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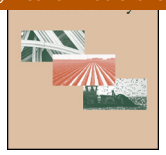

Exploring watershed conservation and water governance along Pangani River Basin, Tanzania

Makarius C.S. Lalika[a,b,*], Patrick Meire[a], Yonika M. Ngaga[c]

[a] Department of Biology, Ecosystem Management Research Group, University of Antwerp, Campus Drie Eiken, Universiteitsplein 1, BE-2610 Antwerp, Belgium

[b] Department of Physical Sciences, Faculty of Science, Sokoine University of Agriculture, P.O. Box 3038, Chuo Kikuu, Morogoro, Tanzania

[c] Department of Forest Economics, Faculty of Forestry and Nature Conservation, Sokoine University of Agriculture, P.O. Box 3011, Chuo Kikuu, Morogoro, Tanzania

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ABSTRACT

Water scarcity is among the contemporary problems of our time across the globe. The problem is worsened by policy failures to enforce water governance and watershed conservation. Consequently, it has curtailed the capacity of watersheds to release hydrological services, water in particular. We carried out this study to explore approaches for watershed conservation and investigate water governance challenges in Pangani River Basin, Tanzania. We collected data by using structured questionnaires and meetings with different actors in the study area. We found that retaining riparian vegetation is the appropriate strategy for watershed conservation and sustainable water flow. Water governance challenges include ineffective and uncoordinated water governing institutional structures; and untrustworthy financial management. We feel that building the capacity of water users association could bring about positive outcomes for both watershed conservation and water governance. We recommend that strategies and policies aimed at improving the flow of hydrological services should also focus on improving the welfare of the local communities, who are the primary beneficiaries of water from watersheds.

1. Introduction

Watershed ecosystems are key natural wealth for economic growth, ecological integrity and other hydrological services (Barbier and Thompson, 1998; Bennett et al., 2005; 2009; Boelee and Madsen, 2006; Boelee, 2011). Watersheds play a crucial role in the delivery of many ecosystem services (ES), including provisioning services, cultural, regulatory and supporting services (Miranda et al., 2003; MA, 2005; Brauman et al., 2007). In recent years, however, watersheds have been degraded beyond provision of water in a sustainable way (SafMA, 2004; De Groot et al., 2010; Lalika et al., 2015a). Water is a finite and exceptional ES as it can be a cultural provisioning, regulating and a supporting service. Thus for ensuring the availability and sustainable supply of this unique ES, it is essential to improve watershed conservation through water governance and strengthening water user associations through training, financial provision for modernizing irrigation infrastructures (Lein and Tagseth, 2009). On the other hand watershed conservation and watershed governance can be achieved through improving river committees as advocated by Komakech and van der Zaag (2011).

Reduced water flow, watersheds and catchment forest degradation are mainly due to failures in watershed governance (Yong et al., 2003; Franks et al., 2011; Brandes, 2005). Watershed governance focuses on improving decision-making in a more inclusive framework, achieving sustainable, healthy watersheds and the flow of benefits from them. Furthermore, watershed governance emphasizes on community benefits from the use of collaborative processes, the development of shared goals, greater trust among conflicting interests, better and more durable resource use decisions based on better information (Franks et al., 2011; Brandes, 2005).

A key factor for watershed governance success is improved collaboration and connections between local communities and decision-makers at the watershed scale. The central goal is to provide alternatives to existing systems of water governance and planning that are focused too narrowly on water, isolating the resource from its broader interactions across sectors and within ecosystems. For effective and efficient watershed governance, there are a number of management components to be fulfilled.

* Corresponding author at: Sokoine University of Agriculture, Faculty of Science, Department of Physical Sciences, P.O. Box 3038 Morogoro, Tanzania. Fax: +255 23 2604648\23 2603404.

E-mail addresses: makarius.lalika@yahoo.com, lalika_2mc@suanet.ac.tz (M.C.S. Lalika).

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They include: actual integration of economic and environmental objectives within the watershed context; integration of policies, programs and protocols which guide outcome-based planning, monitoring and enforcement; and, effective and efficient delivery of watershed services through the development of high-performance public and private organizational structures.

The smooth operations of these components are, however, precluded by fragmented management structures. These implies poor inter-sectoral coordination at field scale; diverging interests of watershed stakeholders and water beneficiaries; incompatibility between formal and informal institutions; lack of upstream and downstream integration; development interventions; inadequate political will to support watershed governance; and the constraining factors to water and forest management integration (Msuya, 2010) and uncoordinated integrated water management policies which contribute to poor and water governance gaps (Msuya, 2010).

Poor governance in the context of this study refers to the failure to manage effectively human uses and their impacts on water and watersheds. Others include poor water allocation, failure to resolve conflicts among diverse interests and failure to mitigate pressure on water from diverse sources (Tropp, 2007). Thus, understanding how watershed governance works is vital towards sustainable water flow.

In Tanzania, watershed governance problems are key obstacles towards sustainable water flow along many rivers including the Pangani River Basin (PRB). A number of reasons contribute to this situation. They include degradation of catchment areas, lack of effective conservation measures, weak and uncoordinated plans for water allocation and rationing, to name just a few. Furthermore, governance is confronted with little responsiveness and accountability, lack of effective institutional set-up, poor accounting and valuation of ES from watersheds (Brandes, 2005; Costanza et al., 1997; Lopa et al., 2011). Fragmented (sectoral) water management approaches speak a lot for the current failure of the watershed conservation intervention strategies (Msuya, 2010; Mombo, 2013). The future existence and sustainability of watershed management options depends largely on the presence of both formal and informal institutions (Mbeyale, 2009; Msuya, 2010). While formal institutions provide constitutional framework where organizations and individuals are brought together in a positive manner, the informal organizations offers norms and informal sanctioning mechanisms to govern the ways of doing things (Msuya, 2010; Blomquist and Schlager, 2005; Ngana et al., 2010).

Responding to the international strategy on water and watershed governance, watershed management in Tanzania has undergone a major paradigm shift by transferring water management to the water user associations (Mbeyale, 2009; Msuya, 2010; Ngana et al., 2010).

