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In search of socio-ecological resilience and adaptive capacity: articulating the governance imperatives for improved canal management on the Barotse floodplain, Zambia

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Abstract: Governance of the commons through collective action remains an ongoing challenge in many rural areas of Africa. In this paper, we articulate how resource governance systems and proprietorship have affected management of canals on the Barotse floodplain in Zambia. We draw from community-based natural resources management and socio-ecological resilience theories to unpack the role of governance in enabling collective action for the management of common pool resources. Our analysis establishes that it is not only the maintenance of the physical infrastructure that matters in governing the commons and ensuring socio-ecological resilience but also the sustenance of collective action among users and key actors. However, when a whole range of uncoordinated national and local institutional structures are active at the local level, proprietorship over the resource is contested and management of the canals becomes sub-optimal. There are clear indications that shifts in political authority from the local to the national level of government in Zambia have negatively affected the institutional arrangements for management of canals on the Barotse floodplain leaving both social and ecological components of the system open to neglect. We conclude by suggesting that the absolutely necessary ingredients for effective operation, maintenance and governance of the canals include ensuring that proprietorship over the resource remains with the users and bottom-up planning approaches are enabled.

Keywords: Adaptive capacity, canal management, commons, floodplain, resilience

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I. Introduction

Governing the ‘commons’ through collective action has been on the agenda of national and international development actors for several decades. It remains an ongoing challenge in many rural areas of Africa. In trying to address this challenge, some scholars have emphasized the importance of governance systems, property rights regimes and ‘*proprietorship*’ (ownership) in enabling sustainable community-based natural resources management (CBNRM). This view is manifest in scholarship from writers such as Murphree (1991), Murombedzi (1991), Chikozho (2010), Measham and Lumbasi (2013), who argue that in sustainable CBNRM, the unit of proprietorship should be the unit of production, management and benefit. The users must also perceive sustainable management of the resource in question as beneficial to them if they are to be motivated to conserve it.

In this paper, we analyse the main governance issues affecting the management of canals on the Barotse floodplain in Zambia, paying particular attention to the institutional dimensions of the canal governance system and the extent to which proprietorship over the canals influences the users’ behaviour and the sustainability of the canals. Thus, we engage with questions about effective canal rehabilitation and maintenance (or lack thereof); who should be held responsible for these functions; why the canals have deteriorated over time and space; and how best to address the deterioration in a more lasting manner that can improve the adaptive capacity and resilience of communities in the area. The main objective of the paper is to decompose key issues relevant to governance in a CBNRM context and proffer suggestions for improving management of the canals as common pool resources shared by communities residing on the Barotse floodplain.

In the paper, we define governance as the process by which decisions are made and authority is exercised regarding the use and maintenance of the canal system (see Ratner et al. 2012; Madzudzo et al. 2013). It is mainly constituted by the formal and informal rules that determine the right to access and use common property resources (in this case the canals) as well as the ownership dimensions that may determine commitment to sustainable resource utilization. This includes the relevant policy and institutional frameworks, customary practices, ownership domains, and relations of power and authority evident in this terrain (see Cousins 1997; UNDP 1997). We also define proprietorship as sanctioned use-rights that include the right to determine the mode and extent of management and use, rights of access and inclusion, and the right to benefit fully from use and management of the resource in question (Murphree 1994).

While we are also keenly interested in resilience as an analytical concept, we do not purport to exhaust all the possible aspects of the concept with which one might engage in the context of the Barotse floodplain canal system. Indeed, that is neither possible nor desirable within the confines of our main objectives. What we seek to do is to zero-in on those aspects that appear vital to the improved understanding of the management of canals in a floodplain context and how issues about governance and proprietorship affect operation and maintenance of the canals. The paper brings sharper focus to bear on the theoretical foundations on which CBNRM is based and the challenges that emerge when proprietorship over local resources is loosely spread across various uncoordinated actors and institutions. The paper is intended to inform the policy agenda of practitioners and scholars who grapple continuously with the challenges that arise in the management of commons.

2. Methodology

This paper is a product of a qualitative stakeholder-oriented study that uses the canal system on the Barotse floodplain as a case study to demonstrate how governance and proprietorship arrangements affect local resource management. Getting a good understanding of the intricate and numerous social relationships and processes guiding use and management of the canals at the local level required us to spend time on the floodplain and interact with the communities. We sought to find out how various actors relate to the biophysical aspects of the hydraulic infrastructure (canals); how they interact and relate to each other; the resource governance structures at national and local levels; evident external and internal factors and actors influencing resource sustainability; and ultimately, options for improving resilience and adaptive capacity of the communities dependent on the canal network. By addressing all these components, we ended up interrogating empirical and theoretical ground common to social ecology and institutional aspects of CBNRM.

Empirical data gathering was conducted from March to December 2014. A detailed review of the available literature was combined with evidence from primary data gathered through key informant interviews, focus group discussions held with some of the communities using the canals, transect walks, and direct observations made across the floodplain. The main intention was to produce a detailed narrative that clearly articulates the perceptions and lived-experiences of people who have been involved in the use and management of canals on the Barotse floodplain. This also included asking questions about how historical and current resource governance and proprietorship arrangements have affected canal management and, by extension, socio-ecological resilience? Which are the relevant institutions and relationships that one should pay attention to when considering institutional re-arrangement for better canal management? In essence, we sought to find out why the canals on the Barotse floodplain have deteriorated over time, why they deteriorated the way they did, key actors in this landscape who

could or should have stopped the deterioration, the efficacy of attempts already made to rehabilitate the canals, and the outcomes of the process to-date. In essence, the narrative that constitutes a large part of the paper emerges out of an involving process of interacting with people on the floodplain, observing and reconstructing how the canals are used daily and seasonally, and capturing the local people's views as they explain what they think should have happened to enable better resilience and adaptive capacity of the whole socio-ecological system.

