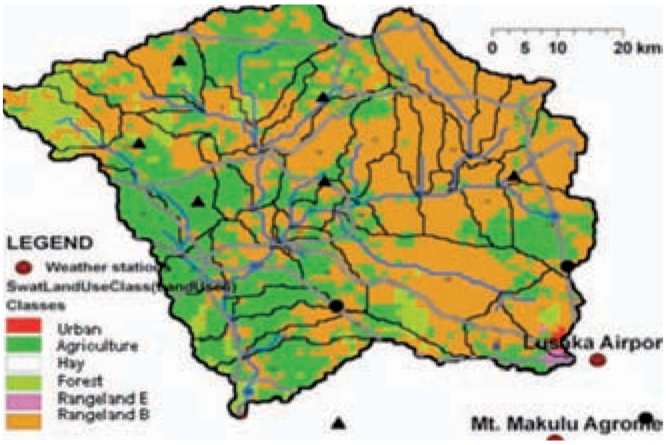

Figure 2: Mwembeshi watershed showing the range of land use types

Figure 3: A manual welll with motorised pumps as a smallholder AWM in use in Mwebeshi watershed

roads that are accessible only during dry seasons. Large scale (commercial) farming is concentrated along the main roads. Small scale farming that produces for subsistence and the market is also mainly located along main roads. The rest of the watershed is sparsely occupied and farmed largely for subsistence on a seasonal basis. The main land uses in the watershed are agricultural and rangeland (savanna), accounting for 39% and 58%, respectively.

There is large scope to intensify production on current smallholder and subsistence farms. They currently produce at low yield levels, averaging 2 t ha^{-1}. Subsistence farmers also practice fallow systems consisting of relocation of crop fields and homesteads in 6-10 year cycles. Comparatively, current commercial farms harvest 2-3 crops per year with maize yields ranging from 10 to 12 t ha^{-1}, suggesting that subsistence and smallholder farmers could attain higher yields with improved management. In addition, only less than 10% of the designated agricultural land is currently under production (equaling to only 4% of the total watershed area), so the possibility of area expansion also exists, if needed.

In addition to intensification possibilities, Mwembeshi watershed holds great potential for improved agricultural water management. Both surface water and groundwater resources are abundant; the watershed receives between 800 and 900 mm of annual rainfall, with potential evaporation ranging from 1580 to 1750 mm y^{-1}. Both rainfed and irrigated agriculture are important for smallholders, subsistence and commercial farmers. Smallholder farmers cultivate less than 5 ha, with maize as the main crop, and consume most of their produce. Although rainfed farming allows only one growing season each year, water supplies are generally adequate to support irrigation in the dry season, if proper storage is available.

Groundwater is already an important water resource for agricultural production in the watershed. Smallholder farmers use shallow wells, and low lying areas with relatively high water tables (*Dambos*) for post rainy season cropping. Irrigation technologies used by smallholders and susbsistence farmers are low-technology, accessing surface or shallow water through gravity, labour, treadle or motor pumps. However, the amount of area smallholders irrigate is currently very small. Commercial farms, on the other hand, largely rely on boreholes and pumps, high-technology systems, to access deeper groundwater resources. Little is known about abstraction volumes because there is currently limited capacity to monitor abstractions from both surface and groundwater.

Institutional networks supporting water resource management

The Mwembeshi smallholder farmers have various levels of organisation and connection to services. Since farmers need to be organized and registered to get assistance from government support programs, farmer organizations such as cooperatives and associations are widespread in the watershed. Farmers along the main roads are usually organised and also well-linked to agricultural extension offices. Subsistence farmers who depend on rainfed agriculture in the less accessible areas of the catchment are not well-organized, and therefore have

Figure 4: Large scale iautomatic irrigation on commercial farmi ias one type of AWM in use in Mwembeshi watershed

Figure 5: AWM as a storage tank which automates pressure for irrigation

less access to agricultural extension services. These farmers could especially benefit from AWM interventions having had little access to training.