Along the PRB the integrated water resource management has been in place for quite sometime through river basin management approaches and water user associations (Lein and Tagseth, 2009; Msuya, 2010; Lalika et al., 2015a). However, enforcement of policies, regulations, guidelines and local by-laws are handicapped with poor governance. For instance, research on how to bring together institutions working on water management (Sehring, 2009; Van der Zaag and Bolding, 2009) showed that local water management efforts were not often fully integrated into government water sector institutional reforms. Full integration entails harmonization of different policies into the same aim, objective, mission and vision; bringing together different management approaches into a single watershed conservation entity; harmonizing different watershed management levels into one management unit; and putting in place administration strategies aimed at solving water use conflicts between local communities and conservation organizations; upstream and downstream water users; hydroelectricity producers and other water users; local communities and foreign investors; smallholder farmers and livestock keepers; and local communities and river basin authorities (Mbonile, 2006; Msuya, 2010).

Lack of harmonization of different institutions aimed at watershed management normally results into unsustainable use of water resources and resource use conflicts. While Van der Zaag and Bolding (2009) argued that for any new water institution to be effective, it must be consistent with both the government and local-level institutions, Komakech and van der Zaag (2011) advocated that understanding the interface between locally developed water institutions and those created by the central government could add insight into the development of integrated catchment management institutions. Therefore, integration of water governance and watershed conservation by strengthening water user associations could enhance sustainable watershed conservation and water flow increase in the PRB.

Majority of small holder farmers along the PRB are engaging on irrigated agriculture. Inefficiency of rainfed agriculture caused by climate change and climate variability (Lalika et al., 2011; Lalika et al., 2015a) has forced smallholder irrigators to resort to irrigated agriculture as strategy to climate change and climate variability. These smallholder irrigators formed water user associations for monitoring water utilization along the PRB. However, the lack of effective water governance for water use fees collection is one of weaknesses of water user associations in the PRB (Lein and Tagseth, 2009). Irrigation officers at canal/village level lack commitment, patriotism, and working ethics in collecting water use fees.

Understanding water governance dynamics would enhance watershed conservation for sustainable water flow. The information could also be useful to policy makers for watershed conservation planning. The objectives of this study were to: (i) identify approaches for watershed conservation used in the study villages along the PRB; (ii) determine the role of water user associations along the PRB; and (iii) examine gaps and weaknesses in watershed conservation and water governance in the study areas along the PRB.

2. Materials and methods

2.1. Description of the study area

2.1.1. Location

This study was conducted in four villages, i.e. Kaloleni and Chekereni villages in Kilimanjaro Region and Karangai and Kikuletwa villages in Arusha Region along the PRB, Tanzania (Fig. 1).

The PRB drains the southern and eastern sides of Mt Kilimanjaro (5985 m) as well as Mt. Meru (4566 m), then passes through the arid Maasai Steppe in the west, draining some of the Eastern Arc Mountains (Pare and Usambara Mountains) which are the World biodiversity hotspots before discharging to the Indian Ocean at Pangani town. Along the PRB there are an estimated 3.8 million people, 80% who rely directly or indirectly on irrigated agriculture for their livelihoods (IUCN, 2007; IUCN and PBWO, 2008; Kamugisha, 2008).

2.1.2. Hydrology and drainage pattern

The hydrology and drainage pattern in the PRB catchment varies considerably both in space and time. The PRB comprises of several sub-catchments with widely different characteristics. The Pangani River which is referred (in other publications) as Pangani Mainstem rises as a series of several small streams and springs on the southern sides of Africa's highest peak, Mt. Kilimanjaro, and Mt. Meru (IUCN and PBWO, 2008; IUCN, 2007). These streams (Nduruma, Tengeru, Sanya, Malala, etc.) create the Kikuletwa and Ruvu Rivers (Himo, Muraini, etc.) which drain further downstream into the Nyumba ya

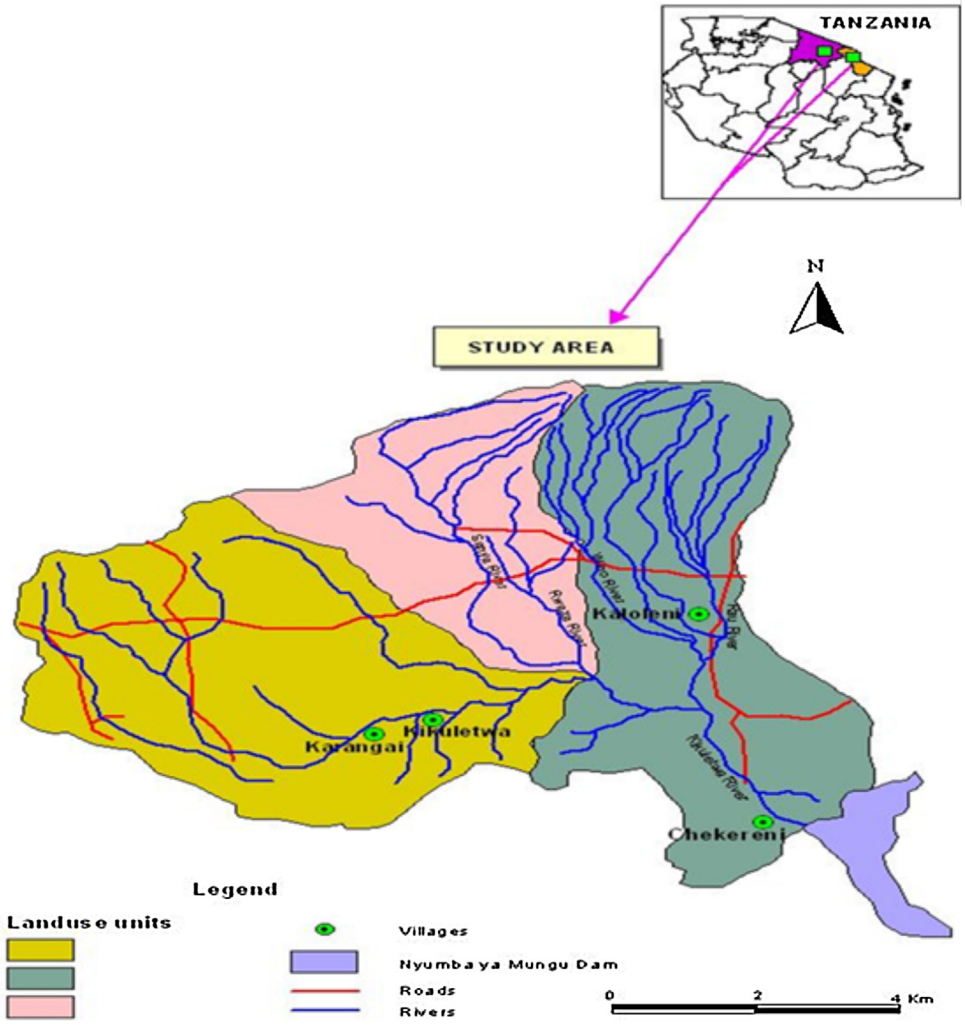

Fig. 1. Location of the study villages along the PRB, Tanzania.