Use of multiple research methods and tools enabled us to obtain a relatively comprehensive picture of the situation on the ground as well as to cross-check the data generated. While relevant data and information pertaining to the whole floodplain was collected, focus group discussions were held with people in the villages of *Lealiu*, *Nanikelako* and *Lower Mwandi* to enable deep analysis of the key issues. Each group was constituted by about 30 people disaggregated by gender and age. Using semi-structured questionnaires, we interviewed 60 purposively selected respondents from among the communities living on the floodplain, officials from national and local government, as well as other development agencies active on the floodplain. The list of respondents in this survey included the Barotse Royal Establishment (BRE) Chiefs and Village Heads, central government representatives such as the Harbor Master, officials from the Water Affairs Department, Central Statistics Office, Ministry of Agriculture, Meteorology Department, Disaster Management Committees, and Concern Worldwide. These respondents were targeted because they have been playing an active role on the floodplain in one way or another for a long time and therefore, they were likely to be able to provide us with a comprehensive picture of the canal management situation on the ground as well as proffer useful recommendations. The questionnaires were analyzed using excel spreadsheets. Our analysis of empirical data was mainly informed by an analytical framework we adapted from Ratner et al. (2012) which disaggregates resource governance into a few key components as shown in Table 1.

Transact walks and boat drives across the floodplain enabled the researchers to visit and observe the current state, use and management arrangements on five canals on the floodplain. These are the *Muoyowamo*, *Musiamo*, *Lubitamei*, *Fisheries*, and the *N'gombala* canals. We focused on these five because they are

Table 1: Dimensions of resource governance.

Dimension of governance	Key questions
Stakeholder representation in decision-making	Which actors are represented in decision-making and how are local communities' voices included?
Distribution of authority and proprietorship over the resource	How is formal and informal authority distributed in decisions over resources and who owns the resources?
Mechanisms of accountability for poor resource management	How are holders of power held accountable for the impact of their decisions over resource management and to whom are they accountable?

Source: Adapted from Ratner et al. (2012).

considered to be the biggest (and therefore main) canals in the area while the rest are smaller and less significant in terms of the biophysical goods and services they provide to sustain livelihoods on the floodplain. Our search for relevant published literature revealed that the majority of scholars who have directly addressed canal management have done so in the context of irrigation systems as opposed to having a specific focus on floodplain canals (e.g. see Baxter and Laitos 1988; Wichelns 1998; Meinzen-Dick et al. 2000; Nkoka et al. 2014).

In the absence of scholarship that directly addresses management of floodplain canals, we embraced insights from scholarship focusing on other resource sectors such as irrigation systems, forestry and wetlands, from a CBNRM analytical stand-point, to try and identify options for improving the institutional arrangements for management of canals on the Barotse floodplain. We understood CBNRM to be an approach involving specifically defined groups of local people collaborating on use and management of natural resources (Murphree 1991; Anderson and Mehta 2013; Borrini-Feyerabend et al. 2013; Nkoka et al. 2014). It is '*community-based*' in that the communities managing the resources have the legal rights, the local institutions, and the economic incentives to take substantial responsibility for sustained use of these resources (Measham and Lumbasi 2013). We felt that such an approach would be useful to the crafting of effective institutions for canal management and improved socio-ecological resilience on the floodplain.

3. Theoretical dimensions of governing the commons

While published literature on institutional design considerations for floodplain canal management in Africa is limited, we still need to know what scope there is for deliberate and systematic institutional analysis and design to produce more useful common pool resource governance regimes. In this paper, we acknowledge that an understanding of the power dynamics between and among various actors together with the local institutional arrangements for floodplain canal management is vital. Power dynamics determine who makes the decisions that affect access to the resource as well as its management. They also reflect how and for whose benefit decisions are made regarding the common property resource (see Abel and Blackie 1986; Alexander 1992; Seiderman et al. 1992). Thus, development of institutions that empower local communities is seen as a prerequisite for enabling the emergence of appropriate proprietorship arrangements that may lead to sustainable resource management.

The foregoing suggests that we should start asking questions about how communities on the Barotse floodplain and similar ecological systems elsewhere can better manage their canals more effectively. Finding answers to such questions could enable the communities involved to increase their resilience to changing environmental and societal circumstances. Resilience theory tends to emphasize community adaptive capacity and cycles of change that interact across several scales (see Gunderson and Holling 2002). When the search for resilience is cou-

pled with the search for more effective resource governance systems, it becomes important to recognize both the designed and self-organizing components of communities and how they interact with their ecological resources. We are convinced that addressing these issues enables us to better understand attributes of institutions that are more likely to lead to the creation of more robust socio-ecological systems.

Consistent with most of the scholarship from institutional economics and related academic disciplines, we consider *institutions* to be a core component of governance systems that must be conceptualized in a much broader sense than just organizations. This includes the formal and informal ‘rules of the game’ or the policy and legal frameworks, and administrative and organizational arrangements that determine access to and use of available resources (see March and Olsen 1989; North 1990; Ostrom 1990; Haller 2002; Saleh and Dinar 2004). At the same time, local communities tend to share power (and are therefore empowered) through consensus decision-making processes even though ultimate authority may continue to rest with government agencies.

In our view, the chances of success can be enhanced by transparent decision-making processes. Therefore, an institutional framework that legitimises the involvement of local communities in resource management and their proprietorship over the resource in question should be seen as the absolutely necessary ingredient for success. This perspective finds common ground with the work of Elinor Ostrom who dedicated most of her life to the study of common property resources and developed what she called ‘*design principles*’ that may now be used to inform the crafting of canal management institutions and, indeed, the governance of any other common pool resource for that matter.¹ On the basis of detailed analyses of many different case studies where there were real or potential conflicts between individual users of common pool resources, Ostrom identified the potential benefit of new governance mechanisms that support the development of mutual trust and cooperation amongst actors, with the state’s role shifting from control to facilitation (see Ostrom 1990, 1999, 2009).

