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Sensitization and Monitoring of Water Use in Irrigation Schemes Based on Efficient Water-Use Technologies

Mtoi Kanyawanah[1] Philipo Patrick[2]
Pangani Basin Water Board, P.O. BOX 7617, MOSHI

Abstract
Kilimanjaro ecosystem, which is of local and global significance, is experiencing an extensive degradation and deforestation which include completely deforested patches and enormous soil-erosion gullies. The highlands of Kilimanjaro region have always provided enough water flows to enable the implementation of traditional irrigation systems that the local people have used. This system threatened by decreasing water flows due to land degradation.The Government of Tanzania, with support from the Global Environment Facility (GEF) through UNDP is implementing a 4-year project aimed at reducing land degradation on the highlands of the Kilimanjaro Region. The Project intends to reverse this trend by reviving and improving the traditional irrigation system with low-cost drip irrigation demonstration schemes that take into account income generation and climate change adapted. As such, low-cost drip irrigation demonstration plots established in Same, Mwanga, Moshi, and Hai districts.Monitoring of improved low-cost drip irrigation demonstration schemes within the Pangani Basin carried out hand-in-hand with awareness creation on observing water use legislations and policies. Water use efficiency (WUE) in relation to furrow irrigation methods revealed that WUE was significantly higher by drip irrigation system. Results obtained prove the water savings range from 44% in Kisangesangeni and Longoi A to 58% in Mabilioni. Farmers were eager to implement the technology after getting training although initial installation cost is high. Therefore Government in collaboration with private entities and NGOs should promote drip irrigation technology by providing linkage to financial institutions like VICOBA and SACCOS for accessing soft loans and as well as market.
Keywords: Pangani basin, public sensitization, sustainable land management, monitoring of water use in irrigation schemes, efficient water-use technologies

INTRODUCTION

The Government of Tanzania, with support from the Global Environment Facility (GEF) through UNDP is implementing a 4-year project aimed at reducing land degradation on the highlands of the Kilimanjaro Region, which has 7 administrative councils, namely Rombo, Hai, Moshi Rural, Moshi Municipality, Siha, Mwanga and Same. The project's goal is to ensure sustainable land management provides the basis for economic development, food security, and sustainable livelihoods while restoring the ecological integrity of the Kilimanjaro region's ecosystems. Its purpose is to provide local land-users and managers with the enabling environment (policy, financial, institutional, capacity) necessary for the widespread adoption of sustainable land management practices.

The Project is covering 40,000 ha, across six watersheds in three mountain blocks of Kilimanjaro, North Pare, and South Pare. The highlands of Kilimanjaro region have always provided enough water flows to enable the implementation of traditional irrigation systems that the local people have used. This is one of the systems threatened by decreasing water levels due to land degradation. The Project intends to reverse this trend by reviving and improving the traditional irrigation system. The Project also intends to have low-cost drip irrigation demonstration schemes that take into account income generation and climate change adapted for use. As such, it established low-cost drip irrigation demonstration plots in Same, Mwanga, Moshi, and Hai districts.

This paper set out to monitor improved traditional irrigation scheme and low-cost drip irrigation demonstration schemes within the Pangani Basin. Monitoring will go hand-in-hand with awareness creation on observing water use regulations and policies. This information will not only to contribute to reduction in amount of water used for irrigation, but also generate revenue because with irrigation, households that will adopt the technology shall be able to grow crops twice or thrice a year.

This paper describes monitoring of abstraction flow in (1) traditional irrigation scheme that has been rehabilitated within Moshi District (*Ngalachu at Mahoma*) and (2) low-cost drip irrigation demonstration schemes those will be established in Same (*Mabilioni at Hedaru*), Mwanga (*Kwamboa at Ugweno*), Moshi (*Kisangesangeni at Kahe*), and Hai (*Longoi A at Longoi*). It is also emphasizes the need for communities to observe water use regulations and policies. The legislation governing water sector is divided into two parts i.e., the Water Resources Management Act (WRMA) No.11 of 2009 and the Water Supply and Sanitation Act No.12 of 2009. The two pieces of legislation are implemented in parallel with other related pieces of legislation in the

[1] Pangani Basin Water Officer, Pangani Basin Water Board (mkanyawana@yahoo.co.uk)
[2] Senior Hydrologist, Pangani Basin Water Board (mwakabengele@yahoo.co.uk)

country, such as Environmental Management Act (EMA) No. 20/2004, Land Act No. 4/1999, EWURA Act No.11/2001, Forest Act and National Irrigation Act, 2013.