Mungu Dam (IUCN and PBWO, 2008; IUCN; 2007). It is the largest water body in the PRB and was constructed in 1965 to enhance river flows for hydropower generation (Mulungu, 1997; Sotthewes, 2008; Ndomba et al., 2008).

2.1.3. Forest and climate

Vegetation in the PRB range from forests on mountain slopes to semiarid grasslands (IUCN, 2003). Major vegetation includes forests, woodlands, bushland, along with grassland thicket and plantation forest (Lambrechts et al., 2002; Turpie et al., 2005; Shaghude, 2006). Forests perform vital hydrological functions in the PRB including the regulation of run-off, prevention of soil erosion, water storage and improvement of water quality (Mehari et al., 2009; Kaoneka, 1993; Newmark, 1998). Variations in the local climate in the PRB are mostly related to topography. The flatter, lower-lying south-western half of the Basin is arid and hot, while the mountain ranges along the northern and south-eastern catchment boundaries have cooler, wetter conditions. The high altitude slopes above the forest line on Mount Meru and Mount Kilimanjaro have an Afro-Alpine climate and receive more than 2500 mm of rainfall per year.

2.2. Data collection

2.2.1. Sampling procedure

We adopted purposive sampling procedure where four villages were earmarked for the questionnaire survey (two in Arusha and Kilimanjaro regions, respectively). Our decision on the location of the villages was based on their proximity to rivers and the reliance of the local communities on water for irrigation. Based on these two criteria, our main target was smallholder irrigators. Within each village, we selected respondents using a table of random numbers that corresponded to the household numbers in the village register.

Household heads were the target for interview, but wherever the head of the household was not around we randomly picked any household member within that particular household who had 18 years and above. According to Tanzania regulations and laws, any one at 18 years and above is regarded as mature person. We adapted the 10% sampling intensity giving a total of 216 respondents were interviewed (Table 1).

2.2.2. Data collection method

During data collection both quantitative and qualitative research approaches were used to collect primary and secondary data. We used structured questionnaires as the main tools to collect primary (quantitative) data. Questionnaire items comprised ques-

Table 1
Interviewed household heads in the study villages.

Region	Village	Total households	Sample size	Sampling intensity (%)
Kilimanjaro	Kaloleni	490	49	10
	Chekereni	550	55	10
Arusha	Kikuletwa	640	64	10
	Karangai	480	48	10
	Total	2160	216	10

Table 2
Summary of data collection methods and target groups.

Objective	Method	Target group
i) To identify methods for watershed conservation	Structured questionnaires	Smallholder irrigators
ii) To identify water user associations and determine their water right and water use fee for irrigation water	Structured questionnaires, group focus discussions, in-door and open consultations, and literature reviews	Smallholder irrigators, irrigation engineers, extension officers, canal managers, leaders of WUAs, irrigation committees and influential farmers,
iii) To identify and examine gaps in watershed conservation and water governance.	Face to face interviews, informal and formal interviews, methodology and framework used by OECD and literature reviews.	Smallholder irrigators, influential farmers, and committees responsible for water management, allocation, rationing, enforcement, collecting water right and water use fees.

tions mainly on water utilization, types of water sources, types of water user associations, amounts paid by individual irrigators to canal managers for water uses, amounts of water right paid by water user associations to PBWO, methods used for watershed conservation, to name just a few.

To collect qualitative data, we carried out a series of in-door and open consultations with individuals and different committees in order to collect data on watershed conservation and water governance. Summary of the methods used to collect data for each objective are presented here under in Table 2.

At the Regional and District levels, we consulted the Water Officer (the head of the PBWO in Moshi), the IUCN Water and Nature Initiative (WANI) officer in Moshi, the District and Municipal irrigation officers (in Meru, Moshi Urban and Moshi Rural).

At the local (field) level, we organized group focus discussions. Participants include Ward and Division agriculture extension officers, chairmen and secretaries of water user associations within the PRB (i.e. Kaloleni, Shamima, Mbukita, Kitamaka and Kammmama), canal irrigation managers, canal irrigation treasurers and influential smallholder farmers.

Moreover, we held discussions with water management committees, water allocation and rationing committees, and committees responsible for enforcing water utilization by-laws, and committees responsible for collecting water right and water use fees. The aim was to solicit information on governance gaps with respect to accountability, transparency and effectiveness of the prevailing water management structures. In order to achieve this aim, we carried out face to face interviews and informal and formal discussions. Furthermore, we adapted the methodology and framework used by Organization for Economic Co-operation and Development (OECD) (OECD, 2009). Under this framework, we gathered information from these committee members on who is responsible for what in terms of water allocation, water rationing with regards to agro-ecological zones, collection of water use fees, rehabilitation of irrigation canals, at different levels and how such responsibilities are defined in their local by-laws. Dialogues were sometimes held in focus group discussions and in some instances we separated them in mini groups in order to allow freedoms of expression.

Key issues during these discussions were: administrative matters, accessibility to information, policy relevance, staff capacity, funding constraints, conservation objectives, and level of accountability of staffs. Results are presented in Table 4. In addition, we discussed about policy instruments with regards to watershed and water governance along the PRB. Policy tools that we focused much on includes: technical, economic, administrative, legal, institutional and social/participatory tools (Plummer and Slaymaker, 2009). Summary of findings these discussions are displayed in Table 5.

Furthermore, we visited different libraries, offices and internet links in order to collect secondary data. We searched, collated and reviewed relevant literatures on watershed conservation, water utilization, water governance and irrigated agriculture (Okurut, 2011; Lalika et al., 2011).

2.3. Data analysis

The 216 structured questionnaires were coded and cleaned for final analyses. We used Statistical Package for Social Sciences (SPSS) version 20.0 to analyse all quantitative data from questionnaires. There after we carried out multiple responses to obtain frequency and percentages of responses from smallholder farmers.