4. Study findings

4.1. Biophysical aspects of the floodplain

The Barotse floodplain is a big seasonal water storage reservoir whose outflow is controlled by the rapids at Sioma Falls, some 50 km downstream of Senanga (Flint and Monde 2006). It covers four of the six districts in the Western Province of

¹ Ostrom’s design principles include clearly defined boundaries for access and use of resource that effectively exclude external unentitled parties from accessing the resource in question; rules regarding the appropriation and provision of common resources are adapted to local conditions; collective-choice arrangements that allow most resource appropriators to participate in the decision-making process; and graduated sanctions that are put in place for resource appropriators who violate community rules (Ostrom 1999).

Zambia, namely Kalabo, Lukulu, Mongu and Senanga (Lewanika 2001; Emerton 2008). It is about 160 kilometres long and 60 kilometres at its widest point and nearly 900 metres above sea level (Chileshe and Pollard 2008). It covers an estimated 550,000 hectares while the total wetland covers about 1.2 million hectares. The area is flooded by the Zambezi 3–5 months per year, from December to May (Lewanika 2001). Therefore, the ecological characteristics and conditions of the Barotse floodplain, as well as the human production systems it supports, depend largely on the timing and duration of the annual floods (Timberlake 1997).

The main wet season runs from November until March with precipitation ranging from 600 mm to 1400 mm, increasing towards the source (Flint and Monde 2006). Inundation of the floodplain depends mainly on rainfall in the upper catchment and on seepage from the uplands. The maximum flood level is attained in April, after which floodwaters gradually recede from May to July (Simwinji 1997). Towards the end of the dry season (September–October), the floodplains become virtually free of surface water. However, once the rain season starts in November, floods occur and cover the entire floodplain. During this time the only means of transport for people is by boat (Leonard 2005).

4.2. Livelihoods sources on the Barotse floodplain

We held detailed discussions with communities through focus group discussions. Our findings revealed that most of the households on the Barotse floodplain rely on a mixed livelihood strategy which is constituted by livestock rearing, crop production, fishing and natural resource exploitation. Table 2 presents the main commodities cited by respondents as constituting the main pillars of the Barotse floodplain economy.

In addition to the products mentioned in Table 2, the people on the floodplain also make use of a wide range of wetland plants, animals and natural resources for their daily subsistence and income. A less documented but quite important component of the livelihood system of communities living on the floodplain though is the network of canals that criss-crosses the floodplain. While the larger river channel remains navigable at all times, smaller channels usually become clogged with plant growth and silt. In most cases, these canals play a major role in ensuring low-cost transport of bulk commodities and people from the hinterland harbours of the Zambezi floodplain. The canals are also very important for irrigation,

Table 2: Main commodities constituting the Barotse floodplain economy.

Crop based commodities	Livestock based commodities	Fisheries products	Forestry based commodities
– Rice;	– Cattle;	– Fresh fish;	– Timber and Timber Products;
– Maize;	– Goats;	– Dried Fish.	– Honey;
– Cassava;	– Pigs;		– Reeds and Papyrus Products.
– Sorghum.	– Chicken.		

drainage, fisheries and cultural activities for communities on the floodplain. The *Muoyowamo* Canal, for instance, is used during the famous *Kuomboka* ceremony that marks the migration of the Lozi king and his people to higher ground during annual flood events.

Communities have adapted to the negative impacts of annual floods in the Barotse floodplain by building homes on mounds and relocating to their second homes on higher ground when their homes on the plain become submerged. However, in recent times, livelihoods have been increasingly disrupted by unpredictable floods, extended periods of drought and intense rainfall, as well as changing socio-economic patterns. Large sections of the traditional canals built in the late 1880s have become heavily silted, thereby affecting agriculture and fisheries production (GRZ 2011). Fields are now easily flooded and crops are destroyed because water no longer flows smoothly through some of the canals. Houses are also sometimes swept away by the floods and as a result, most of the people on the floodplain do not build permanent housing structures. It is clear that changes in the flooding patterns are negatively affecting livelihoods security among the communities on the floodplain and addressing these challenges effectively is now a matter of urgency.

4.3. Canal maintenance on the Barotse floodplain

Prior to independence, maintenance of the canals was managed by the Barotse Royal Establishment (BRE), relying on their traditional authority. After independence in 1964, canal operation and maintenance was delegated to the Department of Water Affairs, who subsequently mechanized the maintenance process (BRL ingénierie and NIRAS 2013). In 1991, responsibility for operation and maintenance of the canals was transferred to the Department of Maritime and Inland Waterways in Mongu. This was also the time when Zambia was undergoing economic structural adjustment programs and thus, funding for many public works was significantly reduced. The budget cut led to a major reduction in the clearing and dredging of the canals (ibid). Officially, the Department of Maritime and Inland Waterways, represented by the Harbor Master and his team, has the responsibility for the operation and maintenance of 3000 km of canals and waterways located in the entire Western Province (DDMC 2012).

Most of our respondents indicated that due to resource limitations, the maintenance of navigation canals has now been limited to 'spot-dredging' which concentrates efforts on the critical points of the main navigation canals (mostly sand-banks blocking navigation) and not on the whole stretch of the canals. Maintenance of agriculture (drainage) canals has been delegated to communities on the floodplain but under the supervision and support of the District Disaster Management Committees (DDMC). However, there is no financial support from the government. The DDMC is presided by the District Administrator and consists of members of different government departments, NGOs such as Concern, Oxfam, and Keepers and the Barotse Royal Establishment. In Table 3, we present the list of main canals in the study villages and their current state.

Table 3: List of canals in the study villages and their current state.