METHODS

Kilimanjaro region, located in North Eastern Tanzania (Figure 1) is within an ecosystem of high national and global importance. The region is home to more than three million people. Average population density is about 104 people per square kilometer in the highland areas being some of the most densely populated regions in the country. Also has three distinct agro-ecological zones based on altitude, soils and climate. The zones include the peak of Kilimanjaro Mountain (1,800 to 5,895 masl), the highlands (900 to 1,800 m.a.s.l) and the lowland /plains (below 900 masl).

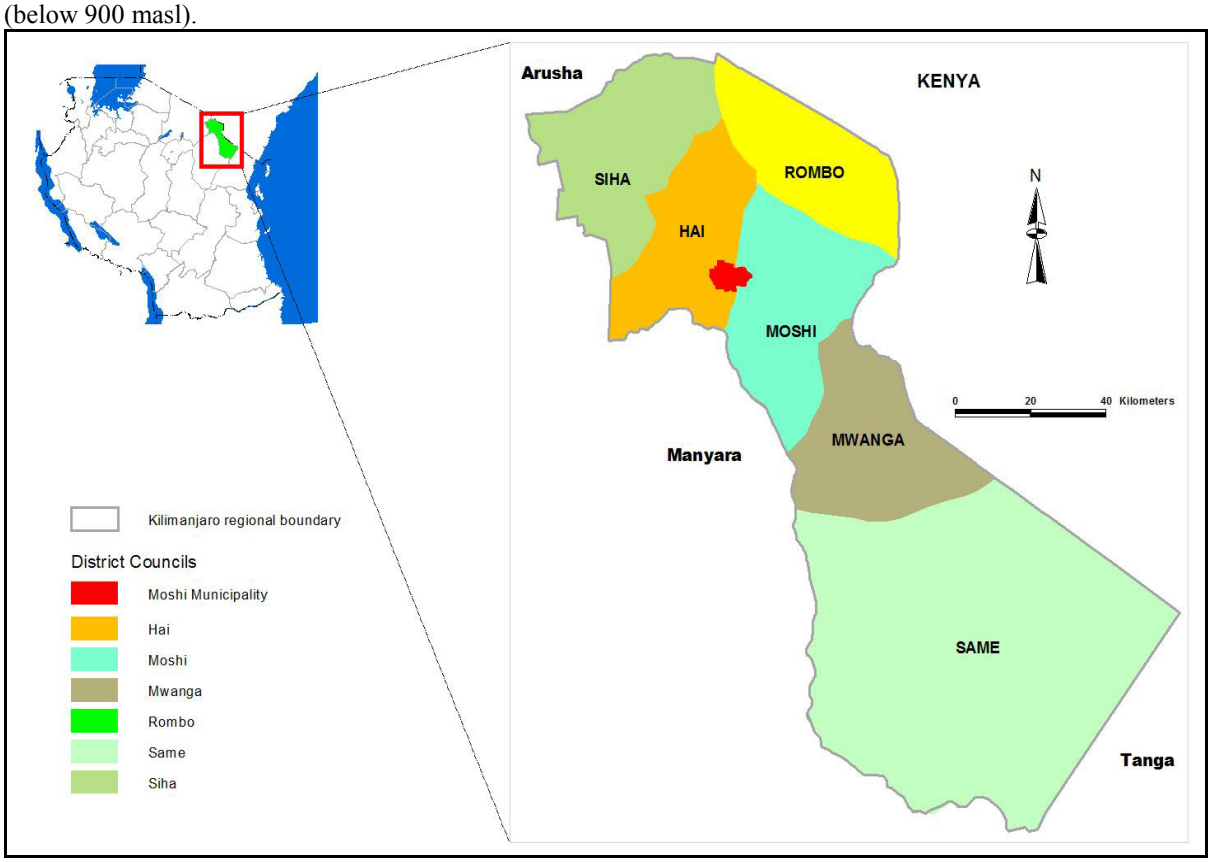

Figure 1: Kilimanjaro region

Awareness Creation

These activities carried out from August to September 2014, by visiting the irrigation schemes shown in Table 1.