For qualitative data on governance, we adapted the Multi-level Governance Framework (MGF) tool (Akhmouch, 2012) to diagnose water governance challenges, governance gaps, transparency and accountability in the PRB. Also, participants during group focus discussions and on-door meetings assisted us to analyse qualitative information through *"content analysis"* approach, a qualitative method which involve dialogue and intensive heated debates. Under this analysis approach, we extracted, examined and digested contents from texts, themes and patterns that manifest in a particular text. This approach was quite useful in our study because it allowed us to break down collected data in a participatory way and understand social reality in a subjective but scientific manner. It is from these hot dialogues and debates that we extracted key information which is summarised in Tables 4 and 5.

Through careful data preparation and interpretation, the results of qualitative content analysis can support the development of new theories and models, as well as validating existing theories and providing thick descriptions of particular settings or phenomena.

3. Results

3.1. Approaches for watershed conservation in the PRB

Results on watershed conservation methods indicated two categories of approaches for watershed conservation in the PRB. These approaches are based on responses from the 216 household questionnaires. The first approach is retaining riparian (*in situ* conservation) vegetation around water sources, and the second one involved applying human approach / interventions (e.g. planting

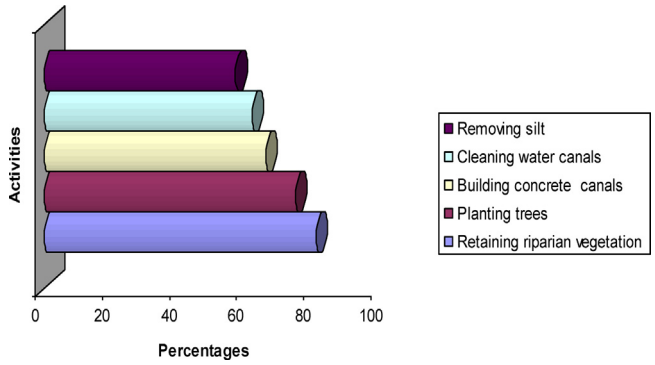

Fig. 2. Responses on methods used for watershed conservation along the PRB, Tanzania.

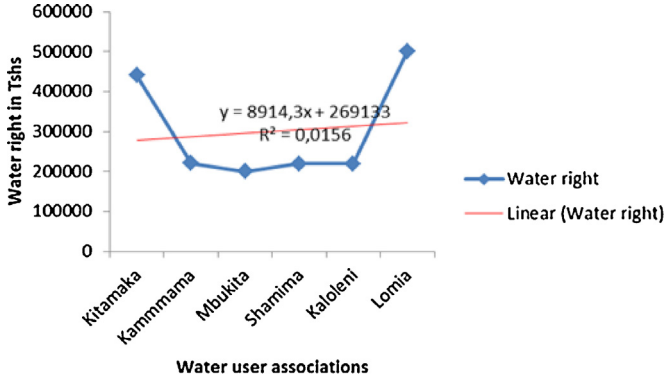

Fig. 3. Water user associations in the PRB, Tanzania.

trees). Other interventions encompass building concrete canals, cleaning water canals and removing silt in both water intakes (springs) and irrigation canals (Fig. 2).

Retaining riparian vegetation (Fig. 2) was preferred by majority of smallholder farmers (the 216 respondents) as the alternative approach as compared to other approaches (Calder, 2007; Lalika et al., 2015b; Timothy and Ekness, 2013). Some of the trees conserved in their natural habitats include *Rauvolfia caffra*, *Melicia excelsa* and *Ficus sycomorus* and varieties of herbs species. From conservation point of view, retaining natural vegetation (*in situ*) is the better than other approach over others due to its multiple benefits. These multiple benefits include ecosystem functions and services such as: climate regulation, soil erosion control, air purification, water regulation, carbon sequestration and biodiversity conservation, to name a few. Approaches that involved human interventions are tree planting around water sources, building concrete canals (to reduce water loss through infiltration and retard sedimentation), cleaning water canals, and removing muds and silt in the canals (Fig. 2). These human interventions are mainly enforced by water user associations.

3.2. Water user associations and fees for irrigation water

3.2.1. Water user associations in the PRB and water rights

In this paper, a water user association refers to the consolidated group of smallholder farmers sharing common interests with respect to irrigated agriculture. We identified seven water user associations in the study area. They include: Kaloleni Irrigation Scheme; Lower Moshi Irrigation Association (LOMIA); *Shango Migungani and Madukani* (SHAMIMA); *Mbuguni, Kikuletwa and Kambi ya Tanga* (MBUKITA); *Kikwe, Taran, Maweni and Karangai* (KITAMAKA); and Karangai, Msitu wa Mbogo, Marurani and Majimoto (KAMMMAMA) (Fig. 3).

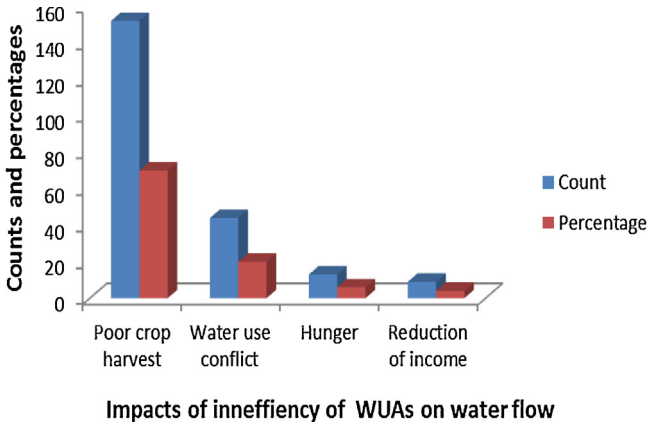

Fig. 4. Impacts of inefficiencies of water user associations (WUAs) in the PRB, Tanzania.

Table 3
Drivers for water reduction along PRB, Tanzania.