Canal	Current State
Bulolo	Not cleared. Currently clogged and blocked
Ikatulamwa	Last cleared in 2011
Kalamba	Not cleared. Currently clogged and blocked
Likomokelo	Not cleared. Currently clogged and blocked
Litakala/Mutondo	Not cleared. Currently clogged and blocked
Malile	Not cleared. Currently clogged and blocked
Nakaliko	Not cleared. Currently clogged and blocked
Sekeli	Not cleared
Lubitamei/Nalului	Adopted into the PPCCR
Mitondo	Not cleared
Musiyamo	Adopted into the PPCCR
Moyowamo	Always cleared because it is used during the Kuomboka ceremony

Table 3 shows that most of the canals are now clogged and blocked. This poses a serious threat to food security within households. As the entire canal network cannot be maintained with the available human and financial resources, the Harbor Master concentrates his interventions on the maintenance of canals and waterways that are navigable in the Western Province. Thus, most of the canals on the Barotse floodplain are not used for navigation. Their maintenance is now done manually by the community members using the canals under the supervision of the Village Headmen. Maintenance and operation of the main canals has been funded under the food-for-work program. Ordinarily, the maintenance of the canals should consist of annual clearance through removal of weeds and sand deposits; annual removal of sand brought by the lateral catchments; removal of sand deposits from eroded banks at the junction of canals and rivers; and reshaping of the canals after every 10 years, corresponding with removal of 20 cm silt on the whole bed (inclusive of the side slopes). These works are generally undertaken after the recession of the annual flood and before the start of the rainy season.

The efficiency of the manual clearing method varies widely depending on the motivation and the effectiveness of local management arrangements. It also depends on the size of the canal and duration lapsed since the last clearing. Manual clearance of canals is supposed to be undertaken annually to reduce clogging and enhance drainage. Manual clearance of canals which have not been regularly maintained annually is difficult and requires additional resources. Clogged canals negatively affect livelihood activities such as agriculture, fisheries and navigation. The DDMC encourages the local communities to clear the canals on a self-help basis. Despite that, people demand to receive a compensation for large scale work. For important manual canal clearing, the community is paid in cash or receives 'food-for-work' in the form of mealie-meal. Nevertheless, not all canals are cleared through this approach. Main focus is given to the navigation canals that tend to have an economic benefit, for example, the Mongu-Kalabo waterway which goes to Angola is regularly cleared to ensure trade between Angola and

Zambia. *Moyowami* canal also gets to be cleared because it is the one used for the prestigious Lozi *Kuomboka* ceremony which attracts tourists and is of greater cultural value.

In the early 2000s, the increase in degradation of the canals became quite evident. The DDMC took the lead in supporting the local population to maintain the main canals. They provided tools and food for work but clearance of the main canals remains inadequate (BRL ingénierie and NIRAS 2013). The consequence of poor maintenance of the agricultural canals is that they rapidly got clogged with silt and vegetation, which prevented water from flowing smoothly. The canals can no longer fulfill their drainage function and this has resulted in water-logging of the soils, especially close to the *Musiamo* canal. Agricultural production also decreased significantly in the affected sections of the floodplain.

Our observations on-site also revealed that during floods, boats and canoes are the main means of transport in between the villages. During the dry season they are also used to cross the canals and rivers. Despite having been dredged several times, most of the canals are sometimes not navigable during the dry season because of insufficient water levels. Some are too shallow to be navigable all year long, even when using canoes. Currently only 10 km of canal are navigable all year round in the area. Poor maintenance of canals also makes it difficult to transport farm produce to the main markets. During our fieldwork, a number of variables were identified as the main drivers of change in the Barotse floodplain system. In Table 4, we present the responses we collated from the focus group discussions that reflect community perceptions about the main drivers of change on the floodplain as well as their anticipated impacts.

Some of the issues presented in Table 4 have a direct bearing on resource governance and socio-economic resilience on the floodplain. National level policy shifts, for instance, had a direct negative effect on canal management on the floodplain.

4.4. Stakeholder perceptions regarding canal management

In this section, we present some of the major perceptions of the stakeholders we interviewed during the study. These perceptions are also consistent with findings from the literature review and direct observations we made during the study. We started our interviews by asking and confirming whether or not the respondent was familiar with the existing management arrangements for the canals on the Barotse flood plain. From a total of 60 respondents, almost all of them (98.3%) indicated that they were familiar with the existing management arrangements for the canals. Only 1 person said that he was not familiar. We asked the interviewees whether or not there were any currently existing restrictions on community members' access to and use of the canals. 91.7% of the respondents indicated that they were not aware of any existing restrictions. They however, also pointed out that there is a body of rights and responsibilities derived from customary law to guide the use of the canals by all communities on the Barotse floodplain. We requested

Table 4. Main drivers of change on the Barotse Floodplain.

Driver of change	Pertinent characteristics and trends on the floodplain	Current and anticipated future impacts
1. Climate change	<p>Irregular rainfalls, flooding, higher temperatures</p> <p>National response to climate change to strengthen 'resilience'</p>	<ul style="list-style-type: none"> • Increased risk of crop failure; • Destruction of infrastructure; • Loss of livelihoods and household assets; • Low Mitigation of flooding on the floodplain. • Increased disease burden. • Improved information flows; • Investment in infrastructure (roads, bridges, canals); • Investment in community-based adaptation that includes agriculture.
2. National policy changes	<p>Decentralized development planning</p> <p>Natural resources management re-centralization</p>	<ul style="list-style-type: none"> • Improved development planning based on local development committees. • Existence of multiple uncoordinated structures for resource management; • Parallel policy and decision-making spaces such as those of the BRE, the donor community and NGOs. Participants stated that "<i>despite their best intentions, these mechanisms also contribute to community marginalization</i>"; • Misalignment between existing governance structures at local level and national structures; • Lack of coordination between national and local development agencies; • Reduced participation of locals in natural resource management; • Unclear ownership of resources and management responsibility; • Physical and institutional deterioration of canals and their management; • Ineffective coordination of responses led at local level; • Community members having less commitment on canal management responsibilities; • Dependency syndrome at community levels caused by a history of food-for-work; • Lack of appropriate governance tools; • Absence or ineffective Community Based Disaster Management Committees. • Lack of shared responsibility towards canal management; • Difficulties in canal maintenance due to high levels of siltation.