Table 1: Irrigation scheme targeted by the Sustainable Land Management Project-Kilimanjaro, Tanzania

District	Irrigation scheme	Size (ha)	No. of HH	Sex		Type of Crops	Remarks
				M	F		
Hai	Longoi A	300	233	100	133	Maize, onions, sunflower, groundnuts beans	
Moshi	Ngalachu	89	500	200	300	Bananas, beans, maize, coffee	Water saving assessment not done b'se rehabilitation was not completed by time of report compilation
Mwanga	Kwamboa	14	60	25	35	Vegetables, beans, banana, maize, tomato	
Same	Mabilioni	24	150	70	80	Maize, tomato	
Moshi	Kisangesangeni	300	450	190	260	Beans, maize, tomato	
Total				**585**	**808**		

The Ngalachu irrigation scheme is a traditional scheme to be rehabilitated as demonstration scheme,

while the rest 4 irrigation systems to be converted into low-cost, environmentally-friendly and non-wasteful irrigation schemes (drip irrigations). All the communities were sensitized on the importance of observing water-use legislations and policies (WRMA, 2009 & NAWAPO, 2002) since each scheme uses irrigation methods that are not environmentally friendly as will be seen in the succeeding paragraphs. Topics covered during the sensitization meetings are as follow;

1. Water Resources Management framework in Tanzania
2. Pangani Basin (mandates and responsibilities)
3. Challenges of water resources management including human activities around water sources, water loss, illegal water abstraction, etc
4. Position of small scale agriculture practitioners as stipulated in Irrigation Policy in the context of;
    - Their role during the project (SLM) design stage
    - Operation and maintenance
    - Role of the government and other individuals in supporting these farmers
    - Sustainability of the project after phasing out
5. Challenges facing small scale irrigators (policy perspectives) including;
    - Inefficient irrigation techniques
    - Intensification of water user conflicts
    - Inadequate understanding of water related laws and policies
    - Poor organization among users
6. Role of the government to attract/ improve irrigation technologies;
    - To attract into the system private sectors in order to improve irrigation efficient technologies
    - To further rehabilitate the existing irrigation infrastructures by involving local farmers as stakeholders
    - To provide any required technical assistance in forming irrigators associations in order to guarantee their livelihood improvement
    - Involvement of more stakeholders in the planning, designing and supervising construction and maintenance of irrigation infrastructures
    - To ensure that all irrigation improvement initiatives shall take into account environmental protection measures
    - To raise awareness to small scale irrigators about good qualities and suitable areas for irrigation
    - The government shall impose favourable conditions to attract private investors and even engagement of small scale irrigators into the practice
    - The government shall pioneer in assessing quantity and qualities of surface and ground water and insist on application of efficient technologies among users
    - Put emphasis in rain harvest and water storage technologies
    - Insist the farmers to switch from business as usual by growing more valuable crops

Figure 2: Awareness creation at Kwamboa irrigation scheme on water use related legislations, policies and regulations

Monitoring Water-use in Irrigation Schemes

Monitoring was done only at the 4 drip irrigation schemes because the rehabilitation works were still underway at Ngalachu. Demonstrations carried out on a plot of about 500-520 m^2 for low-cost drip irrigation schemes. This size was considered suitable for purpose of demonstrating and training of farmers' groups on the efficacy of the system. Due to comparatively higher costs of the drip irrigation systems, than furrow irrigation, the groups agreed to cultivate high value crops such as sweet pepper, tomatoes, and lettuce, etc., for quick cost recovery. At each demonstration plot, a 2000-lt tank was installed into which water is pumped either from a well or irrigation canal and allowed to flow by gravity to the plot.