Factors	Counts	Frequency
Ineffective water user associations	90	41
Climate change and variability	50	23
Water abstraction by foreign investors	38	18
Population increase	29	13
Degradation of watersheds	11	5

Water user associations were established in the PRB to bring together smallholder farmers in their quest for improved supply of irrigation water. However, these associations are facing many difficulties. For instance results from focus group discussions indicated that MBUKITA collapsed due to failure of leaders to convene regular meetings with members (i.e. smallholder irrigators) as per the by-laws and guidelines, failure to give revenues and financial expenditures on regular basis and delay to submit water use fees to the PBWO in Moshi headquarters. Moreover, MBUKITA leaders tended to favour politicians and top civil servants during water rationing. For instance, MBUKITA disintegrated due to poor leadership and unfair irrigation water rationing. This downfall led to the MBUKITA split and formation of new sub-canal leadership. Other problems includes misuse of leadership positions, lack of accountability among leaders, political interference, swindling of collected water user fees, poor enforcement of by-laws, and difficulties in bringing together all water stakeholders along the PRB.

Generally, water user associations are quite essential for facilitating water resources governance at local level (Komakech et al., 2011). In the PRB, water user associations facilitated water management decisions (water allocation and rationing), by-laws formation, supervision and development of water resources infrastructures (e.g. establishment new irrigation canals). Moreover, we found that other objectives behind the formation of these water user associations in the PRB were to enhance equitable allocation for irrigation water, water rationing, and collection of water use fees from small holder farmers. However, inefficiency of these water user associations led to water reduction along the PRB. Fig. 4 shows impacts of inefficiencies of water user associations and Table 3 reveals the drivers for water reduction along the PRB.

These impacts revealed in Fig. 4 encompass poor crop harvest (70%), water use conflict (20%), hunger (6%), and reduction of income (4%).

Drivers for water reduction are indicated in Table 3. These are ineffective water user associations (41%), climate change and variability (23%), water abstraction by foreign investors (18%), population increase (13%) and degradation of watersheds (5%).

Table 4
Water use fees for irrigation water in the PRB, Tanzania.

Region	Village	Attribute	Fees paid by irrigators to WUAs (Tshs)/season	Water right paid by WUAs to PBWO (Tshs)/year
Kilimanjaro	Kaloleni	Mean	3002.30	220000.00
		Maximum	35000.00	
		STD	4962.40	
	Chekereni	Mean	24005.50	500000.00
		Maximum	70000.00	
		STD	10926.20	
Arusha	Kikuletwa	Mean	44250.80	220000.00
		Maximum	600000.00	
		STD	12852.90	
	Karangai	Mean	12222.20	441000.00
		Maximum	36000.00	
		STD	7098.00	

Table 5
Watershed conservation and governance gaps in the PRB, Tanzania.

Governance gaps	Findings
Administrative gap	We found that it is a bit tricky to manage a watershed and its river tributaries because it is a common pool resource with no political or administrative boundaries. In the PRB rivers, natural springs, and ground water are natural resources that have no administrative rather had ecological boundaries. Thus management of such kind of key resources is difficult and controversial. During the meetings, it was even difficult to tell exactly the sources of the rivers, who was responsible for management, and who the upstream and lower stream actors were. These in turn poise difficulties about its management options and governance at large.
Information gap	We found that crucial information with regards to water governance is not shared adequately among key actors and players. For instance PBWO does not share crucial information with other water users and authorities. For instance, information on how much is collected as water user fee, how much is paid to PBWO as water right, and how much is given as subsides for water infrastructure rehabilitation does not go as far as to the local authorities. In turn, it prohibits policy makers and researchers to access crucial information for planning and decision making.
Policy gap	We noticed that there was a lack of concrete integrated (joint) water management plans between different policies dealing with natural resources management across the PRB. For instance, we identified a lack of coherence among ministries and sectors (e.g. forest, water, mineral and agriculture) related to ES management. Respective sectoral ministries lacked effective joint actions and strategic plans with regards to watershed management. Each sector implemented its plans in isolation and not as a single unit or in a holistic approach.
Capacity gap	Like in other river basins in Tanzania, we identified that the PRB faced a lack of competent staff for shouldering high administrative, technical, information dissemination and coordination responsibilities. At the local level, we found a lack of competent officers for ensuring water allocation, equitable water distribution and rationing. We also identified weaknesses in collecting water use fee. There were no well trained staff for handling financial matters, in turn, smallholder farmers were extremely sceptical about the fate of their financial contributions.
Funding gap	We found that government funds were geared towards the provision of social services (i.e. health, education and road construction) at the detrimental of nature conservation. Our observation indicated that watershed conservation for sustainable water flow seemed to be the responsibility of conservation institutions (like WWF and CARE international), and local conservation Non-Governmental Organisations (NGOs). Even government agencies and municipal authorities seemed to care less about setting aside funds for conservation, ultimately undermining the entire governance aspects with regards to conservation, water supply and allocation. For instance findings by Lalika et al. (2015b), shows that financing watershed conservation in the PRB was not given an outstanding priority as compared to other sectors like health, education and road construction. Even the PBWO (the government agency responsible for collecting water user fees and allocating money for water infrastructures) had a budget projection of €159490, 62 and €329665, 85 for 2004/05 and 2008/09 financial years respectively. Surprisingly, only €82693, 72 and €234537, 77 was made available for 2004/05 and 2008/09 financial years respectively.
Objective gap	We identified contradicting interests (trade-offs) between conservation (sustainability) and livelihoods (water utilization) objectives. While conservation organisations (WWF and the forest sector) are dedicated to nature conservation and sustainable natural resources use, on the contrary, water abstractors (e.g. Arusha and Moshi Urban Water and Sewerage Authorities focused much on water distribution and supply regardless of the status of the watersheds where water originated. We noted further that, in some instance, politicians seemed to fight for equitable water allocation (for political gains) without considering the integrity of the sources and the capacity of the watershed to release quality water of recommended quantity.
Accountability gap	We also documented conflicts over unfair water allocation and rationing caused by lack of transparency, responsibility and corruption. It was reported that some of irrigation officers had personal hidden agendas for personal gains in water rationing. Normally, these officers conspired with foreign investors (e.g. flower irrigation companies) over unfair water allocation at the detrimental of smallholder farmers located downstream. Similarly, transparency in revenue collection, water use fees and expenditure was a case in point with regards to accountability and transparency. This was vividly exemplified by the demise of MBUKITA water association.

Source: Adapted from OECD methodology presented in Charbit, 2011).