Table 4 (continued)

Driver of change	Pertinent characteristics and trends on the floodplain	Current and anticipated future impacts
3. Political changes	<ul style="list-style-type: none"> - Conflict between BRE and other authorities; - Institutional intransigence and 'resistance to change'. 	<ul style="list-style-type: none"> • Hierarchical and top-down governance through BRE; • Delays and interruptions of national programs; • Low external investments; • Renewed interest in Lozi culture and heritage; • Isolation from national development.
4. Agricultural and land use changes	Agricultural diversification	<ul style="list-style-type: none"> • Improved availability of agricultural inputs and services beyond maize; • Changes in agricultural market chains (FRA, private sector); • More attention to different agro-ecological zones.
	Deforestation	<ul style="list-style-type: none"> • Soil and environmental degradation;
	Permanent pastures	<ul style="list-style-type: none"> • Loss of livelihoods and food sources. • Soil and pasture management challenges; • Need for fodder;
	Changes in staple crops	<ul style="list-style-type: none"> • 'Fencing out' the poor. • Uncertain future for maize (due to policy changes);
	New crops (rice ...) and livestock (pigs, goats, poultry)	<ul style="list-style-type: none"> • Possible re-emphasis of cassava, sweet potato, sorghum, millet. • Land and water competition;
	Expanding fishing effort	<ul style="list-style-type: none"> • Labour constraints for the poor; • Loss of habitat, biodiversity and wild foods; • New livelihood and income opportunities. • Overexploitation of fish stocks; • Destruction of breeding areas; • Increasingly difficult management challenge.

them to indicate to us who they think is currently responsible for managing the canals? Table 5 summarises their responses.

The responses presented in Table 5 indicate that most of the stakeholders believe that government is responsible for managing the canals. We further probed for the interviewees' perceptions about the effectiveness of the existing canal management arrangements. Only 10% of the respondents felt that the canal management arrangements are very effective; 20% of the respondents felt that the canal management arrangements are somewhat effective; and 70% of the respondents felt that the canal management arrangements are not effective at all. We also asked the respondents about who they felt is likely to manage the canals more effectively than is currently the case. Table 6 summarizes their responses.

Table 6 shows that the interviewees' responses are relatively within the same range. This suggests that all the key actors have a key role to play in canal maintenance and management and therefore, any effective arrangements for the maintenance have to take this into account. We asked the respondents to give us their perceptions about the overall physical condition of the canals now compared to 15 years ago. Table 7 summarizes their responses in this regard.

From the responses presented in Table 7, it is clear that an overwhelming majority of the respondents felt that the canals have deteriorated significantly compared to their physical condition 15 years ago. We then asked a follow-up question to find out the main biophysical reasons for the deterioration. 96.7% of the respondents stated that siltation was the main cause for the canal deterioration while 3.3% of the respondents indicated that they were not sure. The respondents were asked to give their perceptions regarding the main governance-related reasons for the deterioration of the canals. Table 8 presents a summary of the main factors that were raised by the respondents.

Table 5: Actors responsible for canal management.

Variable	% of responses
Government agencies	55.0
Local leadership structures	10.0
Communities	5.0
A combination of government and communities	30.0

n = 60

Table 6: Perceptions about effective canal management.

Variable	% of responses
National government	20.0
Local leadership structures	25.0
Users/Communities	25.0
A combination of these three	30.0

n = 60

Table 7: Perceptions about the physical condition of the canals.

Variable	% of responses
No major change to the canals since 15 years ago	3.3
Canals now in a better condition	0.0
Canals have deteriorated significantly	93.3
Not sure	3.4

n = 60

Table 8: Perceptions about governance-related causes of canal deterioration.

Variable	% of responses
Poor coordination across institutions	73.3
Takeover by government departments	76.7
Lack of user participation	85.0
Insufficient funding	51.7

n = 60

The responses in Table 8 indicate that there are several governance-related causes of the canal deterioration. In essence, several governance factors are significant enough to affect the biophysical condition of the canals. When requested to indicate the key actors in this landscape who could or should have stopped the deterioration of the canals, 96.7% of the respondents stated that government departments in cooperation with local leaders and communities are the key actors. Sixty percent of the interviewees stated that so far attempts already made to rehabilitate the canals have been ineffective. As a result, more and more sections of the canals are getting clogged. They also pointed out that even though there have been increasing interventions by some donor agencies, the impacts of the canal deterioration on livelihoods are quite significant. 96.7% of the respondents argued that there has been a significant increase in the vulnerability of the socio-ecological system as a whole due to the deterioration of the canals.

We requested the respondents to suggest ways of improving the management and governance of the canals in the foreseeable future. Table 9 presents a summary of the main suggestions made.

Table 9: Stakeholder suggestions on how best to manage the canals.

Variable	% of responses
Ensure active user participation and ownership of the canal infrastructure	85.0
Government should act as facilitators and funders rather than active implementers of canal management operations	88.3
Government should embrace the contribution of donor agencies to canal maintenance	65.0
Government should allocate more financial resources for canal maintenance	75.0

n = 60.

4.5. Institutional dimensions of canal management

Findings from our fieldwork show that canal management on the Barotse floodplain is located within a broader geographical and political system that must be understood if the adaptive capacity and resilience of communities in the area is to be improved. Several agencies from the public sector and civil society are now involved in the maintenance and operation of canals with the result that proprietorship over the canals has become hazy and diffuse. Our findings also indicate that most of the institutional constraints to canal management on the floodplain are related to their ownership. Originally, the canals were designed, implemented and maintained by the BRE. The communities on the floodplain and their associations fall under the direct authority of the BRE. Before independence, this traditional structure controlled and managed all local resources with limited contribution from the State even though the BRE had the support of the whole population on the floodplain.