Not only are the farmer networks varied, but the institutional landscape underpinning land and water governance is also much more complex than suggested by formal policy. Social network analysis has illuminated that the informal networks are critical for watershed-level governance of water and land resources (see Figure 6). It appears that there are two parallel governance systems operating at the local level: the official government authorities and the traditional authorities of chiefs and headmen. The traditional authorities perform important functions with regards to land allocation and conflict resolution. In addition, the ongoing decentralization process is bringing new actors to the playing field. This makes it difficult for smallholders and/or organizations implementing AWM interventions to navigate the social landscape, and to create a coherent watershed-level governance structure. Recognizing the importance of partnering with both official and traditional institutions is key to the success and sustainability of smallholder-focused AWM interventions in Mwembeshi.

Assessing the existing social networks, as well as the strengths and weaknesses of various actors, can be an important first step in identifying potential partners for organizations implementing AWM interventions. Formal actors may not be the only, or even the most important, actors to collaborate with. In cases where official actors are inactive, other institutions such as local NGOs or traditional leaders could provide coordinating functions. When addressing gaps or weaknesses in the institutional landscape, existing social structures should be recognized and strengthened.

What potential impacts could AWM interventions have?

Four AWM intervention scenarios for smallholder farmers were explored in the Mwembeshi watershed to assess the potential impacts on water balances and crop yields. These scenarios were compared with the current state water balance and reported crop yields for the area (see Figure 8):

1. Improved rainfed agriculture through improved soil and nutrient management in existing rainfed crops could increase maize yields by 150% to 5.7 t ha^{-1} and vegetable yields by 80% to 7.5 t ha^{-1} with an insignificant decrease in surface flows (about 8%) and groundwater baseflow (about 9%). Since over 80% of the rural population in the watershed rely on rainfed agriculture, such water and land use productivity improvements could have substantial household food security benefits for a majority of farmers in the watershed while only marginally impacting water flows in the landscape.

2. *Intensification of current irrigation areas* was assessed through adding two fully irrigated post-rainy seasons of vegetable crops per year. In this case, an additional 23 mm per year would be withdrawn from surface resources for irrigation. This could decrease surface flows by 13% and groundwater baseflows by 25% while attaining yield gains for vegetables of 185% (11.7 t ha^{-1}). However, intensification of existing irrigation areas would only benefit a small number of smallholders because there is currently very little irrigated area situated along the main roads.

3. *Doubling the irrigated area* through wide smallholder adoption of water lifting devices, such as small motor pumps, could enable abstraction of water from both ground and surface water resources for irrigation of both high value crops (such as vegetables) and existing rainfed crops (such as maize). Expansion would likely be concentrated along the great West and North Roads. Despite the increase in water abstraction, the impact on the overall water balance of the watershed would decrease surface water by about 20% and groundwater baseflow by 25% of current annual flows. Yield gains in vegetable crops could reach 175% while improvements in maize would be a slight 4%. Due to expansion in irrigation area of vegetables, the total produce would increase by 11 t y^{-1}, which could translate into a sizable income for the farmers adopting this AWM strategy.

4. *Construction of small dams for multiple use and benefits* (adding up to 331 499 000 m^3 storage volume for the whole watershed, equaling 10% of annual rainfall) would decrease surface and groundwater flows by about 15 and 20%, respectively, and would have a significant impact on increasing