Ineffective water user associations (41%) along the PRB were reported to be the leading driver for water reduction. We also identified indicators for water reduction along the PRB (Fig. 5). They water use conflicts (43%), Water shortages (17%), river bed visibility (15%), drying of crops (14 %), and drying of water sources (11%).

The ineffectiveness could be due to incompetency of water irrigation officers, insufficient funds collected for as water use fees. Related findings were reported by (Komakech and van der Zaag, 2011) that river committees were important local institutions for managing water allocation and solving water use conflicts between water user actors in Themi River Sub-Catchment in the PRB.

In addition, in some cases, local communities in the study areas lacked a clear understanding about water user association. And this had adverse impacts on smooth operations of water user associations. For instance, findings from secondary information indicated that some of the water users were not aware of the components / contents of the water use permits. For instance, to get a water (permit) right in Tanzania, any water user associations is required

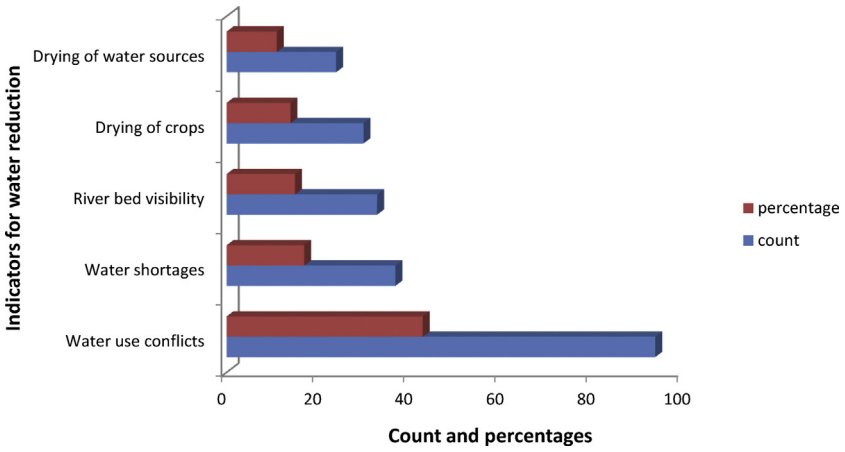

Fig. 5. Indicators for water flow reduction along the PRB, Tanzania.

to be aware of the following special requirement: (i) That your abstraction is subject to inspection by the Pangani Basin Water Office at least once annually; (ii) That the annual water abstraction charges shall be paid as prescribed in Water Resources Management Act No. 11 of 2009 made under Section 96; (iii) That in case of drought or any Public interest your Water Permit will be subjected to review; (iv) That the water after use in the farm shall not be retuned in the river or any other source in a polluted state; (v) That the grantee shall always allow water to flow downstream; (vi) That the grantee shall install a water flow measuring device at the intake before putting water into use and keep records of daily amount of water abstracted; (vii) That the grantee shall submit the records when required; and (viii) That the grantee shall be a member of the Water User Association of their respective area. Unfortunately, during FGDs, we noted that these key issues were not well known to the members of water use associations.

We also noticed differences in the amount of water right fees paid to PBWO. Among the six water user associations that we investigated, *Kitamaka* (i.e. Tshs 441,000.00) and *Lomia* (i.e. Tshs 500,000.00) paid the higher fees as compared to other water user associations. As depicted in Fig. 3 associations located at the extreme ends (upper and lower parts) paid higher water fee than those found in the middle part of rivers. The plausible explanation for the variations is that upstream villages have plenty water so they pay much in the view that the amount would cater for watershed conservation for sustainable water flow. On the other hand lower stream villages were motivated to pay higher amount of water right in view of financing water infrastructures. Water rights for other water user associations are Tshs 220,000.00 (for both *Kaloleni* and *Shamim*a), Tshs 221,000.00 (for *Kammmama*) and Tshs 200,000.000 (for *Mbukita*). According to interviews with irrigation and the PBWO staff, however, the differences in the amount of water right fees depended on the original contracts signed during the establishment of each water user association.

Other factors include the total number of smallholder irrigators per water user association, revenues from crop sales, willingness of farmers to contribute water use fees, water availability for irrigated agriculture, transparency and efficiency fees collection.

3.2.2. *Water use fees for irrigation*

We determined two categories of water use payments. First, fees for water utilization by smallholder farmers to water user associations, and secondly the cumulative yearly payment by water user associations (water right) to the PBWO (Table 3).

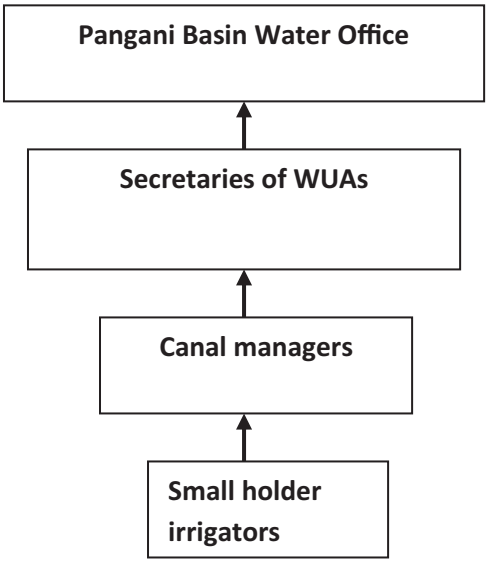

Fig. 6. Water use payment structure in PRB, Tanzania.

Table 4 reveals standard deviations for fees paid by smallholder farmers to water user associations (Tshs/season). The following are the results in descending order: Tshs 12, 852.90 (in Kikuletwa village), Tshs in 10,926.20 (in Chekereni village), Tshs 8743.00 (in Rau River village), Tshs 7098.00 (in Karangai village), and Tshs 4962.40 (in Kaloleni village). Higher standard deviations implies that the marginal utility or intrinsic value of water to smallholder farmers Kikuletwa and Chekereni villages is higher (Tshs 12, 852.90 and in 10,926.20 respectively) than in Karangai and Kaloleni (Tshs 7098.00 and 4962.40, respectively). And this intrinsic value influences water allocation and water rationing within sub-basins and irrigation canals across and within villages. We also investigated the payment structure for water (permit) right and irrigation water. The payment hierarchical structure is displayed in Fig. 6.