From 1964, canal management was mostly taken over by the Zambian Government through the Department of Water Affairs. The transfer of this responsibility from the local level to Government institutions has left very little incentive for communities to be involved in natural resource management. In this landscape, most of the main constraints seem to be centred on legislation, tenure, and ownership of the resources. It is also clear that delegating maintenance of agricultural canals to the local population without sufficient financial support left a gap that non-governmental organizations (NGOs) ended up trying to fill. However, the local community, government departments and the NGOs have not been able to develop an effective management plan for the whole canal network, hence the continued deterioration. It is clear that over time, the rehabilitation, maintenance and use of the canals on the Barotse floodplain has involved a multiplicity of uncoordinated stakeholders that include Government departments, the BRE, DDMC, local and international funding agencies, NGOs and local communities. This also reflects the multiple uses of the canals.

Out of the full range of stakeholders active on the floodplain, there are some who are already playing a key role or have the potential to play a major role in the operation and maintenance of the canals. However, responsibilities for canal operation and maintenance and financial procedures are not well defined. Interventions focusing on the maintenance of the canals are often reactive and not planned well in advance and thus, there is lack of proper planning. Impact of interventions depends on each individual institution's priorities (BRL ingénierie and NIRAS 2013). Government departments sometimes collaborate with NGOs that, in turn, serve as facilitators in the operation and maintenance of the canals.

4.6. The Barotse Royal Establishment

BRE is the governing body of most of the Western Province traditional institutions. It is essentially an informal system of governance based on the norms and values of the Lozi people. Chileshe and Pollard (2008) state that the BRE requires

special mention because of the relative autonomy that it has enjoyed in managing its own affairs as well as its long standing traditional leadership. Its separation in the earlier years of colonial rule as a British protectorate contributes to its continual legitimacy in the Western Province. It draws its mandate from the Barotse agreement of 1964 which includes general traditional governance, natural resource management and conservation and local taxation (Thole and Dodman 1997). Though generally believed, it is not explicitly written that canal operation and maintenance falls under its responsibility (ibid).

The BRE structure is hierarchical and has about six levels of governance. The supreme body of the BRE is the Barotse National Council which is headed by The Litunga. The next level is the *Kuta* which operates as a court followed by the *Ngambela* (prime minister). There is then the district level BRE representative known as the *Induna* and sub-district BRE representative called the *Silalo Induna*. The village Headman represents the BRE at the village level (Simwinji 1997). The local induna is directly responsible for the management of natural resources such as wetlands and canals. His main functions include advising the *litunga*, chiefs and citizens on all issues pertaining to natural resources and planning, controlling and monitoring the utilization of natural resources (ibid). He is therefore, a key figure in the management of canals. Overall, the BRE's activities include provision of guidance on canal development and maintenance policy, mobilization of the users for canal maintenance, and supervising the actual maintenance of village canals through its various administrative structures (Chileshe and Pollard 2008).

The local customary natural resource management legal system is based on five cornerstones which also govern the canals, namely, *milao* (laws), *liswanelo* (body of rights and responsibilities), *lituekelo* (rights of a particular position), *mikwa* (ways of doing things) and *mulatu* (a wrongdoing). During the pre-colonial period, the Lozi implemented policies and legislation that encouraged sound management of the natural resources and canals on the floodplain based on these five cornerstones (Flint and Monde 2006). Kokwe (1995) points out that there are fine examples of how traditional authorities managed to control the use of natural resources, including wetlands. Indeed, the Lozi are recognized for their unique traditional methods of wetland cultivation and sustainable resource management practices (Lewanika 2002).

Since the assumption of resource management responsibility by central government, concerns have been expressed regarding the negative impacts of increasing centralized authority on this system that was previously effective at the local levels. Nevertheless, the traditional authorities still have comparable (if not more) powers than central government to regulate access and use of resources in their localities (see Flint and Monde 2006; Emerton 2008). Results of the focus group discussions and key informant interviews also confirmed that the BRE is a symbol of community interests in the Barotse floodplain. Most of the respondents agreed that the support, and sometimes the mere presence, of the BRE will guarantee community cooperation. Therefore, control over local resource use must remain with the people and the BRE while external agents play facilitatory and advisory

roles. During the focus group discussion, we also requested the respondents to map for us the resource governance leadership landscape on the Barotse floodplain. The results are as displayed in Figure 1.

4.7. Proprietorship and institutional challenges

Discussions with our key informants revealed that there are a number of institutional challenges that affect perceptions about proprietorship over the canals. For example, the Department of Maritime and Inland Waterways prioritizes navigation canals at the expense of all the other canals. It also does not distribute sufficient funds for maintenance regularly. This is often interpreted as a lack of interest and commitment. Central government does not allocate sufficient resources for operations to the BRE. This has left it financially constrained and therefore, unable to sufficiently fund canal maintenance. The Disaster Management and Mitigation Unit maintain canals through food-for-work contracts, but they target food insecure wards, and not prioritized areas or canal reaches for maintenance. Within the wards, the Village Headmen, Satellite Disaster Management Committees (village level) and DDMC orientate the maintenance towards their priority reaches.