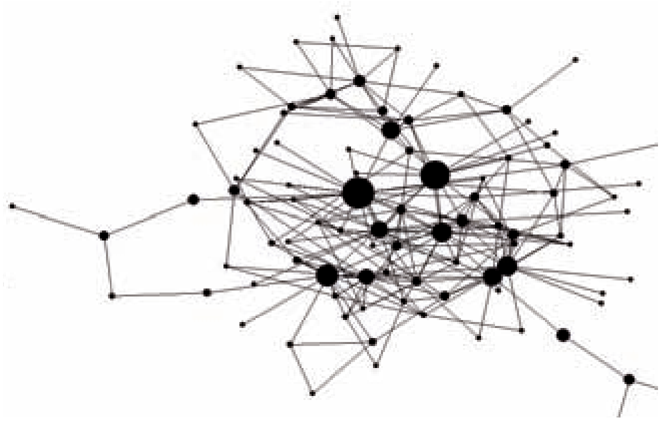

Figure 6: Network map showing existing connections between formal and informal institutions related to governance of water and land resources in Mwembeshi watershed

Figure 7: Polluted water is used to irrigate crops

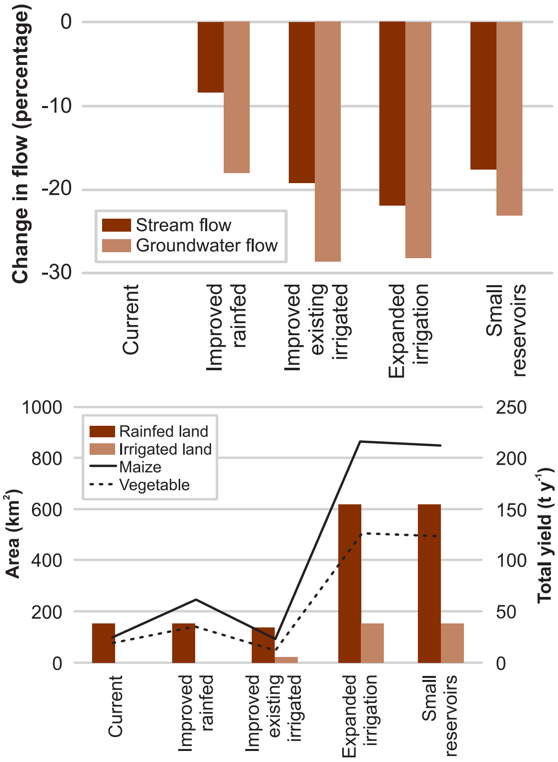

Figure 8: Current state and hydrological impacts of scenarios, a: crop area change (ha) and associated maize and vegetable production (t ha^{-1}) and b: impacts on surface and groundwater resources (as % deviation from current state).

smallholder vegetable yields (around 170% to 11 t ha^{-1}) and only moderate increase in maize yields (13% to 2.6 t ha^{-1}). However, dams could have other multiple use benefits such as access to water in post rainy season.

Dealing with impacts of development

There is an opportunity to unlock the potential of small-scale agricultural water management in the Mwembeshi watershed. However, in order to ensure their sustainability, adequate institutional arrangements need to be in place. Currently, it seems that no organization coordinates the various land- and water-related activities at the watershed (landscape) scale. Thus, potential negative impacts of small and/or large-scale AWM interventions on water and land resources are likely unaddressed unless efforts are made to support institutional governance capacity at the same time.

On the other hand, both formal and informal institutional arrangements for land and water resources management are already in place, suggesting that there are ample opportunities to build on these existing social structures. Attempts to address gaps or weaknesses in the institutional landscape should therefore recognize and build upon already existing actors and their relationships. By providing institutional space for relevant actors to interact (for example, government officials and traditional leaders), new partnerships can be formed that address the need for watershed-level coordination. Traditional leaders, agricultural extension officers, and local NGO workers could facilitate stakeholder dialogue and strengthen interaction between local farmers and higher levels of governance. This would allow better harmonization and coordination of the development of the watershed as a whole, and is likely to be both more cost-effective and sustainable than establishing new governance structures.

Further information:

Stein, C., J. Barron, and H. Ernstson. (2011) A social network approach to analyze multi-stakeholders governance arrangement in water resources management: Three case studies from catchments in Burkina Faso, Tanzania and Zambia. In XIVth World Water Congress. Porto de Galinhas, Pernambuco, Brazil

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