Under the systematic payment order displayed Fig. 6, small holder farmers paid the water use fees to their respective canal irrigation managers. Then these canal irrigation managers handed over the fees (collected from smallholder farmers) to the higher authority (i.e. to the secretaries of water user associations). Finally, secretaries of different water user associations submit the money collected to the final destination (i.e. PBWO). Normally the collected water use fees were meant to cater for rehabilitating irrigation

Table 6
Policy instruments for water governance in the PRB Tanzania.

Policy instruments	Findings
Technical	We found that water allocation and rationing are governed by different authorities. Canal irrigation managers and WUA secretaries were the key people responsible for by-law enforcement for equitable and fair allocation and rationing in their respective water gates, canals and administrative locations. Water shortages in water sources, however, caused a lot of complains and loss of faith among smallholder farmers.
Economic	Our findings with regard to economic instruments indicated substantial reduction of subsidies and financial assistance from PBWO, political leaders and research institutions. There was lack of financial support from Legislators and Members of the Parliaments. We, however, found clues of supports from religious and academic institutions, international and local non-governmental organisations undertaking conservation projects in PRB.
Administrative	We documented that administration failures increased water use conflicts in PRB. The existing administration structures were ineffective, scrappy and uncoordinated with poor water governing institutional structures. Leaders of water WUAs had no power to deal with political leaders (Ministers, Members of the Parliaments, Councillors and Civil servants) who had irrigation farms within their administrative areas.
Legal	We found a clear violation of laws and by-laws with regards to water utilization guidelines. Illegal water abstractions and diversion were reported in almost every meeting that we carried out. According to the guideline for water permit issuance by the Water Ministry, water is supposed to be used according to "Water Resources Management Act, 2009 (URT, 2002). Unfortunately, it was reported that some of these illegal water abstractors were senior government leaders whose tasks was to enforce equitable and equal water allocation and distribution.
Institutional	We identified problems related to ineffective local institutions, lack of clarity of roles and responsibilities with respect to water and watershed management. Furthermore, division of tasks were rather weak and this fuelled conflicts of interest and tug-of-war over power within WUAs. Other shortcomings include questionable resource allocation and untrustworthy financial management.
Social/Participatory	Majority of smallholder irrigators were aware of the existence of "water use permit" initially called "water use right". But it was extremely difficult for them to mention even a single sentence about their right. Smallholder farmers were relatively aware of water management but their effective involvement in planning for watershed conservation and financing water infrastructures was rather low.

Source: Modified from Plummer and Slaymaker, 2007.

(canals) infrastructures and financing other water management operations (Lein and Tagseth, 2009).

3.3. Gaps in watershed conservation and water governance in the PRB

We examined watershed conservation and water governance challenges by adopting seven factors from Charbit (2011). They include administration, information, policy, capacity, funding, objectives, and accountability. Results of our analysis are presented in Table 5.

As explained in Table 5 river basins are an administratively shared nature wealth and require integrated management strategies. We also found that weaknesses in information dissemination, policy constraints and low capacity of technical staff were undermining watershed management and water governance in the PRB. Moreover, lack of adequate funds for financing watershed conservation; contradicting objectives for watershed conservation and lack of accountability and transparency were equally reported as among the challenges contributing to uncertain future of watersheds and their capacity to release water in a sustainable manner. We also identified policy instruments for water governance in the PRB. Results of our assessment (based technical, economic, administrative, legal, institutional and social) are presented on Table 5.

4. Discussions

4.1. Methods for watershed conservation in the PRB

From a conservation point of view, riparian vegetation is an ideal approach for sustainable watershed conservation and supply of multiple ES. Natural vegetation such as trees, herbs and climbers within natural habitats (*in situ* conservation) enhance multiple ecological functions (Costanza et al., 1997; de Groot et al., 2010). Like in Moshi where natural trees are conserved around Kilimanjaro Mountain National Park, Goa and Miwaleni springs, in the Arusha region riparian vegetation around River Nduruma water source facilitate provisioning service by filtering and maintaining water balance at the source. Apart from being the home of biodiversity, riparian vegetation in Meru and Kilimanjaro Mountains are the water towers in the PRB, thus promoting watershed conservation would guarantee sustainable water flow and water quality improvement as well (Calder, 2007).

Tree planting offers multiple socio-economic and ecological benefits as well. In the PRB planted trees along the mountain slopes has been instrumental in soil erosion control, retarding sedimentation, siltation and restoration of degraded forest catchments (Msuya, 2010; Notter, 2010; Ngana et al., 2010). Tree planting along Meru and Kilimanjaro Mountain is carried out by the Ministry of Natural Resources and Tourism through the Forestry and Beekeeping Department, non-governmental institutions, private firms and individuals. However, forests contributions to sustainable water resources management is still a debatable topic. Problems have often arisen from a failure both to communicate results effectively to policymakers and planners, and to challenge entrenched views, and new approaches (Mwanyoka, 2005).

4.2. Water user associations and fees for irrigation water

Water user associations are important vehicles for irrigation enhancement along the PRB. However, the challenges mentioned in section 3.3 contribute enormously to the failure of water user associations to achieve their missions and targets. These failures of water user associations are aggravated further by the drivers for water flow reduction as listed in Table 3. Climate change and variability (Lalika et al., 2015a) affects water and environmental flow (i.e. quality, quantity and timing) along the PRB which affect small holder farmers living downstream. The situation is worsened by ineffective water user association and poor water governance. For instance enforcement of actions and by-laws has been a stumbling block for quite sometime. Poor governance and weak water user associations contribute to the current skewed distribution and allocation of irrigation water. Enforcement of by-laws and failure of water user associations to mediate water use conflicts are among the poor water governances across the PRB. The weakness and failure of water user associations is exemplified by the collapse of MBUKITA due to lack of accountability and transparency in revenues and expenditures. Poor governance in water allocation and rationing has further aggravated the situation.

The impact of inefficiencies of water user associations (Fig. 4) typifies the problems along many river basins in Tanzania including in the PRB (Lein and Tagseth, 2009). For instance, these impacts in Rau River and Kikuletwa villages have led to rivalry among small holder farmers and upstream large scale farmers (Mbonile, 2005). Similarly, we identified that in recent years crop yield has gone down due to inefficiencies of water user associations. For example, the study villages the crop harvest ranged from 3 to 11 bags per hectare. According to the Meru District Agriculture Extension Officer (personal communication) when there is ample rainfall or plenty irrigation water, maize harvest is normally from 30 to 40 bags of maize per hectare.