Flow measurements for each irrigation scheme (Mabilioni at Hedaru), Kwamboa at Ugweno, Kisangesangeni at Kahe, and Longoi A at Longoi) were done by small current meter (pygmy). Sampling was done two times (before and after scheme rehabilitated). Amount (total) of water applied in millimeter (mm) in each irrigation method was calculated using the following formula;

$$\text{Total water applied in (mm)} = \frac{\text{Total water applied in } (m^3)}{\text{Size (area) irrigated } (m^2)} \times 1000$$

While water saving in (%) is calculated as follow;

$$\text{Water saving in (\%)} = \frac{TW_{furrow} - TW_{drip}}{TW_{furrow}} \times 100\%$$

Where;

TW_{furrow} = Total water applied in (mm) by furrow

TW_{drip} = Total water applied in (mm) by drip

Figure 3: Flow measurement at Kimwangamao (Kisangesangeni) irrigation scheme for monitoring abstraction water from the river

RESULTS AND DISCUSSION

Irrigation agricultural production in most parts of Tanzania is affected by water shortage due to climate change which is contributed by many factors including encroachment of water sources. In view of this, drip irrigation is the most appropriate method that farmers can adopt and be assured to produce good crops in terms of quantity and quality using little water available.

Water use efficiency (WUE) in relation to different irrigation methods revealed that WUE was significantly higher by drip irrigation system as shown in Table 2 below. For example the results obtained prove the water savings range from about 30% in Kwamboa to about 63% in Mabilioni. Variations in water savings are

due to combination of factors like soil type, evaporation, water demand by crop and different size of original farm area. These findings are in accordance with the various researchers including http://irrigation.org.au/wp-content/uploads/2013/03/Drip-Irrigation-brochure-final-for-print-v8.pdf which reported that "analysis of 112 studies into drip versus flood (furrow) irrigation (in comparable situations) revealed that water savings of 15-55% and yield increases of 18-50% are achievable". Therefore the technology can assure sufficient water available for various uses including domestic, environmental, industrial, and agricultural in the region (Kilimanjaro) regardless of water scarcity due to climate variability and change. Although affordability of the initial installation costs is a big challenge to most of local farmers, the government in collaboration with private entities and NGOs should encourage and promote the technology by providing linkage to financial institutions like Village Community Banks (VICOBA), SACCOS, etc for accessing soft loans and market.

Table 2: Comparison of water use under drip and furrow irrigation systems in three district of Kilimanjaro Region, Tanzania

Name of scheme	Method of irrigation	Area irrigated (m^2)	Flow rate (m^3/h)	Irrigation time (h)	Applied water per irrigation (m^3)	Water requirement in depth (mm)	Water saved (%)
Longoi A	Drip	500	0.88	8	7.04	14.08	51
	Furrow	500	0.60	24	14.40	28.80	
Kisangesangeni	Drip	500	0.88	8	7.04	14.08	51
	Furrow	500	0.60	24	14.40	28.80	
Mabilioni	Drip	500	0.88	8	7.04	14.08	63
	Furrow	500	0.80	24	19.20	38.40	
Kwamboa	Drip	500	0.88	8	7.04	14.08	30
	Furrow	500	0.42	24	10.08	20.16	

Note:

- Estimated an average of water use is 3.5 tanks of 2000 litres in 8 hours of a day for all four installed drip systems applied.
- Furrow system assumed irrigation done in 24 hours due to some leakages of conveyance canal

CONCLUSION AND RECOMMENDATION

Conclusion

Most farmers in the demonstration sites were new in drip irrigation technology, but after training and participation in the installation process they are now familiar with it (how it works, advantages of it and how to maintain it). However, farmers are interested in practicing the technology but affordability of the initial installation cost (about 500,000/= without a tank) is a challenge to them. However for sustainable implementation of the technology, the following should be done;

- Farmers should be encouraged to install drip system at their own costs;
- Technical backstopping to spread drip irrigation technology (from four selected demonstration sites) to more farmers should be maintain by extension officers; and
- Since the technology is expensive, farmers should be encouraged in producing high value crops (i.e. vegetables) for aiming high returns in a short time to recover their initial costs. This should go hand-in-hand with market availability (farmers to get assured of selling their crops at good prices).

Recommendation

The installed drip irrigation systems in four selected demonstration areas should be properly maintained in order to ensure their sustainability. Therefore the technology can assure sufficient water available for various uses including domestic, environmental, industrial, and agricultural in the whole region (Kilimanjaro) regardless of water scarcity due to climate variability and change. Also these results can minimize water use conflicts among local farmers. In view of this, drip irrigation is the most appropriate and efficient irrigation method that farmers can adopt in the region (Kilimanjaro).

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