NGOs are involved in canal maintenance within the context of their support to local communities. However, they only maintain the canals in communities with whom they are able to forge partnerships, rather than based on prioritization of hotspots requiring urgent maintenance. There has been a gradual but consistent decline in the sense of ownership of the canals among the communities. They now often demand food or funds from government and other external agencies as a pre-condition for their involvement in clearing canals even though

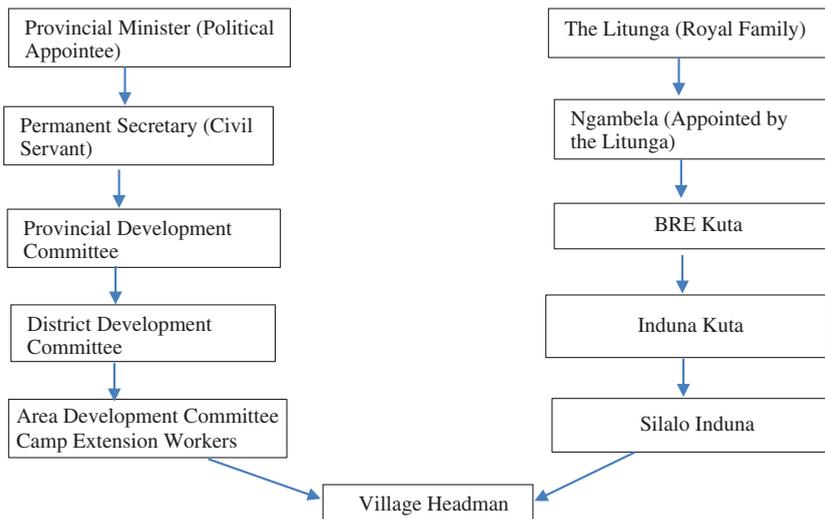


Figure 1: Parallel leadership structures on the Barotse floodplain.

they are the main beneficiaries of well-maintained canals. Locally, communities located downstream also depend on the maintenance that is done by communities upstream. Thus, when a community does not do its own part of maintenance on a canal, other communities along this canal may suffer from the consequences. Collaboration between relevant ministries is very weak. In the same fashion, there is very little synergy between departments. For instance, the Department of Maritime and Inland Waterways is unable to mobilize other relevant government departments and agencies to leverage available resources for canal operation and maintenance.

Almost all the responsible institutions have neither a canal management master-plan nor a specific institutional strategic plan that includes canal operation and maintenance. In the absence of these plans it is not surprising that there is no alternative investment plan for the canals. Instead the practice of over-reliance on government funding continues even though the funding is clearly inadequate. No record of canal maintenance is kept and no reporting is done of the corresponding disbursements, except for DMMU that keeps records of the relief maize distributed. In the face of all these challenges, one can conclude that there is a real need for systematic planning to enhance canal maintenance on the Barotse floodplain as well as proper coordination among the key stakeholders. Clear chains of responsibility and proprietorship should also be established. Creation of a canal operation and maintenance plan and a coordination organization consisting of representatives of all the main stakeholders could enable the realization of this ideal situation.

5. Discussion

Our findings indicate that the Lozi people have preserved strong traditional management systems under the guidance of the BRE. As such, any interventions designed to build their adaptive capacity will need to carefully consider the prevailing social and environmental conditions and also get full endorsement of traditional and local authorities. The erosion of power of traditional authority in the country and Barotseland in particular has left local communities disoriented and ready to abandon their traditional responsibilities that included ensuring strict observation of sustainable customary resource access and use practices. Thus the tension between government officials and traditional authorities over leadership roles at the local level is quite remarkable.

Our findings suggest that even though the BRE and government departments may often work at cross purposes, the relationship between them is quite dynamic. In many instances, there is tension between the two, but in other cases they cooperate. For instance, the government is always involved in the annual *kuomboka* ceremony organized by the BRE. These institutional dynamics have a bearing on how canal governance and management may be improved on the floodplain. It is clear that both government and traditional leaders have to be involved in the planning processes for canal governance and management, and such engage-

ment may enable both groups to agree on areas of leadership and recognize each other's responsibility. Such engagement also presents the opportunity to address challenges arising from the tensions between parallel authority systems as well as to craft more robust institutional innovations for resource management on the floodplain.

The foregoing suggests that any systematic analysis of the institutional dimensions of canal governance on the Barotse floodplain and elsewhere must assess how national policy ultimately affects resource proprietorship and ownership at the local level. In addition, interventions designed to improve adaptive capacity of the local communities need to improve coordination among the various actors and strengthen downward accountability so that the actions of government agencies respond more directly to the needs and priorities of communities on the floodplain. This also suggests that local traditional authority is an essential component of adaptation to climate change and variability on the floodplain because they understand local conditions and vulnerabilities far better than national governments. However, as the Barotse case study demonstrates, national government remains an important player in this landscape as this is the level where policy-making takes place and eventually affects or enables local adaptation strategies.

Overall, our findings suggest the existence of institutional structures for management of the canals in both the government and the traditional local leadership system. However, capacity for coordinated implementation of cost-effective approaches to canal management still needs to be strengthened. This requires more inclusive, stronger platforms for dialogue between key stakeholder groups as well as stronger participation and utilization of these platforms by all actors. Despite their best intentions, the existence of near-parallel decision making structures and spaces contributes to the marginalization of local communities. In turn, the communities stop actively participating in local resource management. Therefore, integrated planning for effective local resource governance involving BRE, the Government, communities, and other key players from civil society should be treated as a priority goal.

5.1. Implications for theory

Evidence from the Barotse floodplain and other parts of the world indicates that canals constitute a specific type of hydraulic infrastructure that can deteriorate rapidly if there are no systematic efforts to maintain it. Current management practices on the Barotse floodplain indicate general neglect and deterioration of the canals. The usual reaction to the neglect of canal maintenance has been a pattern of *'build-neglect-rebuild'* which, in the wake of widespread budgetary constraints, cannot be an option for the future (see Huppert et al. 2003). Persistent challenges emerging from the design, construction, operation, maintenance, and use of canals often lead practitioners and theorists to reassess the emphasis on the bio-physical in planning water conveyance systems and to stress the importance of governance systems. Special attention is then placed on organizing or re-organizing users to

optimize the economic investments made on the infrastructure. It is increasingly clear that *maintenance* has both technical and institutional dimensions that enable the canals to operate at a certain level of desired performance capacity or to restore them to a particular ideal capacity. Therefore, investment in physical capital alone is not enough. It must be accompanied by investments in social capital as reflected in robust institutional re-configurations and governance arrangements that make maintenance and management more sustainable.