Water flow irregularities are contributed by illegal abstraction by companies mainly from USA and Western Europe carrying out irrigated agriculture (mainly horticultural crops). Other inefficiencies of water user associations to enforce fair water allocation and rationing the in the PRB results include water hunger and reduction of cash income. Similar sentiments along these aspects were reported by (Komakech and van der Zaag, 2011) who found that river committees were ineffective to downstream users because enforcement of the water allocation schedule was a problem due to bribes for water use outside the legal hours. Given that misallocation and corruption is a governance problem, something has to be done for the future efficiency of water user associations and sustainability of water flow (Matthews, 2012).

Smallholder farmers are quite aware of the need for paying for irrigation water. As revealed in Table 4, the standard deviations for Kikuletwa and Chekereni are higher as compared to standard deviations for Karangai and Kaloleni villages. This remote location (far downstream) has implication on water availability, utilization and rationing. Kikuletwa and Chekereni villages are located at the far downstream part (Fig. 1) where water demand and competition is higher than in Karangai and Kaloleni villages. Thus being located upstream, Karangai and Kaloleni villages experience water in abundance and the competition is a bit smaller as compared to Kikuletwa and Chekereni which are located at the extreme downstream. So there is a need for regulating equal and fair water allocation and rationing between upstream and downstream villages.

Similarly, equal distribution of water for smallholder farmers within villages is essential and could motivate smallholder farmers to increase water use payment for unit increases of irrigation water. Thus deliberate measures need to be enforced so as to improve the efficiency of water user associations and improve the water governance and watershed conservation.

4.3. Gaps in watershed conservation and water governance in the PRB

As indicated in Table 5, fragmented, antagonistic interests and priorities of sectoral policies are hindrance to watershed conservation and governance. Shortage of competent technical staff, corruption, lack of accountability and transparency are key constraints precluding irrigated agriculture in the PRB. From the analysis on seven parameters displayed in Table 5, corruption and lack of transparency affect negatively the fair and equal water allocation and rationing. Rich people bribe water canal irrigation managers for illegal water allocation contrary to the set-down bylaws. Some of canal irrigation managers and secretaries of water user associations are bribed by foreign investors for illegal water abstraction and allocation. Water abstraction and excessive withdrawals affect water flow, economic activities and ecological processes downstream. Our discussions during in-door meeting indicated that foreign firms/investors are no longer perceived as investors, rather they are enemies of smallholder farmers and water grabbers (Mathews, 2009; Woodhouse, 2012; Mehari et al., 2009; Duvail et al., 2012; Williams et al., 2012). Thus, our opinion is that we should invest on capacity building by governing people first. It is through investment on capacity development that watershed conservation and water governance could be achieved. Although Plummer and Slaymaker (2007) advocate that strong and effective capacity building is vital for sustainable water management programmes, in some instances, capacity building may not yield the desired results.

In this connection, capacity building should target first the irrigation engineers and irrigation extension workers who are the key actors in enhancing water utilisation along the PRB. Once the extension officers are empowered, it would be easier for them to create smallholder farmers' knowledge on water user right (permit) and other shortcomings identified in Table 5. It is against this background that deliberate measure should be put in place in order to build the capacity of water users and other stakeholder along the PRB. Once stakeholders are aware of watershed conservation approaches and water governance dynamics, then it would be easier for them to understand their roles, responsibilities, knowledge on water use by-laws, to mention a least.

Similarly, the current study attempted to link water governance gaps with policy instruments. As revealed in Table 6 the disjoint between theory and practice is among the challenges for water governance in the PRB and most of river basin management in developing countries (Calder, 2007; Mehari et al., 2009; Franks et al., 2011).

With respect to awareness and policy issues, majority of smallholder farmers didn't know exactly about water right (water use permit) and were not aware of the conditions governing water user associations. Surprisingly enough, even the water user associations leaders didn't know the whereabouts of this important document. It is from this background, we feel that awareness creation should be a priority for if water governance is to be achieved. Once smallholder famers are aware and well informed about it, it would be easier for them to translate issues from theory to practises.

On the other hand smallholder farmers have no problem with the current structure of payment for irrigation water (Fig. 6). This payment structure is convenient and even easier to them. But their doubts are those individuals (people) who misuse water use fees. The operationalization of this payment setup faces a lot of governance shortcomings including corruption, lack of accountability, transparency and administrative failures as elaborated in Table 6.

5. Conclusions

The present study has indicated that retaining riparian vegetation in their natural habitat is the recommended approach for conservation of watersheds in PRB. This is an important lesson especially to ecologists and communities residing along river basins facing similar problems like in the PRB. The potential and usefulness of riparian vegetation lies in the fact that they have multiple benefits. Apart from enhancing water flow, riparian vegetation enhances ecological functions and provision of multiple ES. Nevertheless, despite a number of scientific reports linking conservation of riparian forest and water flow, a lot is yet to be researched in order to verify the clear link.

Enhancing smallholder farmers to form and strengthen existing water user associations along the PRB is essential for sustainable watershed conservation and water flow as well. The presence of water user associations in the study area is a testimony of the implementation of the Dublin Principles (Lein and Tagseth, 2009) on public involvement and decentralization of resource base conservation at local level scale. Devolution of power at the lowest local level (Dublin Principles) is also echoed by the study by Komakech and van der Zaag (2011) who found that formation of river committees were key towards lessening water use conflicts and sustainable

water management along the PRB. Despite the prevailing challenges facing water user associations, findings of the current study are key for policy makers on the urgent need of letting the power go to the lowest level (Ostrom, 1990; Ostrom and Schlager, 1996; Ostrom et al., 1993). The weaknesses and challenges facing water user associations would form the basis for sustainable watershed conservation, water governance, and hence sustainable water flow along the PRB.

Watershed conservation and water governance are among the contemporary challenges of our time across the globe. Watershed conservation and challenges facing water governances reported in this study indicates clearly why we need to increase efforts in the quest for nature conservation. Thus, dedicating our efforts to governance improvement would bring about the desired outcome. Improving watershed conservation and water governance should go hand in hand with efficient, effective and transparency in water use fees collection, handling and utilisation. It is through good water governance that smallholder farmers would be motivated to contribute more water utilisation.

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