The case of the Barotse floodplain is indicative of other cases where the service of national water infrastructural systems deteriorate mainly because of reductions in state financial and technical support for operation and maintenance. Examples abound in national irrigation systems (for instance, see Shah et al. 2002; Saleh and Dinar 2004; Nkoka et al. 2014). It is clear that state withdrawal of full financial support needs to be compensated for by increased activities of local water user associations (communities), to minimize deterioration of the water infrastructure. Appropriate policies to enhance the communities' organizational capacity should be instituted as they provide a useful option in the absence of state capability to monitor and enforce rules regulating local resource use.

This study has enabled us to reach conclusions regarding rehabilitation of canals in developing countries. We observed that very few examples of successful large-scale canal rehabilitation exist and the key concepts and models that may provide guidance in the near future are yet to be formulated. However, this paucity of scholarship and knowledge focusing primarily on floodplain canal management should not stop us from theorizing about possible options in this domain. We are convinced that lessons of experience from other common pool resource sectors such as irrigation canal management provide interesting and relevant insights. If we accept that canal operation and maintenance is essentially a service function involving multiple actors with different interests and constraints, then there are a few key challenges for ensuring effective governance of service delivery in this domain as rightly pointed out by Huppert et al. (2003). These include, developing or improving institutional arrangements such that they bring about effective coordination among the involved actors; designing institutional arrangements such that they provide incentives which motivate all actors in a service arrangement to be accountable to one another for provision of the agreed service; and designing the service provision process so that institutional arrangements are compatible with the existing institutional framework conditions. All these pre-conditions happen to be glaringly lacking on the Barotse floodplain.

These pre-conditions also suggest that appropriate governance models and coordination mechanisms for collective action are required to ensure that canals are managed and maintained effectively. The internal collective decision making of user associations has to function in order to make crucial decisions effectively. From the literature and the Barotse floodplain experiences, it appears that watersheds may be managed by a wide range of governmental and non-governmental actors, whose decisions influence the health and integrity of ecological systems as well as the functionality of the physical infrastructure put in place. In such a

scenario, the main challenge is to get the portfolio of actors to work together more effectively and in the process, build, manage, and maintain inter-organizational networks (in other words, to develop an effective governance system based on credible institutions).

It is also clear from the Barotse floodplain case study that inadequate maintenance of the water infrastructure has serious consequences. Indeed, the relative lack of attention by governments and international development agencies to the so-called '*maintenance paradox*' is remarkable. Our perspective on this is that local ownership (proprietorship) of the infrastructure and informed local decision-making are essential to effective resource governance. Therefore, more emphasis should be placed on *process* and the key actors involved rather than just on outputs. Ultimately, the resource users themselves should be able to determine why their initial efforts were not effective, and decide how the rehabilitation work should be re-oriented. Important issues that inevitably arise in this context include clearly defining property rights to the hydraulic infrastructure and related resources.

It is also important that public agencies implementing canal improvement projects avoid destroying the existing property relationships and replacing those with state-held property rights that alienate resource users from the facilities and remove their incentive for engaging in collective management activities. In this paper, we contend that effective management and maintenance of the canals on the Barotse floodplain will remain an illusion as long as the institutions and processes that govern the interaction of the involved stakeholders do not ensure effective coordination and motivation of these actors. There is need to focus attention on multiple actors, local context and integrated development planning on the floodplain.

6. Conclusion

This paper has demonstrated that the human and ecological systems active on the Barotse floodplain are intertwined. Due to a variety of historical social processes of change, a high proportion of people on the floodplain rely mostly on the biophysical environment for their livelihoods but do not enjoy a high degree of resilience. To date, the relationship and impact on the natural functioning of the socio-ecological system has been relatively small compared to human interactions with other floodplain ecosystems elsewhere. However, this position is increasingly coming under threat due to rising human populations and changing biophysical processes, particularly those related to climate variability and change. There are also clear indications that shifts in political authority from the local to the national level of government have led to seriously diminished and degraded canal management in the Barotse floodplain leaving both social and ecological components of the system open to neglect. The floodplain now needs careful, environmentally conscious management, and sensitive, participatory input from outside agencies to reduce vulnerability and exploit the economic opportunities that exist in the area.

Where adaptation and resilience-building is required, the main objective of specific measures taken should not only be to develop alternative strategies to replace or protect current productive activities that may no longer be sustainable in a technical sense. It also presents the opportunity to make better use of indigenous knowledge, governance systems and institutions that have helped the local inhabitants to cope with climate change over the decades. This is not to say the traditional canal management practices are necessarily efficient and environmentally sustainable. We argue that there is room for combining existing knowledge with technology transfer, skills importation and capacity building in governance and policy making both at local and national levels. Key here is the contention that inspiration for adaptation and socio-ecological resilience can and must be generated locally if adaptation measures are going to be successful.

We set out to analyse the main governance issues affecting the management of canals on the Barotse floodplain, paying special attention to the institutional dimensions of the canal governance system and the extent to which proprietorship over the canals influences the users' behaviour and the sustainability of the canals. We engaged with questions about effective canal rehabilitation and maintenance (or lack thereof); who should be held responsible for these functions; why the canals have deteriorated over time and space; and how best to address the deterioration in a more lasting manner that can improve the adaptive capacity and resilience of communities in the area.

In this respect, findings from this study have enabled us to conclude that efforts to manage the canals should be considered within the confines of an integrated livelihood system that constitutes the entire floodplain. While the need to rehabilitate or upgrade the canals in the Barotse floodplain system is not in question, it has to be done within the context of robust governance arrangements at the local level that provide lasting support to the management and maintenance of the canal system. Throughout this paper, we have made it clear that no strategy for local resource management can be expected to succeed if it does not take into account the interests of the local communities and the multitude of parties involved. Ultimately, the governance architecture for canal management on the Barotse floodplain and elsewhere should be carefully designed taking into account the need for clarity on proprietorship and active participation of the users in decision-making over the resource in question. In this way, more effective institutional configurations for resource governance may emerge.

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